BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE

Faculty of Engineering & Technology
B. Tech. - Mechanical
New Syllabus

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY) Pune.

Faculty of Engineering & Technology
Programme : B. Tech. (Mechanical) (2021 Course)

Course Structure & Syllabus
(Choice based credit systems-2021)
B.Tech (Mechanical)Semester I to VIII

Curriculum (2021-22) Manual1.

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Executive summary

Students pursuing engineering studies need to be well equipped and state of art with the latest technological trends and industrial requirements. To produce the students with high caliber and technically sound, enrichment in the curriculum content and various quality initiatives are needed. This is possible only when the students undergo studies with an updated and evolving curriculum to match global scenario.

Curriculum Development History

- In ambits of Deemed University- 2000
- Curriculum of SPPU Accepted
- First Revision in 2004
- Second Revision in 2007
- Third Revision in 2011
- Fourth Revision in 2014
- Fifth Revision in 2018 was expected

The proposed curriculum is developed to inculcate the advanced engineering skills to cope up with upcoming industrial and societal needs. Students will be imparted with advanced contents from respective field and innovative delivery methods.

To inculcate the advanced engineering skills and knowledge, branch specific courses have been introduced from the Sem – I itself. There are total 38 theory courses, 4 vocational courses, 3 MOOCs, 2 projects, technical research paper writing, no. of application software courses, no. of practical based courses, 6 Industry taught courses along with 60 days exclusive internship have been incorporated in the curriculum with 230 credits and 6500 Marks.

There will be collaboration with the prominent industries to execute the vocational courses. These industries will deliver the content and execute the hands-on session to inculcate the required engineering skills of particular course. Also, one course per semester will be entirely delivered by the expert/s from the industry of respective field for which blended teaching learning will be adopted.

Students will apply the knowledge of respective courses and develop the prototype/ model as a part of project based learning.

To give the experience of technical writing and research article, students have to develop the two projects in pre final and final year respectively and shall submit the research article to reputed journal for publication. This will inculcate research aptitude among students and will enhance the research profile of institute also. Incorporation of various practical based courses in respective discipline, will give hands on experience to students to understand the engineering concept in better way. Nowadays all practices and process in the field are being computerized and automated. Hence, it was pertinent to increase software content in the curriculum. It was demand from the industry that every engineer should be conversant with Software/Programming/Data analysis and automation process. Hence, courses to such as C, C++, Python, Machine Learning, Artificial Intelligence are added in curriculum of all discipline. Students who wish to develop their career in the IT field, significant courses related to computational engineering and application software have been incorporated in the curriculum of each discipline.

National Education Policy is insisting the Online and Digital Education and Ensuring Equitable Use of Technology. To inculcate the self-learning approach amongst the students, proposed curriculum has introduced Massive Open Online Courses to all the students to provide an affordable and flexible way to learn new skills, advance the career and deliver quality educational experiences at scale.

2. Curriculum Content

- Curriculum derived from Latin word 'Currere', which means a race course or runway on which one runs to reach a goal.
- Curriculum is the instructional and educative programme by following students achieve their goals, ideals and aspirational life.
- Curriculum is a standards based sequence of planned experiences,

  which students practice and achieve proficiency in content and applied learning skills.
- Its confidence building process.
- Its total learning experience of the individuals.
- Its interactive system of instructions and learning with specific goals, contents, strategies, measurements and resources.
- The desired outcome of curriculum is successful transfer / development of knowledge, skills, and attitude.
- Curriculum should lead to transformation of student to contributory member of the society.

We tried to develop curriculum , which will meet these concepts.

Curriculum is the outline of concepts to be taught to students to help them meet the content standards. **Curriculum** is what is taught in a given course or subject. It refers to an interactive system of instruction and learning with specific goals, contents, strategies, measurement, and resources. It is a course of study that will enable the learner to acquire specific knowledge and skills. A **curriculum** consists of the "roadmap" or "guideline" of any given discipline. Both the philosophy of teaching of the instructors as well as of the educational institution serve as two of the principles upon which a curriculum is based.

In Engineering, a **curriculum** is the combination of instructional practices, learning experiences, and students' performance assessment that are designed to bring out and evaluate the target learning outcomes of a particular course. It is the goals, assessments, methods, and materials used to teach a particular skill or subject and includes thinking under "skill.". The curriculum needs to be planned and designed in such a way so as to sequentially improve students' knowledge and skills.

Placement is an important parameter and outcome of a good curriculum, which satisfy the need of good placement. The written curriculum is a plan of what is to be taught so that the student gets good placement. For this , a variety of technical and non-technical courses that are required to complete a specific degree so as to help the student for placement are included in the curriculum. In addition to technical knowledge , it should also include social behaviors as well as content and thinking skills.

Overall, the curriculum should be such that it should develop a student in a good job seeker, good entrepreneur and also a good human being.

All the above aspects are taken care in the curriculum of **B. Tech-2021** course. This will develop different abilities in a student.

3. Curriculum Preamble

The curriculum 2021 is formed such that it will develop different abilities in a student. It a combination of blended teaching learning process in which both online and offline teaching is a part of the curriculum. In order to develop affection towards the discipline a student has selected, core discipline courses are included right from first year. This will also help to give the overall idea about the branch / discipline to the student.

Interaction with the industry is increased in this curriculum by introducing two new concepts –

1. **Vocational Course** and 2. Industry Taught Course.

Vocational Course (VC), a student will able to develop a specific skill set from the relevant people/ agency from the industry. This will add in gaining new skill sets required by the industry. Such Vocational Courses are included from Semester III to Semester VI of the curriculum. Department also design vocational course relevant for the discipline, which add practical knowledge to students. The vocational courses should be discipline specific. 4 vocational courses and 8 credits are integrated with curriculum.

Industry Taught Courses (ITC) are the courses which will be taught by the people from industry who are experts in the relevant field, either partially or fully. This will provide a scope to students to gain the latest knowledge as used in industry and also to have direct one on one interaction with the industry. This will develop a confidence among the students. Such teaching by industry experts will be as per their availability, if required online and other than official college hours also. Thus, there is a blend of online and offline teaching, knowledge from academicians as well as from industry. Total six Industry Taught Courses are included in the curriculum.

Industry Internship of 60 days at the end of Semester VI integrated with curriculum, will also add to the interaction with the industry. A student will avail his training in industry or on site or in any design office or research organization as allotted to him/by the institute. A separate logbook will be maintained by the student during this period duly signed daily by the competent authority.

Project Based Learning is a part of almost each course of the curriculum. Small projects on relevant topics will be allotted to the students as a part of term-work of that course. This will inculcate the habit of applying the knowledge learnt to solve practical problems.

Two Projects are included in two stages, one in third year (Sem V and Sem VI) and the second in final year (Sem VII and Sem VIII). Improvement in Research, thinking ability and application of theoretical knowledge to develop practical ideas is the main purpose of these projects.

Publication of a research paper is the outcome expected from the Project work and as a motivation, separate credits are allotted for this. Students are expected to write research article based on Project-I in standard journals in final year. Guide for Project -I will help in writing the research article.

To develop the self studying, self-learning skills, each student has to join the **MOOC/NPTEL** courses and will get the certification of the respective course. This will also give him/her a chance to get the knowledge from teachers from well known institutes of national repute. Three such MOOC/NPTEL courses are included each in Semester III, Semester V and Semester VII and separate credits are allotted to it.

Various new courses are introduced in the curriculum thereby introducing the current and latest technology to students. Basic Science and Engineering Science course contents are designed to match the requirement of the specific disciplines.

Number of software related to that branch/ discipline are included as part of the curriculum. This will help the students to get good placement.

Few soft courses are introduced to non-circuit branches. This will give a soft feel to such branches and also to inculcate confidence among the students.

In addition to technical abilities, a student needs to be developed as a good human being. For this, he will complete social activities in Semester IV and Sem VIII.

Thus Curriculum-2021 satisfies the requirements of National Education Policy-2021.

"Knowledge, Skill, Behavior" are the three attributes that are inculcated in a student when he completes his B.Tech. course under Curriculum-2021.

Recommendations considered

- UGC- Quality mandate
- National Education Policy (NEP)

- AICTE model curriculum
- Curriculum of International Universities
- Curriculum of Indian Universities
- Feedback from HR of industries called for placements
- Market perception

Methodologies Adopted In Designing Curriculum (2021-22)

- 19 Basic Points for design of Curriculum
- Listing of common points (credits, marks, No. of courses, common courses, industry taught courses, vocational Programmes etc.)
- Conducted series of meetings
- Conducted in depth one on one discussions with HoDs
- Planned three workshops,
- Eminent experts from Industry, IITs, IISER, NIT, SPPU, Central Universities were invited for workshops
- First workshop - Course structure, Titles of courses, Industry taught courses, Vocational Courses.
- Second workshop - Content of first and second year courses
- Third workshop - Content of third and fourth year courses- (Planned)

4. Salient features

- Total 250 contact hours teaching are incorporated.
- Credit based 38 theory courses being offered to achieve global standards of quality.
- Curriculum offers practicals to more than 80 % (~ 30 theory courses) theory courses.
- Total 230 credits (6500 marks) are offered for the entire B. Tech. programme.
- Theory courses contains 60% of courses and 20% to practical courses.
- Tutorials (6 Credits), online courses (6 Credits), vocational courses (6 Credits), projects (18 Credits), internship (3 Credits), Research Publication (2 Credits) and social activities assigned (4 Credits) contains remaining 20% of credits
- Blended education policy is adopted considering its importance. 20% courses are taught in online mode.
- Incorporation of 6 industry taught courses is one of the important and strategic step.
- Adopting 4 vocational Programmes in cooperation with industries, renowned agencies, universities will improve skillsets of our students.
- 60 days industrial internship to meet the requirements of industry.
- Including of 2 projects to enhance technical skills & self learning.
- Research paper based on Project-I will inculcate research aptitude among students.
- Project based learning practically for all courses will enhance the ability of application of knowledge and problem solving aptitude.
- NPTEL/ MOOC courses in online mode are introduced as integrated part of the course structure.
- To understand social responsibility and social activities of weightage of 4 credits are integrated part of the course structure.
- Quantitative Techniques and communication courses are introduced to enhance the analytical ability of students and address employability.
- Wide range of elective courses have been offered to provide the choice, to explore the knowledge in their domain of interest.

Salient Features

Sr. No.	UGC (Quality mandate)/ NEP2020-Recommendations	Curriculum (2021-22)
1	Learning Outcome-based Curriculum Framework (LOCF)	a) Programme outcomes and course outcomes are being made ready
2	Imparting Life Skills to Students.	a) Quantitative techniques b) Communication skills c) Bridging gap with Industry by vocational courses d) Self learning by NPTEL/PBL/Two projects
3	Social and Industry Connect	a) 6 Industry taught courses b) 4 Vocational courses c) 60 days internship d) Time and credits for social activities
4	Promotion of Research and the Creation of New Knowledge.	a) Research publications based on projects b) Project based learning
5	Blended Education	a) 15% courses in online mode b) NPTEL/MOOC courses in online mode
6	Technology Enabled Learning/Self Learning	a) NPTEL/MOOCS
7	Software Applications	a) Programme specific softwares and Software application Courses

5. Curriculum Details

5.1. Courses-Theory/Practical's/Tutorials/Units/Co-mapping and Engagement

Courses-Theory/Practical's/Tutorials/Units/Co-mapping and Engagement, University exam and internal assessment

The B.Tech. 2021 offers Credit and Outcome based curriculum with total 230 credits, required for graduation with a Bachelors' degree (B.Tech). The Under-Graduate Programme (B.Tech) is of four years duration i.e of eight semesters (two semesters/year).

Engagement of Courses:

The courses in revised curriculum structure of B.Tech. program are categorized under Core courses, Elective courses, Engineering Science courses and Basic Science courses. These courses are taught to students by engaging them through lectures, practical or tutorials by respective course coordinators. From semester I to VI, there are five (lecture engaged and assessed) courses and in semester VII and VIII there are four (lecture engaged and assessed) courses which are mandatory. All the courses have varying hours of engagement and credits. Theory lecture engagement varies between 3 hours to 4 hours/week, practical engagement varies between 2 hours to 4 hours/week for the respective courses. The contents of every course is divided into six units. Each unit can be covered in 6 hours or 8 hours depending on the total allotted hours/week of lecture engagement for the respective course. Some courses are solely practical oriented. These courses will be only engaged through laboratory sessions.

Outcome Based Curriculum:

Planning and realization of teaching and learning related to outcome-based curricular model requires that initial element shall be an outcome. It serves as a basis for defining modes of evaluation and validation of outcomes. The curriculum defines the Course Outcomes (COs) and course objectives for every course. The outcomes are assessed through various activities and evaluation of learner's performance in various examination schemes i.e Theory/Practical/Oral/Term work.

Credit Calculation:

The course credits are computed based on the teaching hours per week for that course using the formula as mentioned below.

Credits earned by the Student = Credits earned in Theory (Th) + Credits earned in Practical (P) / Oral (O) + Credits earned in Tutorial (T)

Here, as mentioned above, the credit assignment for Th/P/O/T of any course is based on number of teaching hours of that course. It is as mentioned here:

Number of Credits for Theory (Th) courses = Number of classroom teaching hours per week for that course (1:1 correspondence)

Number of Credits for Practical (P) / Oral (O) courses = Number of laboratory hours per week for that course / 2 (0.5:1 correspondence)

Number of Credits for Tutorial (T) courses = Number of tutorial hours for that course (1:1 correspondence)

Example: If a course has 4 hours of classroom teaching, 2 hours of laboratory session and 1 hour of tutorial, then the credits assigned for that course will be 4(Th), 1(P/O) and 1(T) respectively.

Examination Pattern:

A) University Examination (UE)

The pattern for theory examination is of 60:40, where the learner can earn 60 Marks (maximum) through University Examination (UE) and 40 marks (maximum) are assigned for Internal Assessment (IA). For the UE of Practical/Oral assessment, the total marks allotted are 50. The laboratory assessment is divided into three assessment heads viz. Term work (TW), Practical (P) and Oral (O). The students will be assessed through TW or P or O or combination of any of these for the courses that have practical assessment. 25 Marks are assigned to TW/P/O each, so when a learner is assessed for practical through TW and P heads, he/she will be assessed for 50 marks.

B) Internal Assessment (IA)

The Internal Assessment (IA) for the respective courses will be performed through Unit Tests (UT) and Assignments. Total two UTs of 20 marks each will be conducted and the average marks of these two UTs will be considered. Similarly, course coordinators will design the class assignments in terms of exercises, case studies, real world problems or mini projects, which the learners have to submit from time-to-time, as mentioned by the deadline of each assignment. While designing the assignment, the course coordinators will provide the assessment criteria to the learners and maximum score (marks) for the assignment as well. If there are multiple assignments, then the average of score (from score attained in all assignments) will be calculated and considered as IA marks. This way, the learner will be assessed for 20 marks (maximum) for assignments.

Hence, total marks for UT and assignments are 20 each and so, IA will be of 40 marks. The score for IA is calculated as:

IA Score attained by learner (Max 40) = Average Score attained in UTs (Max 20) + Score attained in Assignments (Max 20)

5.2. Credit Concept: Equivalence

In CBCS 2021 Course structure, the allotment of credits are as follows:

Theory class of 1 hour: 1 Credit

Practical class of 2 hours: 1 Credit

Tutorial class of 1 hour: 1 Credit

Project, Research Paper & Social Activity: 1 Credit

5.3. Vocational course

Vocational learning opportunities play a important role in skill development and employability of student. Vocational courses are ways of implementation of theoretical knowledge in the practice. The importance of vocational development can largely be summed up as the difference between theoretical knowledge vs. practical skills. The vocational courses are based on the teaching of practical skills. These courses are designed to introduce the manual skills in the professional education in addition to the theory. These courses will serve as bridge courses for professional growth and career improvement.

Aims & objectives of vocational courses:

- To provide students with technical knowledge and skills necessary for progressive education in engineering profession.
- To give a better understanding of the emerging of technology.
- To train the student with necessary skills leading to skilled personnel who will be enterprising and self-reliant.
- To enhance the skill of students for becoming self-sustained engineer.
- To reduce the mismatch between the demand and supply of skill man-power.

In this curriculum at B.Tech Programme, there are four vocational courses introduced i.e. in Semester III, IV, V and VI. The courses offered at these semesters are as per the requirement of the programme.

Methodology:

The vocational courses shall be conducted in association with the companies through MoUs. The candidate shall be provided training in the industries in respective area. The training can also be given by the company experts in the college with appropriate infrastructure. Departments can design vocational programme/course as per employability skills for an engineer of respective discipline required. The student shall have to attend the training sessions for at least 4 hours per week. The training sessions shall be organized on weekends or on the extended hours of the college timing.

A faculty-in-charge will be appointed to monitor the functioning of the vocational course as well as monitor the performance of the student for the said course.

The student has to maintain proper record of the training attended throughout the semester and submit the report on the work carried out. The record has to be checked and signed by the faculty –in-charge.

Assessment:

The assessment of the performance of the candidate for the vocational courses shall be in the form of term work and oral. The term work and oral carry 50 marks. The candidate performance shall be evaluated based on the training undertaken by the candidate throughout the semester. Student shall give presentation of skills he learned through vocational courses followed by viva. External examiner for the same shall necessarily from relevant industry.

A total of 2 credits shall be allotted per vocational course per semester.

Certificate:

Every candidate shall be awarded a certificate after successful completion of the vocational course as per the rules & regulations.

The certificate shall be jointly signed by concerned authorities of college and the company.

5.4. Industry Taught Courses

PREAMBLE:

The concept of Industry Offered Courses enables bridging of technological gaps between students and state-of-the-art technologies used current in the industry.

OBJECTIVES: To

i. Impart the state-of-art technology course existing in the industry.

ii. Expose students to application of technologies adopted by industry.

iii. Train students for solving real-world projects in respective industries by applying technical knowledge gleaned from an industry expert

iv. Make students draw benefit from the experience of veterans from industry. Knowledge sharing by industry experts.

v. Align student's mind-set towards industrial environment through the instructor from industry. Provide industry instructor lead courses.

CREDIT/HRS.:

Percentage of Industry Taught Courses in the programme = ...%

METHODOLOGY:

A) A faculty shall be appointed as course co-ordinator. Roles and responsibilities of Course coordinator are as follows:

(i) Act as a liaison between identified Industry expert and department.

(ii) Arrange schedule of lectures in consultation with identified Industry expert.

(iii) Keep record of students' attendance.

(iv) Collect feedback from students and suggest changes and modifications in lecture delivery method by industry subject expert.

(v) Keep record of Unit Test Performance and Practicals along with experts.

(vi) Organise visit to the industry relevant to the course.

B) Execution:

(i) The Identified industry expert can conduct theory classes on weekends or as per convenience of Industry experts either through offline or online mode. The courses which are to be taught by expert from industry are already identified and confirmed in workshop-I

(ii) Practical sessions will be conducted by course coordinator. Panel of experts from Industry shall be identified to teach the course before the commencement of the respective semester and submitted for the approval of the Head of the Institution with financial layout.

BHARATI VIDYAPEETH

(DEEMED TO BE UNIVERSITY)

COLLEGE OF ENGINEERING, PUNE – 411043.

Approval format for Expenditure for Industry Taught Course

Date:

Name of the Department: ____

1. Budgetary allocation for industry expert (As per Budget 2021-22) Please mention total amount (in Rupees) and other bifurcations, if made---------------- (to be filled at college level)

2. No. of Lectures (Industry offered Course wise / Subject wise) required with specific subjects:

Sr.No.	Title of the course	Name of Department	Semester	Work Load per week	Details of Industry Expert(s)				Total Remuneration
					Name & Designation of Expert	Name of the company	Contact Details	Honorarium per lecture	
1									
2									
3									

Recommendation for Course Coordinator
Recommendation for HoD
Recommendation for Principal

3. Total financial Outlay for honorarium of Faculty: (Industry taught courses-Subject wise): with number of lectures (in Hours) in UG sections

Sr. No.	Name of industry Expert	Honorarium	Financial Outlay (in rupees)
1			
Total			

Signature of HoD **Signature of Principal**

Request format-To Industry Expert

To

……

Subject: Industry Taught Course (ITC) for B.Tech (…..) , Sem-____

Dear Sir,

Greetings from Dept. of __________, Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune

Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, BV(DU)COEP an AICTE approved institution, was established in the year 1983 and is a constituent unit of Bharati Vidyapeeth (Deemed to be University), accredited (3rd Cycle) with 'A+' grade by NAAC and NBA.

In the national arena, BV(DU)COE Pune has been among top 100 Engineering Colleges of India, consecutively for five years (99th ranking in 2020) by MHRD in June 2020. It has also been ranked 20th at national level by AICTE Internshala for internships. Our reputation as India's premier engineering institution is further enhanced by being honored with the Platinum category by AICTE-CII survey. College is proud to be ranked 11th across India by the prestigious magazine India Today. DATAQUEST a leading journal, ranked BV(DU)COEP in 3rd position amongst the Top 50 Private T - Institutes of India. The college ranked 17th position in the survey conducted by Times of India in 2019.

----Brief about dept-----

The course curriculum has a multi-dimensional approach, it not only implements a dynamic, qualitative, and evolved structure and syllabus, but also incorporates a good and healthy mix of theoretical and practical exposure. In this regards the institute promotes and encourages courses in line with industry expectations and forthcoming challenges which should ease the students for undergoing industry offered courses for practical exposure of applications of Education system. This is much required to bridge the gap between Industry and Academia and by promoting industry orientation for creating a complete industry ready professional.

To fulfil these objectives, curriculum design, which will be implemented from the academic year 2021-22, B.Tech. program includes 6 courses taught by industry experts. With reference to the subject mentioned above, we request you to teach… ….. Total…… number of lectures (60 min each) are required to be delivered. A blended learning, to be offered for the students through combining online or offline teaching wherever and whichever is best possible. Therefore, I request you to send acceptance letter, mode of teaching, convenient day and time slot to teach the said course. Enclosed please find herewith standard format for reply.

With Thanks and Regards,

Sign and stamp of Head, Dept of ________

Enclose:- Course content

Reply

To

The Principal

BV(DU)

COE,

Pune.

Subject: - Acceptance for delivering/ conducting lecture of the course -------- of B.Tech(-----), Sem(---).

Ref.: - Your letter ------------------ dated-

Dear Sir,

This has a reference of your letter mentioned above. It gives me immense pleasure to accept your invitation to deliver lectures in the said course. Following will be the time-table for the lecture.

Sr. No.	Title of Course	Time	Days						
			Mon	Tue	Wed	Thu	Fri	Sat	Sun

Sincerely

<Signature >

< Name of Expert>

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COLLEGE OF ENGINEERING, PUNE – 411043.

Date:

AGREEMENT TIME-TABLE

Name of department:

Name of industry taught course:

Sr. No.	Day	Date	Time Slot

(Name & sign. of HOD with date & stamp) (Name & Sign. of Concerned Person)

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Industry Taught Courses (Assessment- Theory/ Practical)

- One course coordinator should be appointed for the course. All documents related to assessment of the course will be maintained by the course coordinator.
- Total assessment of Industry Taught Course -Theory is of 100 Marks.
- Assessment of this course consists of Internal Assessment and End Semester Exam which carry 40 Marks and 60 Marks, respectively.
- Internal Assessment consists of assignments and mini projects.
- One real world project (mini project) is considered as part of Internal Assessment.
- Students should give presentation on given topic.
- Industry expert should set question papers.
- In case of practical exam, industry expert can take oral exam (may be online) and students will perform the experiments in the presence of course coordinator in the department.

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B.Tech (Brach Name) Sem __

Title of ITC: - _________

Record of Lecture Taken

Sr. No.	Lecture No.	Unit no.	Date of Conduction	Topic Covered	No. of Students Attended	Sign

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COLLEGE OF ENGINEERING, PUNE – 411043.

Bill format for remuneration for Industry Taught Courses

(The bill should be submitted directly to the concerned department on or before 5th of every month)

1. Name of industry expert: ______________________________
   Company/Industry name:
2. Name of the Department: ______________________________
3. Remuneration for the Month: ______________________________
4.

Name of the Bank	Branch	A/C No.	IFSC

5. Contact Details: -

Email	Cell Phone No.

6. Details of lectures delivered:

Sr. No.	Title of the Course	Class	Date	No. of lectures	Total Remuneration (Rs./lecture)
	Total				

Date: ______________

____

Signature of the Industry expert

Certified that has been appointed by the ----- dept as an industry expert for the course vide order No. ____________________

dated. ____________________ has delivered ____ lectures/taken classes during the month/ Sem ____________________

and is entitled to honorarium of Rs. ____________________(@Rs. ------ /- per lecture/per day)

Course Coordinator: ____________________

____

Signature of the Head of the Department with Seal

Date:

Receipt: -

Received with thanks ₹-------- from BVDUCOE, Pune towards conduct of -------- lectures of the course ------------- of B.Tech(-------), Sem--- --.

Signature of Industry Expert

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY)
COLLEGE OF ENGINEERING, PUNE – 411043.

Payment Record
(Copy to be maintained in the Department)

Sr. No	Name of Department	Name of course	Name of Industry Expert	Name of company	Email	Mo. No	Address	Amount	Remark/ check number transaction id

Encl:
1) College voucher copy
2) NEFT/RTGS copy

5.5 MOOCs Implementation

To inculcate the self-learning approach amongst the students, proposed curriculum has introduced Massive Open Online Courses to all the students. It will provide an affordable and flexible way to learn new skills, advance the career and deliver quality educational experiences at scale.

Also, National Education Policy is insisting the Online and Digital Education and Ensuring Equitable Use of Technology.

A massive open online course (MOOC) is an online course aimed at large-scale interactive participation and open access via the web. In addition to traditional course materials such as videos, readings, and problem sets, MOOCs provide interactive user forums that help build a community for the students, professors, and teaching assistants (TAs).

BV(DU)COE Pune is having active NPTEL local chapter-partnership. Proposed curriculum has introduced three MOOCs at B.Tech Sem – III, Sem V and Sem VII with following objectives.

1. To provide e-learning through online web and video courses in Engineering by experts in the country in that subject.
2. To develop self-learning attitude in students.
3. To provide platform for knowledge enhancement of student's as per their area of interest.
4. To update students with advanced technologies.
5. To make the students more employable.
6. To prepare the students for competitive exams like GATE and also for higher studies.

Methodology of Assessment:

- Department shall publish list of NPTEL courses in every semester. Student can refer selected one of them in respective semester.
- Considering pre-requisite, proposed curriculum has provided with the various subject baskets as per the courses available.
- Students need to enroll for the course in each academic year as mentioned in the structure.

- Students need to attend all online lectures and complete all assignments as per schedule for registered course.
- Student will register and appear for exam conducted by NPTEL and shall submit the copy of course completion certificate received after passing the exam for registered course.
- Accordingly, the credits will be allotted to the student for respective MOOCs.
- Students have the flexibility to attempt the said course during the entire B.Tech Programme to earn the credits of respective MOOCs.
- NPTEL courses relevant to respective branch are only expected to select by students. Credits will not be awarded if general/ non engineering courses opted.

5.6 Project I and II

Project Stage I Objectives:

Provide help to the students

- In generating a new idea or modify existing system for solving societal, industrial and/or institutional problem.
- In review of literature that aligns with new idea and/or existing systems and clearly defining the problem
- In developing a workflow process/methodology for the desired system.
- In designing various components of the system assembly
- In developing a CAD model of the desired system.
- In writing the technical report based on the work completed

Project Stage II Objectives:

Provide help to the students

- In fabrication of the experimental setup/new system and/or purchase of standard components
- In pilot run and/or validation of new system for its performance
- In modifying the system if required to improve its performance.
- In detailed parametric studies of the modified system and analyzing the results
- In writing the technical report, research article and/or filing a patent.

Particular	Hours per week	Credits allotted
Project I stage I	2	4
Project I stage II	2	4
Project II stage I	4	4
Project II stage II	4	6

Assessment & Evaluation:

For Project-I Stage I & II		
	Assessed through	Marks
Assessment Tools	Presentation 1	10
	Presentation 2	10
	Presentation 3	10
	Continuous Assessment by guide	10
	Final Project demonstration, presentation & viva voce (University Examination)	60
	Total Marks	**100**

For Project-II Stage I & II		
	Assessed through	Marks
Assessment Tools	Presentation 1	20
	Presentation 2	20
	Presentation 3	20
	Continuous Assessment by guide	20
	Final Project demonstration, presentation & viva voce (University Examination)	120
	Total marks	**200**

Minimum number of in-sem. project presentations: 03

Parameters for evaluation of project in University examination

1. Idea of Project/Topic
2. Technical content
3. Innovation
4. Experimentation/Model development/Software development/Simulation development etc.
5. Participation as an Individual
6. Research Potential
7. Project Hardware/Software
8. Fabrication/Model/Equipment development
9. Data Analysis
10. Attendance
11. Timely completion
12. Report writing
13. Presentation

Prepare a format for report card of indicating progress, assessment and progressive evaluation of the project. This progressive evaluation record (PER) is prerequisite for university examination.

Progressive Evaluation Record (PER) shall be submitted in the department at the end of the semester and made available at time of university examination.

Format for Internal Examination for Project- I & II
B.Tech (------), Sem--------

Roll No.	PRN	Name of student	Term Work Marks			
			Presentation- I (10%)	Presentation- II (10%)	Presentation- II (10%)	Continuous Assessment by Guide (10%)

Format for University Examination for Project- I & II

Roll No.	PRN	Name of student	Parameter for assessment of project and marks for examination													Total out of 100	Any five parameters out of remaining
			Idea of Project/ Topic	Technical content	Innovation	Experimentation/Model development/ Software development/ Simulation development etc	Participation as an Individual	Research Potential	Project Hardware/ Software	Fabrication/Model/Equipment development	Data Analysis	Attendance	Timely completion	Report writing	Presentation		
			10	10	10	10	10	10	10	10	10	10	10	10	10		

Out of 13 parameters, parameters no. 1,3,4,6 & 8 are mandatory and may be considered for assessment of the project. Each parameter will carry 10 marks for Project-I & 20 marks for Project-II.

5.7 Social Activities for the Learners

A) Introduction

The prime objective of Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune is holistic development of students. The learner achieves the status as "whole" when he/she has not only achieved success in academics but also has succeeded in bringing the nation up by connecting with socially left-out elements and bringing ray of hopes into their lives. In this respect, the new curriculum encourages the learner on the social activities. In this case, student's social activities are provided by the colleges, but not limited to them. Total of four credits assigned for these activities.

B) Objectives

a) To make people create balances, so they do not only focus on academic aspects, but there can also be other aspects to have in life.

b) To build better relationship with others.

c) To create great balance with the academic aspects.

d) To learn and understand society.

e) To develop the nature of help and enhance the ethical norms for behaviors.

f) Teamwork

C) Outcome of Social Activities:

The social activities make a good impact on learners. The learner:

a) Will be able to understand the needs of society.

It enables a learner to consider the perspective of other people and understand their needs by interacting with people from diverse backgrounds.

b) Will be able to understand different perspectives and engage other cultures.

Social events develop social skills and empathy—the outward-oriented dimensions of emotional intelligence (EQ). The interactions or conversations elicited by events helps students build relationships, understand different perspectives and engage other cultures. Social events provide an opportunity to expand one's social circle.

c) **Will be able to maintain positive outlook towards life.**

With high adaptability to diverse situations and a good level of understanding of other's opinions, socially aware learners are less likely to indulge in negative behavior. They are also less vulnerable to stressful situations and have fewer chances of getting involved in undisciplined behavior. These students also have a more positive outlook on life.

d) **Will be able to maintain good emotional health.**

Social activities keep the learners sharp and mentally engaged, and this is important to prevent the onset of serious diseases like dementia or Alzheimer. Connecting with others helps keep you in a positive mood, which in turn wards off depression by improving physical health and maintaining good emotional health as well.

D) Sample list of Social Activities (not limited to them)

a) **Organizing Educational Camps**

Educational camps may be organized for the socially and economically week elements, especially in rural areas or even in the slum areas of the city, by making them aware of the importance of education and their own human rights.

b) **Tree Plantation Drive**

There are so many health benefits to having plants around – like fresher air, improved emotional state, and reduction of illness in and around the society. Tree plantation in this respect plays a crucial role. Just planting the tree is not enough but it should be made to grow to its extent.

c) **Offer Helping Hand for Martyrs Family by Fundraisers**

Soldiers fight for our country, securing our borders. They don't think of their family and sacrifice their lives for us, and what we do for them? Packages are announced every time after the death of our worriers but rarely reaches them. Families keep waiting for years. In this regard, few of these forgotten families can be visited and a small helping hand can be lend to them, to make them lead their further life peacefully. Fundraising in this respect, is a great student society social idea. It is incredible to see how people can bring positive change if they work together. The youth can make a team with an external organization to take part in a purposeful community event as mentioned above.

d) National Service Scheme

It will help in the overall personality development of a learner by participating in projects that benefit the community. This extra-curricular activity is sponsored by the Ministry of Youth Affairs and Sports.

e) Felicitations of People who have contributed to the society but now forgotten by the society

There are so many intellectuals in our society who have achieved great heights in their field, who are stalwarts in different field but never came into limelight, their contribution is not recognized. Few of these can be invited publicly or visited at individual level by making a team and felicitate to appreciate their contribution towards the society or nation. Some of these stalwarts may be like Anand Kumar who teaches underprivileged students for IIT-JEE without a penny, Shekhar Naik who is the Captain of Indian Blind Cricket Team, Ranjeet Singh Desale who even being a rural teacher, is awarded by UNESCO with Global Teacher Prize, Ritu Biyani who fought cancer, traveled across the country to spread awareness.

f) Street Play on Social Awareness

This is also typically known as “Nukkad Natak”. This form has been used to propagate social and political messages and to create awareness amongst the people regarding social issues. What is important is that the plays make the people think. The play is seen by many people of different age groups who then question and discuss the contents of the play. There have been several plays exposing the mechanism of black marketing and hoarding. Some talk of the use of political power for pressurizing people. Others highlight caste conflicts or ideas about hygiene and health. Street plays are also used to encourage literacy amongst villagers. Street plays on some of the topics like degradation of Indian media, hypocrisy, responsibility towards environmental concerns, brain drain, dilapidated educational structure, safety issues and rights for women. child labor, organ/human trafficking etc., can be thought of. The learners can participate in street play festivals like Manthan Mahotsav, the largest street play festival in India.

g) Poster Exhibition on Contributions of Heroes of India

The learners can organize an exhibition to not only display but explain the contribution of Indian Heroes who have been forgotten and remained in the book of history. Some of these inspiring heroes may be Mihir Sen, Khashaba Dadasaheb Jadhav, Anandibai Joshi – First woman doctor from India, Bhikaji Cama, Khudiram Bose, Baba and Prakash Amte etc. Such exhibitions make inspired, the youth of today's generation.

h) Waste Clean Drive

i) Educating literacy-poor societies about disposal of nature-harming objects

j) Distributing needful items for living in economically backward societies

k) Organizing early completion on national issues.

l) Cleaning of Public Places/ Traffic Management/ Police Mitra.

m) Organizing activities under engagement of people with Science and Technology.

Report of social activities conducted each student shall be prepared in standard format. Appropriate documentary evidences shall be part of report of students correspondence with respective authorities for social activities, permissions, certificates from Institutes/Organization/Local Government are essential documents for award of credits under this head.

E) Summary

Thus the interactions or conversations elicited by such social events help students to build relationships, understand different perspectives and engage other cultures and these events not only will uplift the moral of the society but also ignite minds of generations ahead to provide their support and enthusiastically participate in such activities. Such interactions will certainly provide an opportunity to expand their own social circle.

5.8 Internship

Internship of 60 days is incorporated as an integrated part of curriculum structure-2021. The primary objective of internship is to make students familiar with industry environment and to take up on- site assignment as trainees or interns in order to bridge the gap between theory and industrial practices. It is mandatory for students to undergo in-plant training after completion of semester VI in reputed industrial organization. The student shall submit the "Intern Certificate" issued by the industry organization as well as a technical report not exceeding 30 pages within the stipulated time to be eligible for making a presentation before the committee constituted by the department. On the basis of daily work carried out in the industry, student shall prepare a record book. This record book shall be checked and signed by his/her supervisor from the industry where he/she is doing internship on daily basis.

University examination carries 50 marks and after successful completion, student may be awarded 3 credits for the internship work. Standard format for record book shall be as below. Marks will be awarded out of maximum 50 and three credits will be given upon completion of internship towards the degree requirements, as per the regulations. Internship will ultimately assist students to apply theory learned in classroom to industrial practices so as to understand engineering/technical solutions in a global, economic, environmental and societal context.

5.9 Research paper publication

Research paper publication is one of the innovative features of programme curriculum- 2021.

1. It has been & introduced in 7th semester. Two credits are awarded for the same subject to publish of research paper. Student shall publish a research paper in peer reviewed/ Standard journal(not in paid journals) based on research work carried out for Project-I. Guide for Project-I shall be responsible for Writing manuscript, Selection of journal for publication, Submission of manuscript to the journal. Progress report of publication of research paper shall be prepared in standard format and submitted for the award of credits. Students shall be first author of research papers. No name either of faculty members except guide or other students shall be added without any contribution in research/project work. Format for progress report of research paper published (To be maintained by Guide). A departmental committee comprising of head of department, project guide, and one senior professor will review the progress of this activity periodically (not exceeding three months). The suggestions/comments offered by committee will be incorporated in due course of time to accomplish the task within a predetermined period.

2. Research paper publication as a integrated part of the course structure, will inculcate research aptitude among students. This will help there in seeking admissions in reputed International Universities for higher studies. Further, this research aptitude developed may enhance his employability also.

3. This activity is expected to generate 15 to 20 publication per year, which will enhance research profile of department and institute too.

4. Hence, there should be team of maximum 3 to 4 students per project except very exceptional projects. Prior permission to increase team size is essential.

Weekly progress report of the research paper publication.

Title of the project -

Name of the Guide -

Weekly schedule of meeting- Day------- Time-----

Student Details - Name--------- PRN------ Roll No.---

Sr. No.	Week No.	Date	Work completed/done by students per week

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. ***Engineering knowledge****: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.*
2. ***Problem analysis****: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.*
3. ***Design/development of solutions****: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriateconsideration for the public health and safety, and the cultural, societal, and environmental considerations.*
4. ***Conduct investigations of complex problems****: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis ofthe information to provide valid conclusions.*
5. ***Modern tool usage****: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activitieswith an understanding of the limitations.*
6. ***The engineer and society****: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevantto the professional engineering practice.*
7. ***Environment and sustainability****: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and needfor sustainable development.*
8. ***Ethics****: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.*
9. ***Individual and team work****: Function effectively as an individual, and as a member or leaderin diverse teams, and in multidisciplinary settings.*
10. ***Communication****: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and writeeffective reports and design documentation, make effective presentations, and give and receiveclear instructions.*
11. ***Project management and finance****: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member andleader in a team, to manage projects and in multidisciplinary environments.*

12. ***Life-long learning**: Recognize the need for, and have the preparation and ability to engage inindependent and life-long learning in the broadest context of technological change.*

Statements of Programme Specific Outcomes (PSOs)

PSO1:Apply the knowledge of thermal, design, manufacturing engineering and computational sciences to solve Mechanical Engineering problems.

PSO2:Apply Mechanical Engineering principles for research, innovation and develop entrepreneurial skills.

PSO3:Apply concepts of mechanical engineering to asses' societal, environmental, health and safety issues with professional ethics.

Program Educational Objectives (PEOs) of the B. Tech. Mechanical are:

Graduates will be able,

- *To fulfill need of industry and society with theoretical and practical knowledge.*
- *To engage in research, innovation, lifelong learning and continued professional development.*
- *To fulfill professional ethics and social responsibilities.*

B. TECH. MECHANICAL: COURSE STRUCTURE: CBCS: 2021

B. Tech. (Mechanical) Sem.-I

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C101	Linear Algebra, Calculus & Complex Variables	4	-	1	60	40	-	-	-	100	4	-	1	5
2	C102	Waves & Solid State Physics	3	2	-	60	40	25#	-	-	125	3	1	-	4
3	C103	Electrical Engineering Systems	4	2	-	60	40	25#	-	-	125	4	1	-	5
4	C104	Statics and Dynamics	3	-	-	60	40	-	-	-	100	3	-	-	3
5	C105	Computer Aided Drafting &Visualization*	3	4	-	60	40	25	25	-	150	3	2	-	5
6	C106	Metal Joining Processes	-	2	-	-	-	50#	-	-	50	-	1	-	1
7	C107	Soft Computing-I	-	4	-	-	-	50	-	50	100	-	2	-	2
		Total	**17**	**14**	**1**	**300**	**200**	**175**	**25**	**50**	**750**	**17**	**7**	**1**	**25**

*End Sem. Examination of 4 Hrs.; #: Based on TW & internal oral examination

B. Tech. (Mechanical) Sem.-II

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C108	Differential Equations, Probability & Statistics	3	-	1	60	40	-	-	-	100	3	-	1	4
2	C109	Chemistry of Engineering Materials	3	2	-	60	40	25#	-	-	125	3	1	-	4
3	C110	Mechanical Engineering Systems	4	2	-	60	40	25	25	-	150	4	1	-	5
4	C111	Electronics Engineering Systems	4	2	-	60	40	25#	-	-	125	4	1	-	5
5	C112	Computer Aided Machine Drawing*	3	4	-	60	40	25	-	25	150	3	2	-	5
6	C113	Sheet Metal Operations	-	2	-	-	-	50#	-	-	50	-	1	-	1
7	C114	Soft Computing-II	-	2	-	-	-	25	-	25	50	-	1	-	1
		Total	**17**	**14**	**1**	**300**	**200**	**175**	**25**	**50**	**750**	**17**	**7**	**1**	**25**

*End Sem. Examination of 4 Hrs.; #: Based on TW & internal oral examination

B. Tech. (Mechanical) Sem.-III

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C201	Thermodynamics-Principles	4	0	-	60	40	-		-	100	4	-	-	4
2	C202	Mechanics of Fluids	4	2	-	60	40	25	-	25	150	4	1	-	5
3	C203	Manufacturing Technology@	3	2	-	60	40	25	-	25	150	3	1	-	4
4	C204	Strength of Machine Components	3	2	1	60	40	25#	-	-	125	3	1	1	5
5	C205	Mechanisms of Machines*	4	2	-	60	40	25	25	-	150	4	1	-	5
6	C206	Python Programming-I	-	2	-	-	-	25	-	-	25	-	1	-	1
7	C207	Vocational Course-I $	-	2	-	-	-	25	25	-	50	-	1	-	1
		Total	**18**	**12**	**1**	**300**	**200**	**150**	**50**	**50**	**750**	**18**	**6**	**1**	**25**
8	C208	Social Activity-I**	-	-	-	-	-	-		-	-	-	-	-	2

*End Sem. Examination of 4 Hrs.; @Industry Taught Course-I; $Automobile Servicing-I; **Add-on Course

B. Tech. (Mechanical) Sem.-IV

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C209	Thermodynamics-Applications	4	2	-	60	40	-	50	-	150	4	1	-	5
2	C210	Theory of Machines	3	2	1	60	40	-	25	-	125	3	1	1	5
3	C211	Science of Engineering Materials	4	-	-	60	40	-	-	-	100	4	-	-	4
4	C212	Entrepreneurship Development Skills@	3	-	-	60	40	-	-	-	100	3	-	-	3
5	C213	Machine Design & Analysis-I*	4	2	-	60	40	-	25	-	125	4	1	-	5
6	C214	Solid Modelling	-	2	-	-	-	25	-	25	50	-	1	-	1
7	C215	Python Programming-II	-	2	-	-	-	25	-	25	50	-	1	-	1
8	C216	Vocational Course-II$	-	2	-			25	25	-	50	-	1		1
		Total	**18**	**12**	**1**	**300**	**200**	**75**	**125**	**50**	**750**	**18**	**6**	**1**	**25**
9	C217	MOOC-I**						-			-		-		2

*End Sem. Examination of 4 Hrs.; @Industry Taught Course-II; $Automobile Servicing-II; + End sem. Exam. of 100 marks; ** Add-on Course

B. Tech. (Mechanical) Sem.-V

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C301	Heat Transfer-Principles & Applications	4	2	-	60	40	25	-	--	125	4	1	-	5
2	C302	Turbo Machinery	4	2	-	60	40	25	25	-	150	4	1	-	5
3	C303	Hybrid & Electric Vehicles@	4	-	-	60	40	-	-	-	100	4	-	-	4
4	C304	Computer Integrated Manufacturing	3	2	-	60	40	25	25	-	150	3	1	-	4
5	C305	Machine Design & Analysis -II*	3	2	1	60	40	25	-	-	125	3	1	1	5
6	C306	Vocational Course-III $	-	2	-	-	-	25	25	-	50	-	1	-	1
7	C307	Computer Oriented Numerical Methods	-	2	-	-	-	25	-	25	50	-	1	-	1
		Total	**18**	**12**	**1**	**300**	**200**	**150**	**75**	**25**	**750**	**18**	**06**	**1**	**25**
8	C308	Environmental Studies+	2	-	-	50	-	-	-	-	50	-	-	-	-
9	C309	Social Activity-II**	-	-	-	-	-	-		-	-	-	-	-	2

*End Sem. Examination of 4 Hrs.; @Industry Taught Course-III; $Logistics & Stores Management; +Mandatory Audit Course; ** Add-on Course

B. Tech. (Mechanical) Sem.-VI

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C310	Introduction to CFD & FEA	4	2	-	60	40	25	-	25	150	4	1	-	5
2	C311	Refrigeration & Air Conditioning	3	2	1	60	40	25	25	-	150	3	1	1	5
3	C312	Industrial Engineering &Management@	3	-	-	60	40	-	-	-	100	3	-	-	3
4	C313	Quantitative Techniques, Communication & Values	4	0	-	60	40	-	-	-	100	4	-	-	4
5	C314	Mechanical System Design*	4	2	-	60	40	25	25	-	150	4	1	-	5
6	C315	Vocational Course-IV$	-	2	-	-	-	25	-	25	50	-	1	-	1
7	C316	Introduction to Data Science	-	4	-	-	-	25	-	25	50	-	2	-	2
		Total	**18**	**12**	**1**	**300**	**200**	**125**	**50**	**75**	**750**	**18**	**6**	**1**	**25**
8	C317	MOOC-II**						-			-		-		2

*End Sem. Examination of 4 Hrs.; @Industry Taught Course-IV; $Refrigeration & Air Conditioning Systems Maintenance; ** Add-on Course

B. Tech. (Mechanical) Sem.-VII

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C401	Industrial Automation	3	2	-	60	40	25	25	--	150	3	1	-	4
2	C402	Elective-I	3	2	-	60	40	25	-	--	125	3	1	-	4
3	C403	Production Planning & Control@	4	-	-	60	40	-	-	-	100	4	-	-	4
4	C404	Power Plant Technology	3	2	1	60	40	25	-	-	125	3	1	1	5
5	C405	Measurement & Metrology Techniques	-	2	-	-	-	25	25	-	50	-	1	-	1
6	C406	Machine Learning	-	2	-	-	-	25	25	-	50	-	1	-	1
7	C407	Project Stage-I	-	2	-	-	-	50	50	-	100	-	3	-	3
8	C408	Internship***	-	-	-	-	-	25	25	-	50	-	3	-	3
		Total	**13**	**12**	**1**	**240**	**160**	**200**	**150**	**-**	**750**	**13**	**11**	**1**	**25**

@Industry Taught Course-V

B. Tech. (Mechanical) Sem.-VIII

Sr. No.	Course Code	Name of Course	Teaching Scheme (Hrs./Week)			Examination Scheme (Marks)						Credits			
			L	P	T	ESE	IA	TW	OR	PR	Total	L	P	T	Total
1	C409	Renewable Energy Technologies	3	2	-	60	40	25	-	-	125	3	1	-	4
2	C410	Elective-II	3	2	-	60	40	25	-	-	125	3	1	-	4
3	C411	Energy Audit & Management@	4	-	-	60	40	-	-	-	100	4	-	-	4
4	C412	Reliability & Machine Condition Monitoring	3	2	1	60	40	25	25	-	150	3	1	1	5
5	C413	Project Stage-II	-	4	-	-	-	100	100	-	200	-	6	-	6
6	C414	Operations Research Practices		2	-	-	-	25#	-	-	25	-	1	-	1
7	C415	Robot Movement Systems		2	-	-	-	25#	-	-	25	-	1	-	1
		Total	**13**	**14**	**1**	**240**	**160**	**225**	**125**	**-**	**750**	**13**	**11**	**1**	**25**
8	C416	Research Paper Publication**						-			-		-		2

@Industry Taught Course-VI; #: Based on TW & internal oral examination; **Add-on Course; ***Period of 60 days

Elective-I	Six Sigma, Lean & Agile Manufacturing, Waste to Energy Conversion, Jig, Fixture & Die Design, Artificial Intelligence, Principles of Air Craft & Submarine Design
Elective -II	Industrial Product Design, Engineering Economics, Project Management & Ethics, Virtual Reality, Additive Manufacturing & Rapid Prototyping

Designation of Course	Linear Algebra, Calculus and Complex Variables		
Course Code	**C101**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial: - 01 Hours/ Week	Internal Assessment	40 Marks	
	Tutorial	-	01
	Total	**100 Marks**	**05**

Course Prerequisites:-	1. Students should have a knowledge of basic algebra. 2. Students should have a knowledge of vector algebra. 3. Students should have knowledge of complex numbers.
Course Objectives:-	To provide knowledge about 1. Rank, consistency of system of equations and partial differentiation. 2. Vector differentiation and vector integration. 3. Function of complex variable.
Course Outcomes:-	On completion of the course, students will be able to– 1. **Understand** rank of matrix and apply it test consistency of linear system. 2. **Understand** the partial derivative and evaluate indeterminate forms. 3. **Understand** vector differential operator and vector identities. 4. **Understand** line, surface and volume integrals and **apply** it evaluate to work done. 5. **Understand** the analytic functions. 6. **Understand** Taylors and Laurentz series.

Course Contents

Unit-I	Linear Algebra: Matrices	(08 Hrs.)
Rank, Normal form, System of Linear Equations, Linear Dependence and Independence, Linear and Orthogonal Transformations. Eigen values, Eigen Vectors, Cayley – Hamilton Theorem. Application to problems in Engineering		
Unit-II	**Partial Differentiation and Indeterminate forms**	**(08 Hrs.)**
Functions of two or more variables, Partial derivatives, Homogeneous functions, Euler's theorem, Total derivative, Change of variables. Indeterminate forms: L' Hospital's Rule, Evaluation of Limits		
Unit-III	**Vector Differential Calculus**	**(08 Hrs.)**
Physical interpretation of Vector differentiation, Vector differential operator, Gradient, Divergence and Curl, Directional derivative, Solenoidal, Irrotational and Conservative fields, Scalar potential, Vector identities.		
Unit-IV	**Vector Integral Calculus and Applications**	**(08 Hrs.)**
Line, Surface and Volume integrals, Work-done, Green's Lemma, Gauss's Divergence theorem, Stoke's theorem. Applications to problems in Fluid Mechanics, Continuity equations, Streamlines, Equations of motion, Bernoulli's equation.		
Unit-V	**Complex Variables**	**(08 Hrs.)**
Function f(z) of complex variable, limit, continuity and differentiability of f(z),Analytic function, necessary and sufficient conditions for f(z) to be analytic (without proof),Cauchy-Riemann equations in cartesian coordinates (without proof)Milne-Thomson method to determine analytic function f(z) when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. Harmonic function, Harmonic conjugate and orthogonal trajectories.		
Unit-VI	**Complex Integration**	**(08 Hrs.)**
Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof).Taylor's and Laurent's series (without proof). Definition of Singularity, Zeroes, poles of f(z), Residues, Cauchy's Residue Theorem (without proof).		

Assignments:

Problems and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

1. Linear algebra: matrices
2. Partial differentiation and indeterminate forms
3. Vector differential calculus
4. Vector integral calculus and applications
5. Complex variables
6. Complex integration

Tutorials:

Problems and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

1. Matrix algebra and system of linear equations.
2. Eigen values and eigenvectors.
3. Partial differentiation.
4. Indeterminate forms.
5. Fourier series; gradient, divergence, and curl.
6. Directional derivative, scalar potential and vector identities.
7. Line, surface and volume integrals.
8. Application of Gauss, Stokes and Green's theorems.
9. Analytic functions, Cauchy-Riemann equations.
10. Limit continuity and differentiability.
11. Cauchy's integral theorem and integral formula.
12. Taylor and Laurent series.

Text Books

1. P. N. Wartikar and J. N. Wartikar, "Applied Mathematics (Volumes I)", 7th Ed., Pune Vidyarthi Griha Prakashan, Pune, 2013.
2. P. N. Wartikar and J. N. Wartikar, "Applied Mathematics (Volumes II)", 7th Ed., Pune Vidyarthi Griha Prakashan, Pune, 2013.

References

1. B. S. Grewal, "Higher Engineering Mathematics", 42nd Ed., Khanna Publication, Delhi
2. B.V. Ramana, "Higher Engineering Mathematics", 6th Ed., Tata McGraw-Hill, New Delhi, 2008.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Ed., John Wiley & Sons, Inc., 2015.
4. Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Ed., Cengage Learning, 2012.
5. Michael Greenberg, "Advanced Engineering Mathematics", 2nd Ed., Pearson Education, 1998.

Project Based Learning

Students are expected to prepare report on any one topic, write its definition, applications and analyze the hypothetical data. Also, write pseudo code for it, wherever applicable.

1. System of linear equations solution
2. Rank of matrix
3. Total derivative
4. L' Hospital's Rule

5. Dimension and basis
6. Curl and divergence
7. Work done
8. Gauss divergence theorem
9. Stokes theorem
10. Eigen values and Eigen vectors
11. Bernoulli’s equation
12. Cauchy-Riemann equations in detail
13. Harmonic conjugate and orthogonal trajectories
14. Cauchy’s Integral formula
15. Cauchy’s Residue Theorem

Unit Test-

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	Waves & Solid State Physics		
Course Code	**C102**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites:-	Students are expected to have a basic understanding of physics and calculus.
Course Objective	1. To impart knowledge of basic concepts in physics relevant to engineering applications in a broader sense with a view to lay foundation for the Mechanical Engineering.
Course Outcomes:-	1. Infer the wave nature of light and apply it to measure stress, pressure and dimension etc. 2. Summarize the structure and properties of lasers to their performance and intended applications. 3. Explain mechanical properties of solid matter, and connect to applications in the field of engineering. 4. Use the knowledge of nanoscience to develop new materials with tunable properties. 5. Use analytical instruments for understanding the nanomaterials. 6. Interpret the superconductivity and perfect diamagnetism, and give a qualitative description of the Meissner effect and its applications.

Course Contents

Unit-I	Wave Optics	(06 Hrs)
Interference- Interference of waves, interference due to thin film (Uniform and non-uniform), Applications of interference (optical flatness, interference filter, non-reflecting coatings. **Diffraction-** Introduction, Classes of diffraction, Diffraction at a single slit (Geometrical method), Conditions for maximum and minimum, Plane diffraction grating, Conditions for principal maxima and minima. **Polarisation -**Introduction, Double refraction and Huygen's theory, Positive and negative crystals, Nicol prism, Dichroism.		
Unit-II	**Lasers**	**(06 Hrs.)**
Principle of laser, Einstein's coefficients, Spontaneous and stimulated emission, Population inversion, Ruby laser, Helium-Neon laser, Semiconductor laser, Single Hetro-junction laser, Gas laser: CO_2 laser, Properties of lasers, Laser speckles, Applications of lasers (Engineering/ industry, medicine, communication, Computers), Holography.		
Unit-III	**Solid State Physics**	**(06 Hrs.)**
Free electron theory, Density of states, Bloch theorem (Statement only), Origin of band gap, Energy bands in solids, Effective mass of electron, Fermi-Dirac probability function and position of Fermi level in intrinsic semi-conductors (with derivation) and in extrinsic semi-conductors, Band structure of p-n junction diode under forward and reverse biasing, Conductivity in conductor and semi-conductor, Hall effect and Hall coefficient, Photovoltaic effect, Solar cell and its characteristics.		
Unit-IV	**Nano-science**	**(06 Hrs.)**
Introductions of nanoparticles, properties of nanoparticles (Optical, electrical, Magnetic, structural, mechanical), synthesis of nanoparticles (Physical and chemical), synthesis of colloids, growth of nanoparticles, synthesis of nanoparticles by colloidal route, applications, quantum dots – wide band semiconductors, direct/indirect band gap semiconductors.		
Unit-V	**Analytical Instruments**	**(06 Hrs.)**
Motion of a charged particle in electric and magnetic fields, Electrostatic and Magnetostatics focusing,		

Electron sources, Wavelength and resolution, Specimen limitation, Depth of field and focus, Transmission electron microscope (TEM), Scanning electron microscope (SEM), Field emission scanning electron microscope (FESEM), X-ray Spectroscopy, Energy Dispersive X-ray Spectroscopy(EDS), Atomic force microscopy(AFM), X-ray diffraction(XRD), Bragg's law, Powder X-ray diffraction.		
Unit-VI	**Smart Materials and Superconductors**	**(06 Hrs)**
Introduction to smart materials, active smart polymers, shape memory alloys, Electro and Magneto Rheological Fluids, Introduction to composites, types of composites. Introduction to superconductivity; Properties of superconductors: zero electrical resistance, critical fields, persistent current, Meissner effect - Type I and Type II superconductors, Low and high temperature superconductors (introduction and qualitative)		

Term Work:
Practical (Any Eight of the Following)

1. Determination of radius of plan convex lens/wavelength of light/Flatness testing by Newton's rings
2. Determination of wavelength of light using diffraction grating
3. Determination of resolving power of telescope
4. Determination of thickness of a thin wire by air wedge
5. Determination of refractive index for O-ray and E-ray
6. Determination of divergence of a laser beam
7. Particle size by semiconductor laser
8. Determination of wavelength of laser by diffraction grating
9. To study Hall effect and determine the Hall voltage
10. Calculation of conductivity by four probe method
11. Study of solar cell characteristics and calculation of fill factor
12. Determination of band gap of semiconductor
13. Synthesis of metal oxide nanoparticles (ZnO/ZnS/Gold)
14. UV-VIS spectra of synthesized semiconductor nanoparticles
15. To determine the velocity of sound
16. Measurement of average SPL across spherical wave front and behavior with the distance
17. Expansion chamber muffler: investigation of muffler response as a filter in the low frequency approximation by determining insertion loss.
18. Interference of sound using PC speakers
19. Determination of velocity of sound in liquid by ultrasonic interferometer
20. Ultrasonic probe - a study
21. Mini-project based on contents of syllabus.

Assignments

Six assignments to be given by the subject teacher (Theory)-one from each unit/one mini project with report-students can work in group of 4 Maximum

Text Books

1. A Textbook of Engineering Physics, M N Avadhanulu, P G Kshirsagar and TVS Arun Murthy, S. Chand Publishing (2018)
2. Engineering Physics, R K Gaur and S L Gupta, Dhanpat Rai Publishing Co Pvt Ltd (2015)
3. Concepts of Modern Physics, Arthur Beiser, Shobhit Mahajan and S. Rai Choudhury, McGraw Hill Education (2017)

Reference Books

1. Fundamentals of Physics, Jearl Walker, David Halliday and Robert Resnick, John Wiley and Sons(2013)

2. Optics, Francis Jenkins and Harvey White, Tata Mcgraw Hill (2017)
3. Principles of Physics, John W. Jewett,Cengage publishing (2013)
4. Introduction to Solid State Physics, C. Kittel, Wiley and Sons(2004)
5. Principles of Solid State Physics, H. V. Keer, New Age International (1993)
6. Laser and Non-Linear Optics, B. B. Laud,New Age International Private Limited (2011)
7. Nanotechnology: Principles and Practices, Dr. S. K. Kulkarni, Capital Publishing Company (2014)
8. Science of Engineering Materials- C.M. Srivastava and C. Srinivasan, New AgeInternational Pvt.Ltd. (1997)
9. Introduction to Electrodynamics –David R. Griffiths, Pearson (2013)
10. Renewable Energy: Power for a Sustainable Future, Boyle, Oxford University Press (2012)

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. Case study on measurement and effect of environmental noise in the college
2. To develop a demonstration model of heat sensor in process control
3. To develop a demonstration model of automatic solar powered time regulated water pumping
4. Case study on solar technology: an alternative source of energy for national development
5. To develop a demonstration model of double pendulum.
6. The study on the effect of length on the resistance of a copper wire (verification of ohms law r directly proportional to l)
7. To prepare a chart on comparison of various method used in measuring the gravitational constant g
8. To develop a demonstration model of digital distance measuring instrument
9. Case study on electric power generation by road power
10. Case study on vibration of bars.
11. To determine absorption coefficient of sound absorbing materials
12. To develop a demonstration model to understand quantum confinement effect in wide band semiconductors
13. To develop a demonstration model of Tesla Coil
14. To develop a demonstration model of thin film interference in soap film-formation of colours
15. To develop a demonstration model of LiFi- wireless data transfer system using light

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Electrical Engineering Systems		
Course Code	**C103**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Perquisites: -	Students should have basic knowledge of Physics, Chemistry and Mathematics
Course Objectives: -	1. The course introduces fundamental concepts of DC and AC Circuits, Electrical Measurement, Transformers, Induction Machines, DC Machines, Basics of power transmission, distribution & safety measures.
Course Outcomes: -	1. **Understand** and **apply** knowledge of Basic laws and network theorems to solve electrical networks 2. **Understand** and **apply** knowledge of AC Circuits, Switch gear and electrical measuring instruments 3. **Understand** and **apply** fundamental concept of magnetic and electromagnetic circuits for operation of Transformers 4. **Understand** AC motors, it's control techniques for various mechanical engineering applications 5. **Understand** DC motors, it's control techniques for various mechanical engineering applications 6. **Understand** working of Transmission, Distribution of power use of safety rules.

Course Contents

Unit-I	DC Circuit Analysis and Network Theorems	(08 Hrs.)
Circuit Concepts: Concepts of network, active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and bilateral elements, R, L and C as linear elements, source transformation, Kirchhoff's laws, loop and nodal methods of analysis, star-delta transformation. **Network Theorems:** Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem (simple numerical problems).		
Unit-II	**AC Circuits and Switch Gear, Electrical Measurement**	**(08 Hrs.)**
AC Circuits: Representation of sinusoidal waveforms, peak and RMS values, phasor representation of AC quantities, real power, reactive power, apparent power, power factor. Analysis of single-phase AC circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), series and parallel resonance. Three phase balanced circuits, voltage and current relations in star and delta connections. **Measuring Instruments:** Power measurement in three phase circuits. Electrical instruments such as wattmeter, energy meter, tong-tester, megger and power analyzer. **Switch Gear:** Introduction to LT Switchgear, NO and NC Contacts, Contactors, relay, timers, use in control panel, application in interlocking and protection, symbols.		
Unit-III	**Magnetic Circuit and Electromagnetic Induction**	**(08 Hrs.)**
Magnetic Circuit: flux, flux density, field strength, analogy between electric & magnetic circuits, magnetic circuits with DC and AC excitations, magnetic leakage, B-H curve, hysteresis and eddy current losses, magnetic circuit calculations, mutual coupling. **Electromagnetic Induction:** Faradays law of EMI, induced emf, lenzs law, self inductance, coefficient of self inductance (L), mutual inductance, coefficient of mutual inductance (M), self induced emf and mutually induced emf, coefficient of coupling, inductance in series, types of inductor, their application and energy stored in magnetic field **Transformers:** Single phase and Three phase: Working principle, Construction, Types, applications.		
Unit-IV	**Induction Machines**	**(08 Hrs.)**

Three Phase Induction Motor: construction, types, rotating magnetic field, principle of operation, slip, frequency of rotor current, rotor emf, rotor current, expression for torque, conditions for maximum torque, torque slip characteristics, starting torque in squirrel cage and slip ring motors, effect of change in supply voltage on torque, slip and speed , relation between full load torque and maximum torque, power stages in induction motor, vector diagram and equivalent circuit, no load and block rotor test, speed control of 3 phase motor, starting methods for 3 phase induction motor, circle diagram, construction and calculation.

Single Phase Motor: construction, double revolving field theory, starting methods & types of single-phase motor, equivalent circuit.

Servomotor: construction, types, working, characteristics, application in automation and robotics.

Unit-V	**DC Machines**	**(08 Hrs.)**

DC Generator: construction, emf equation of dc generator, methods of excitation, losses, condition for maximum efficiency, armature reaction, interpoles and compensating winding, commutation, methods of improving commutation, characteristics of separately excited and self excited dc generator.

DC Motor: Working principle, voltage equation, condition for maximum power, torque developed, operating characteristics of dc motor, starting: 3 point and 4 point starter, speed control methods, Swinburne's and brake test of dc shunt motor. Soft-starting of dc motors.

Unit-VI	**Basic of Power transmission and distribution, Safety Measures**	**(08 Hrs.)**

Basic of Power transmission and distribution: classification of transmission lines, transmission line parameters, ABCD constants, voltage regulation, ferranti effect, efficiency of transmission line. 3-phase 3-wire and 3-phase 4-wire distribution system, feeders, distributors, main lines, comparison of various distribution systems, load power factor improvement techniques.

Safety Measures: Safety measures in electrical system, safety rules, basic principles of earthing-types of earthing.

List of Assignments:

The students will be given total **twelve** assignments (Two assignments on each Unit respectively).

1. DC Circuit Analysis
2. Network Theorems
3. AC Circuits and Switch Gear
4. Electrical Measurement
5. Single Phase Transformer
6. Three Phase Transformer
7. 3 Phase induction motor
8. Single phase motor
9. DC Generator
10. DC Motor
11. Power transmission and distribution
12. Safety Measures

List of Experiments:

Note: Term work shall consist of Minimum **Eight** Experiments from the following list.

List of Practicals to be performed in the laboratory:

1. Plotting B-H characteristics for a material
2. Verification of Kirchhoff‟s Laws
3. Verification of Superposition Theorem
4. Verification of Thevenin‟s Theorem
5. Verification of Maximum Power Transfer Theorem
6. Study of R-L series, R-C series, R-L-C series circuit
7. Time response of R-L series and R-C series circuit
8. Verification of voltage and current relationships in star and delta connected 3-phase networks
9. Single lamp controlled by two different switches (staircase)
10. Two lamps controlled independently from two different switches (parallel)
11. Series connected lamps

12. Study of Electricity bill(Industrial / commercial)
13. Direct loading tests on single phase transformer
14. Mini-project based on contents of syllabus.

Text Books

1. Basic Electrical Engineering - D. P. Kothari, J Nagarath (TMC)

Reference Books

2. Electrical Technology - Edward Huges (Pearson)
3. Electrical power system technology - S. W. Fordo, D. R. Patric (Prentice Hall)
4. Principles of Electronics-Dr. H. M. Rai (SatyaPrakashan)
5. Electronic Devices and Circuit Theory- R. L. Boylestad and L. Nashelsky (PHI)
6. Electrical, Electronics Measurements and Instruments - (SatyaPrakashan)

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. To develop a practical kit for verification of Thevenin's theorem.
2. To develop a practical kit for verification of Superposition theorem.
3. To develop a practical kit for verification of Maximum power transfer theorem
4. To develop a practical kit for verification of Norton's theorem.
5. To develop a practical kit for study of R-L-C Series circuit.
6. To develop a practical kit for study of R-L-C parallel circuit.
7. To develop a practical kit for study of voltage and current relationships in star connected network.
8. To develop a practical kit to understand voltage and current relationships in delta connected network.
9. To develop a demonstration model of single-phase transformer for practical application.
10. Case study on transformer operation and testing by using professional software.
11. To develop a demonstration model of Smart Energy meter using GSM
12. To develop a demonstration model of Safety measures in electrical system.
13. Case studies on – Learning industrial Safety through films/Videos
14. Case studies on – Learning industrial Safety through posters/charts

Unit Tests

Unit Test-I	Unit-I,II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Statics and Dynamics**		
Course Code	**C104**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
	Internal Assessment	40 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites:-	1. Engineering Physics 2. Engineering mathematics
Course Objective	1. To study different types of forces in a plane. 2. To study Centroid and moment of inertia 3. To study friction in machines 4. To study Kinetics of linear and circular motion 5. To study basics of civil engineering
Course Outcomes:-	The students should be able to 1. **Understand** the concept of force and **apply** it along with the concept of equilibrium in 2D and 3D system with the help of free body diagram. 2. **Understand** the significance of centroid and moment of inertia 3. **Understand** the concept of friction and estimate required force to overcome friction. 4. **Analyze** body in motion using force and acceleration, work energy, impulse momentum principles 5. **Analyze** body in motion using centripetal and centrifugal force principles 6. **Understand** the basic concept of civil material, building component and foundation techniques.

Course Content

Unit-I	**Resultant and Equilibrium**	**(06 Hrs.)**
Types and Resolution of forces, Moment and Couple, Free Body Diagram, Types of Supports, Classification and Resultant of a force system in a Plane - Analytical and Graphical approach. Equilibrant, Conditions of Equilibrium, Equilibrium of a force system in a Plane, Force and Couple system about a point, Virtual work.		
Unit-II	**Centroid, Moment of Inertia and Friction**	**(06 Hrs.)**
Centroid of line and plane areas, Moment of Inertia of plane areas, parallel and perpendicular axis theorem, radius of gyration, least moment of inertia. Introduction to frictional force, preliminary concepts, laws of friction. Introduction to machines, Relation between Mechanical advantage, Velocity ratio and efficiency, Reversible and non-reversible Machines. Simple lifting machines and their velocity ratio, gear train.		
Unit-III	**Analysis of Trusses, Frames and Cables**	**(06 Hrs.)**
Two force members: Introduction to trusses, types of trusses, perfect and redundant trusses, Analysis of plane trusses by method of joint and method of section, cables subjected to point loads. Multi force member: plane frame.		
Unit-IV	**Kinematics of particles and rigid body**	**(06 Hrs.)**
Rectilinear motion, velocity and acceleration in terms of rectangular coordinate system, Motion along plane curve path, tangential and normal component of acceleration, motion curves (a-t, v-t, s-t), Projectile motion Rigid body- Introduction to general plane motion,		
Unit -V	**Kinetics of Particle**	**(06 Hrs.)**
Force and acceleration, introduction to basic concepts, D'Alembert's principle, equation of dynamic equilibrium, Newton's second law of motion. Work energy principle and law of conservation of energy, impulse and momentum, law of conservation of momentum, Impact and collision.		

Unit-VI	Structural Materials and Foundations	(06 Hrs.)
Types of structures based on loading, material and configuration; structural materials: concrete, construction steel, bricks, flooring material and tiles, paints, plywood, glass and aluminium **Foundations-** Function of foundation, concept of bearing capacity and its estimation, types of foundation and its suitability, causes of failure of foundation.		

List of Assignments

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Resultant and equilibrium of forces
2. Centroid & Moment of Inertia
3. Friction
4. Trusses, frames and cables
5. Kinematics of particles
6. Kinematics of rigid body
7. Kinetics of particle
8. Structural materials and foundations

Text Books

1. "Engineering Mechanics", Bhavikatti S.S. and Rajashekarappa K. G., New Age International (P) Ltd.
2. "Engineering Mechanics (Statics and Dynamics)",Tayal A.K., Umesh Publication.
3. "Engineering Mechanics-I and II (Statics and Dynamics)", Mokashi V.S., Tata McGraw Hill Publication.

Reference Books

1. "Engineering Mechanics (Statics and Dynamics)", Hibbeler R. C., McMillan Publication.
2. "Vector Mechanics for Engineers-Vol.-I and Vol.-II (Statics and Dynamics)", Beer F.P. and Johnston E.R., Tata McGraw Hill Publication.
3. "Engineering Mechanics (Statics and Dynamics)", Shames I.H., Prentice Hall of India (P) Ltd.
4. "Engineering Mechanics (Statics and Dynamics)", Singer F.L., Harper and Row Publication
5. "Engineering Mechanics (Statics and Dynamics)", Meriam J.L. and Kraige L.G., John Wiley and Sons Publication.
6. "Engineering Mechanics (Statics and Dynamics)", Timoshenko S.P. and Young D.H., McGraw Hill Publication.

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. To prepare demonstration model for various types of beams.
2. To prepare demonstration model for various types supports.
3. To prepare chart for various types of force system with suitable real-life examples.
4. Case study on various situations where varignon's theorem is used.
5. To prepare demonstration model or to prepare a chart on equilibrium system of forces of various engineering applications.
6. To prepare chart on different types for trusses with showing various members.
7. To prepare demonstration model of any one type of truss.
8. To prepare demonstration model of the basic geometrical figures and locate the centroid of them.
9. To prepare demonstration model of the I and T section and locate the centroid of them.
10. To prepare chart for parallel axis and perpendicular axis theorem with suitable example.
11. To prepare chart on types of friction in various field conditions.

12. To prepare chart on application of friction.
13. To prepare chart on motion curves.
14. To prepare chart related to lifting machine and relevant industrial applications.
15. To development of excel sheet for projectile motion (at least three problems).
16. To development of excel sheet for work energy principle (at least three problems).
17. To prepare chart on work energy and Impulse momentum principle with suitable example.
18. Case study on different structural materials and comparison of its mechanical properties.
19. To prepare demonstration model of different types of foundations.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Computer Aided Drafting & Visualization		
Course Code	C105		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites: -	Fundamentals of Mathematics
Course Objectives: -	1. To understand the basic principles of engineering drawing and highlight the importance of Computer Aided Drafting in engineering. 2. To develop the graphical skills for communication of concepts & idea through technical drawings.
Course Outcomes:-	1. **Understand** the fundamental concepts of CAD Drawing, its applications, different types of lines, curves and dimension technique with practical application. 2. **Understand** the concept of Orthographic projections and **apply** it to draw detail views by using 1st angle projection method. 3. **Understand** the concept of isometric projection and **apply** it to construct 3D view of a component. 4. **Understand** the concept of projections of Point, Line and plane; and **apply** to draw its projection by using 1st angle projection method and to locate its traces. 5. **Understand** the concept of projections of different types of solids and sectioned solids; and **apply** to draw its projection by using 1st angle projection method. 6. **Understand** the concept of Development of Lateral surfaces; and **apply** to development of simple and sectioned Solids.

Course Contents

Unit-I	**Fundamentals of CAD and Engineering Curves**	**(08 Hrs.)**
Introduction to Engineering Drawing, Types of lines and Dimensioning, Layout and size of drawing sheets, Scales. **Engineering Curves-**Ellipse drawing by Focus-Directrix Circle Method and Concentric Circle Method, Involutes of a circle, Cycloid, Archimedean Spiral, Helix on cone and Cylinder. Fundamentals of Computer Aided Drafting (CAD) and its applications, Various software for Computer Aided Drafting. AutoCAD initial setting and AutoCAD commands		
Unit-II	**Orthographic Projection**	**(08 Hrs.)**
Basic principle planes of Projections, First and Third angle method of Projection, Orthographic Projections of given Pictorial view by first angle projection method only, Sectional orthographic Projection. Orthographic Drawing by using AutoCAD.		
Unit-III	**Isometric Projections**	**(08 Hrs.)**
Principles of Isometric Projections-Isometric Scale, Isometric Axes, Isometric Projections and Isometric Drawing. Constructions of Isometric view from given Orthographic Views and given origin. Isometric Drawing by using AutoCAD.		
Unit-IV	**Projection of Points, Lines and Plane Surfaces**	**(08 Hrs.)**
Projections of Points, Projections of Oblique lines in First Quadrant, Traces. **Projections of Planes-** Projection of perpendicular and oblique planes(polygonal and circular surfaces), Obtaining true shape of plane surface. Projection of Points, Lines and Plane Surfaces by using AutoCAD.		
Unit-V	**Projection of Solids and Sectioned Solids**	**(08 Hrs.)**

Introduction of solids-Types of solids, Projection of solid inclined both references plane, Projection of common solids such as prism, pyramid, cylinder and cone. Projection of solids cut by AIP and AVP, obtaining true shape of a section. Projection of Solids and Sectioned Solids by using AutoCAD.		
Unit-VI	**Development of Lateral Surfaces**	**(08 Hrs.)**
Development of the lateral surfaces of solids like Prisms, pyramids, cylinders and cones. Development of cut solids. Development of Lateral Surfaces by using AutoCAD.		

Term work

Term work shall consist of **seven** A2 size (594 mm x 420 mm) sheets using **AutoCAD.**

1. Types of lines, Dimensioning practice, 1st and 3rd angle methods symbol.
2. Engineering Curves
3. Orthographic Projections
4. Isometric views
5. Projections of Points and Lines and planes
6. Projection of Solids and Section of solids
7. Development of Lateral surfaces

Assignments: Minimum five problems on each unit in A3 size Drawing Book

Textbooks

1. "Elementary Engineering Drawing", N.D. Bhatt, Charotar Publishing house, Anand India.
2. "Text Book on Engineering Drawing", K.L.Narayana & P.Kannaiah, Scitech Publications, Chennai.

Reference Books

1. "Fundamentals of Engineering Drawing", Warren J. Luzzader, Prentice Hall of India, New Delhi.
2. "Engineering Drawing and Graphics", Venugopal K., New Age International publishers.
3. M. B. Shah and B. C. Rana, "Engineering Drawing", 1st Ed, Pearson Education, 2005.
4. P. S. Gill, "Engineering Drawing (Geometrical Drawing)", 10 Edition, S. K. Kataria and Sons, 2005.
5. P. J. Shah, "Engineering Drawing", C. Jamnadas and Co., 1 Edition, 1988.

Project Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. To obtain industrial drawings to identify the types of lines, dimensioning methods and method of projection.
2. To develop the model/charts based on engineering curves.
3. To prepare model/chart for identification of engineering curves in nature for industrial, societal, etc application.
4. To demonstrate different methods of orthographic projection.
5. To demonstrate projection of Points.
6. To demonstrate projection of Lines.
7. To demonstrate projection of Planes.
8. To demonstrate projection of Solids.
9. To demonstrate developments of surfaces for solids.
10. To demonstrate industrial application of development of surfaces such as steam carrying pipes, Ducts of air conditioning systems, etc.
11. To demonstrate Isometric projection method through model of a cube.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Metal Joining Processes		
Course Code	**C106**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical: -02 hours/Week	Term Work	50 Marks	01
	Total	**50 Marks**	**01**

Course Prerequisites:-	Students should have basic knowledge of Materials, Physics, Chemistry and Vocational Course.
Course Objectives:-	The student should 1. To acquire the knowledge of Arc and Gas Welding Processes 2. To acquire the knowledge of Resistance and Solid-state Welding Processes
Course Outcomes:-	The students should be able to– 1. **Understand** the different Arc and Gas Welding Processes and **apply** for welding Joints 2. **Understand** the different Resistance and Solid-state Welding Processes and **apply** for welding Joints.

Course Contents

Unit-I	Introduction to Welding Processes	(12 Hrs.)
Introduction, Classification of welding processes, Advantages and disadvantages of welding processes Soldering, Brazing. **Arc Welding Processes**-Carbon arc, Submerged arc, Tungsten inert gas (TIG), Metal inert gas (MIG), Plasma arc, Stud welding and related arc welding processes –Theory, Comparison on merits, limitation and applications, Fluxes used in arc welding. Characteristics of Welding Processes. **Gas Welding**– Processes and equipment used, Types of flames, Gas cutting– Merits, demerits and applications.		
Unit-II	**Resistance Welding and Solid-State Welding**	**(12 Hrs.)**
Resistance Welding– Spot, Seam, Projection, Butt, Percussion welding, Tube welding, Electric resistance welding process, its merits, demerits, and applications. **Introduction of Solid-State Welding-** Pressure, Diffusion, Ultrasonic, Explosive, Friction, Forge, Principle, Equipment used and Flux used, Merit's, demerits and application of the above process.		

Term Work: List of Experiments

1. Edge Preparation of various welding Joints.
2. Making the Joint with Arc Welding Process. (One Individual Job)
3. Making the Joint with Resistance Welding Process. (One Individual Job with spot welding)
4. Making the Joint with TIG or MIG Welding Process.(One Individual Job)
5. Making the Joint with Gas Welding Process.(One Individual Job)
6. Making the Joint with Soldering Process.(One Individual Job)
7. Making the Joint with Braze Welding Process.(One Individual Job)
8. Study / Demonstration on Ultra Sonic Welding.
9. Study / Demonstration on Friction Welding
10. One Industrial Visit to get the detail Knowledge of Advanced Welding Processes and Latest Technology in Welding.

Text Books

1. O.P.Khanna , A Text Book of Welding Technilogy, DhanpatRai and Sons
2. Md. Ibrahim Khan, Welding Science and Technology, New Age International (P) Ltd.
3. Chapman W.A.J "Workshop Technology "volume I,II.III, ELBS.

Reference Books

1. P.N.Rao , Manufacturing Technology- Vol I, Mcgraw Hill Education 9 India Pvt.
2. Hajra Choudhary S.K. , Bose S.K. "Elements of Workshop Technology" Volume I,II
3. Richard Little, "Welding And Welding Technology" Pearsons Education second Edition.

Designation of Course	**Soft Computing- I**		
Course Code	**C107**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical: -04 hours/Week	Term Work and Practical	100 Marks	02
	Total	**100 Marks**	**02**

Course Prerequisites	Basic Mathematics
Course Objective	The goal of the course is that students should develop techniques for problem solving using a programming language.
Course Outcomes	Students should 1. **Understand** basics of C++ and **apply** that knowledge to write simple programs. 2. **Understand** the uses of operators and **apply** them in writing programs. 3. **Understand** the concept of conditional statements **apply** them in writing programs. 4. **Understand** the concepts of loops in C++ **apply** them in writing programs. 5. **Understand** the concepts of user defined functions, recursion and **apply** them in writing programs 6. **Understand** the concept of overloaded functions and **apply** them in writing programs

Course Contents

Unit-I	**Introduction to C++**	(08Hrs.)
Introduction to C, C++; Object oriented programming; Programming Fundamentals; Data and Data Types		
Unit-II	**Operators in C++**	(08Hrs.)
Declarations in C++; Operators in C++; Introduction to classes and objects and strings		
Unit-III	**Conditional Statements**	(08Hrs.)
Relational and logical operators; If statements; Switch Statements		
Unit-IV	**Loops**	(08Hrs.)
Loops in C++; For loop; While loop; Do while loop; Jump statement		
Unit-V	**Functions I**	(08Hrs.)
Functions basic formats; Recursion		
Unit-VI	**Functions II**	(08Hrs.)
Overloaded functions; Local, Global and Static Variables		

Term Work

Term work shall consistof programs (not limited to)listed below based on syllabus.

1. C++ "Hello, World!" Program
2. C++ Program to Print Number Entered by User
3. C++ Program to Add Two Numbers
4. C++ Program to Find Quotient and Remainder
5. C++ Program to Find Size of int, float, double and char in Your System
6. C++ Program to Swap Two Numbers
7. C++ Program to Find ASCII Value of a Character
8. C++ Program to Multiply two Numbers
9. C++ Program to Check Whether Number is Even or Odd

10. C++ Program to Check Whether a character is Vowel or Consonant.
11. C++ Program to Find Largest Number Among Three Numbers
12. C++ Program to Find All Roots of a Quadratic Equation
13. C++ Program to Calculate Sum of Natural Numbers
14. C++ Program to Check Leap Year
15. C++ Program to Find Factorial
16. C++ Program to Generate Multiplication Table
17. C++ Program to Display Fibonacci Series
18. C++ Program to Find GCD
19. C++ Program to Find LCM
20. C++ Program to Reverse a Number
21. C++ Program to Calculate Power of a Number
22. C++ Program to Check Whether a Number is Palindrome or Not
23. C++ Program to Check Whether a Number is Prime or Not
24. C++ Program to Display Prime Numbers Between Two Intervals
25. C++ Program to Check Armstrong Number
26. C++ Program to Display Armstrong Number Between Two Intervals
27. C++ Program to Display Factors of a Number
28. C++ Programs To Create Pyramid and Pattern
29. C++ Program to Make a Simple Calculator to Add, Subtract, Multiply or Divide Using switch...case
30. C++ Program to Display Prime Numbers Between Two Intervals Using Functions
31. C++ Program to Check Prime Number By Creating a Function
32. C++ Program to Check Whether a Number can be Express as Sum of Two Prime Numbers
33. C++ program to Find Sum of Natural Numbers using Recursion
34. C++ program to Calculate Factorial of a Number Using Recursion
35. C++ Program to Find G.C.D Using Recursion
36. C++ Program to Convert Binary Number to Decimal and vice-versa
37. C++ Program to Convert Octal Number to Decimal and vice-versa
38. C++ Program to Convert Binary Number to Octal and vice-versa
39. C++ program to Reverse a Sentence Using Recursion
40. C++ Program to Calculate Power Using Recursion

Text Books

1. "Let Us C++", Kanetkar Yashavant, BPB Publications

Reference Books

1. “C++ programming Today”, Barbara Johnston, Prentice Hall of India, New Delhi.
2. “C++ how to program”, Paul Deitel and Henry Deitel, Prentice Hall of India, New Delhi.
3. "Accelerated C++: Practical Programming by Example", Andrew Koenig and Barbara E. Moo, Addison-Wesley Publications
4. "C++: The Complete Reference", Herbert Schildt, McGraw Hill Publications.
5. "C++ Primer"; Barbara E. Moo, JoséeLajoie and Stanley B. Lippman; Addison-Wesley Professional
6. "Programming: Principles and Practice Using C++", BjarneStroustrup, Addison-Wesley Professional

B. Tech. Mechanical
Sem.-II

Designation of Course	Differential Equations, Probability & Statistics		
Course Code	**C108**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- 01 Hours/ Week	Internal Assessment	40 Marks	
	Tutorial	-	01
	Total	**100 Marks**	**04**

Course Prerequisites:-	Students should have knowledge of 1. Derivative and Integration 2. Partial derivative 3. Basic of statistics
Course Objectives:-	To provide knowledge about 1. Various methods to solve first order and first degree and n^{th} order differential equation. 2. Integral transform and application of partial differential equation. 3. Methods of interpretation of numerical data and probability distribution.
Course Outcome:-	Students will be able to 1. **Understand** methods of first order and first-degree differential equation. 2. **Understand** the methods of ordinary differential equations and **apply** it to mass spring system. 3. **Understand** Laplace transform and evaluate particular solution of wave, one- and two-dimensional heat equation. 4. **Understand** the multiple integrals and apply it to evaluate area and volume. 5. **Understand** various technique to **analyze** and numerical data. 6. **Understand** probability distribution and testing of hypothesis.

Course Contents

Unit-I	Differential Equation	(06 Hrs.)
Formation of the ordinary differential equations (ODEs), Solution of an ordinary differential equation, Equations of the first order and first degree, Linear differential equation, Bernoulli's equation, Exact differential equations, Equations reducible to exact equations		
Unit-II	**Linear Differential Equations**	**(06 Hrs.)**
Solution of nth order LDE with Constant Coefficients, Method of Variation of Parameters, Cauchy's & Legendre's DE, Solution of Simultaneous & Symmetric Simultaneous DE, Mass spring system.		
Unit-III	**Laplace Transforms and Applications of Partial Differential Equations**	**(06 Hrs.)**
Laplace transform: Definition of Laplace transforms, Properties of Laplace Transform (Properties without proof). Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative, Partial fractions method & first shift property to find inverse Laplace transform. Inverse Laplace transform using Convolution theorem (without proof). Applications of partial differential equation: Basic concepts, modeling of Vibrating String, Wave equation, One- and two-dimensional Heat flow equations, method of Separation of variables.		
Unit-IV	**Multiple Integrals and its Applications**	**(06 Hrs.)**
Double and Triple integrations, Applications to Area, Volume, Mean and Root Mean Square Values.		
Unit-V	**Statistics**	**(06 Hrs.)**
Measures of central tendency, Standard deviation, Coefficient of variation, Moments, Skewness and Kurtosis, Correlation and Regression, Reliability of Regression estimates.		

Unit-VI	Probability and Probability Distributions	(06 Hrs.)
Probability, Bayes Theorem, Probability density function, Probability distributions: Binomial, Poisson, Normal, Test of hypothesis: Chi-square test, t-test.		

Assignments

Problems and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Differential equation.
2. Linear differential equations.
3. Laplace transforms and applications of partial differential equations.
4. Multiple integrals and its applications.
5. Statistics.
6. Probability and probability distribution.

Tutorials:

Problems and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. First order equation (linear and nonlinear),
2. Higher order linear differential equation with constant coefficients
3. Euler-Cauchy equation
4. Legendre's DE
5. Laplace transformation
6. Applications of partial differential equation
7. Double and Triple integrations
8. Applications to area, volume, mean and root mean square values.
9. Sampling theorems, conditional probability; mean, median, mode and deviation.
10. Correlation and regression, reliability of regression estimates.
11. Probability, bayes theorem, probability density function
12. Binomial, poisson and normal distributions.

Text Books

1. P. N. Wartikar and J. N. Wartikar, "Applied Mathematics (Volumes I and II)", 7th Ed., Pune Vidyarthi Griha Prakashan, Pune, 2013.

Reference Books

1. B. S. Grewal, "Higher Engineering Mathematics", 42nd Ed., Khanna Publication, Delhi
2. B.V. Ramana, "Higher Engineering Mathematics", 6th Ed., Tata McGraw-Hill, New Delhi, 2008.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Ed., John Wiley & Sons, Inc., 2015.
4. Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Ed., Cengage Learning, 2012.
5. Michael Greenberg, "Advanced Engineering Mathematics", 2nd Ed., Pearson Education, 1998.

Project Based learning topics:

Students are expected to prepare report on any one topic, write its definition, applications and analyze the hypothetical data. Also, write pseudo code for it, wherever applicable.

1. Formation of differential equation
2. Exact differential Equation
3. Linear differential equation
4. Solution of nth order LDE with Constant Coefficients
5. Mass spring system
6. Transform (Properties with proof).

7. Applications of partial differential equation in mechanical engineering
8. Multiple integrals applications
9. Applications of Multiple integrals applications to Area, Volume
10. Random Sampling
11. Stratified random sampling
12. Reliability of Regression estimates.
13. Bayes Theorem
14. Probability density function
15. Testing of hypothesis

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	Chemistry of Engineering Materials		
Course Code	C109		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03Hour/ Week	End Semester Examination	60 Marks	03
Practical: -02 Hours/Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites: -	Higher Secondary chemistry.
Course Objective: -	The student should acquire the knowledge of 1. To develop the interest among the students regarding chemistry and their applications in engineering. 2. To develop confidence among students about chemistry, how the knowledge of chemistry is applied in technological field. 3. The student should understand the concepts of chemistry to lay the groundwork for subsequent studies in the field such as Mechanical Engineering.
Course Outcomes: -	After completion of the course students will be able to 1. **Apply** the concept X-ray diffraction technique to study crystal structure. 2. **Understand** the concept of the metallurgy in the study of metals. 3. **Understand and apply** the knowledge of Ferrous & Non-Ferrous materials for various engineering applications. 4. **Apply** the knowledge polymer and plastics to study advanced materials. 5. **Understand** the knowledge of composite materials for various engineering applications. 6. **Understand** different types of corrosion and suggest control measures in industries.

Course Contents

Unit-I	**Crystal Structures**	**(06 Hrs.)**
Study of crystal structure, Indexing of planes and directions, Slip planes, linear and Planner density calculations, volume density calculations, Imperfections in crystals, effect of crystal structure defects on various properties, Allotropic and polymorphism of metals, formation of solid solutions.		
Unit-II	**Extractive Metallurgy**	**(06 Hrs.)**
Introduction, Occurrence of metals, types of ores, concentration of ores by physical methods, Crushing and Sizing, Froth- Flotation, Magnetic Separation, Gravity separation method. Chemical methods- calcination, Roasting, Reduction of ore by Pyrolysis, Chemical reductions, Electrolytic refining of metals.		
Unit-III	**Ferrous & Non-Ferrous Materials**	**(06 Hrs.)**
Metallic materials: Introduction, Alloy- definition and classification, purposes of making alloys. Ferrous alloys, Introduction to steel making, blast furnace and electric steel making: Plain carbon steels (mild, medium and high), Nonferrous alloys: Copper alloy (Brass), Nickel alloy (Nichrome), Aluminum alloy (Duralumin and Alnico). **Green Chemistry:** Definition, Twelve principles of Green Chemistry.		
Unit-IV	**Introduction to Polymers, Plastics and Rubbers**	**(06 Hrs.)**
Polymers: Introduction, plastics, thermo softening and thermosetting plastics, industrially important plastics like phenol formaldehyde, urea formaldehyde and epoxy resins, Conducting polymers and Biopolymers (Introduction, examples, and applications), types of rubbers, Acrylics.		
Unit-V	**Introduction to Composites**	**(06 Hrs.)**
Introduction, types of composite, different types of reinforce materials, characteristics of reinforced materials, matrix materials composition, properties and uses of fibre reinforced plastics (FRP), Carbon fibres, Boron Nylon etc, and glass reinforced plastic (GRP). Ceramic matrix composite. Metal Matrix composite.		
Unit-VI	**Corrosion & Protective Coatings**	**(06Hrs.)**
Introduction corrosion, types of corrosion, hydrogen embrittlement, stress corrosion, Pit type corrosion,		

corrosion prevention methods, Metallic coatings, Electroplating, Methods of cleaning articles before electrodeposition, Electroplating methods, Electroless plating, Some other metallic coatings, Modification of environment, Cathodic Protection, chemical conversion coatings, Organic Coatings, Paints, Varnishes, Enamels, Special paints. CVD and PVD coatings.

Term Work

List of Experiments

1. Preparation of polystyrene/phenol-formaldehyde/urea-formaldehyde resin.
2. To determine molecular weight/radius of macromolecule polystyrene/ polyvinyl alcohol by viscosity measurement.
3. Estimation of percentage of Iron in Plain Carbon Steel by Volumetric Method.
4. Study of corrosion of metals in medium of different pH.
5. Determination of rate of corrosion of aluminium in acidic and basic medium.
6. Determination of percentage of Ca in given cement sample
7. Preparation of phenol-formaldehyde resin/ urea-formaldehyde.
8. Estimation of copper in brass solution.
9. Determination of rate of corrosion of aluminium in acidic and basic medium.
10. To obtain metallic coating on base metal by using both the methods, Electroplating and Electroless plating.

Assignments

1. Linear and Planner density calculations with volume density calculations.
2. Extractive Metallurgy.
3. Purposes of making alloy like Ferrous alloys.
4. Twelve principles of Green Chemistry.
5. Conducting polymers and Biopolymers.
6. Thermo softening and thermosetting plastics.
7. Fiber reinforced plastics (FRP).
8. Heat treatment oftool steels
9. Organic Coatings, Paints, Varnishes, Enamels, Special paints for corrosion prevention.
10. Types of corrosion and its preventive measures.

Test Book

1. A Textbook of Engineering Chemistry by S. S. Dara and S. S. Umare, S. Chand & Company Ltd., New Delhi.
2. A Textbook of Engineering Chemistry by C. P. Murthy, C. V. Agarwal and A. Naidu, B S Publications, Hyderabad.
3. A Text Book of Engineering Chemistry, Shashi Chawla, Dhanpat Rai & Co, 2004

Reference Books

1. Material Science and Engineering Metallurgy by V D Kodgire, Everest publications
2. Materials Science by O P Khanna, Khanna publications
3. Engineering Chemistry (16th Edition) Jain, Jain, Dhanpat Rai Publishing Company, 2013.
4. Engineering Chemistry by Dr. A. K. Pahari and Dr. B. S. Chauhan, Laxmi Publications (P) Ltd, New Delhi.
5. Polymer Science, V. R. Gowarikar, N. V. Viswanathan, jayadev Sreedhar, Wiley Eastern Limited
6. Polymer Science and technology (2nd Edition), P. Ghosh, Tata McGRAW Hill, 2008
7. Polymers: Chemistry & Physics of Modern Materials (2nd edition) J.M.G. Cowie, Blackie Academic & Professional, 1994.

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. To prepare a demonstration model on Biopolymers.
2. To prepare a epoxy resins by using suitable method.
3. To write a review paper based on applications of fibre reinforced plastics (FRP) and get it published in reputed journal (eg. Google Scholar).
4. With the help of green chemistry principles, to prepare any organic dye by using Traditional and Green pathway.
5. To prepare a demonstration model a hardware model based on Electroless plating and calculate cell voltage.
6. To write a review paper based on Conducting polymers and get it published in reputed journal (eg. Google Scholar).

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Mechanical Engineering Systems**		
Course Code	**C110**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hour/ Week	End Semester Examination	60 Marks	04
Practical: -02 Hours/Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites: -	Higher Secondary Physics
Course Objective: -	To teach students about 1. Introduction to systems in Thermal Engineering 2. Introduction to systems in Design Engineering 3. Introduction to systems in Manufacturing Engineering
Course Outcomes: -	Students should 1. **Understand** the fundamentals of power producing and absorbing devices. 2. **Understand** the fundamental concepts of renewable and non-renewable energy systems. 3. **Understand** the fundamentals of mechanism of machines. 4. **Understand** the fundamentals of power transmitting devices. 5. **Understand** the fundamentals of machine tools and manufacturing processes. 6. **Understand** the fundamentals of robotics and its applications.

Course Contents

Unit-I	**Power Producing and Absorbing Systems**	(08 Hrs.)
Power Producing Systems: I. C. Engines- Basic nomenclature, Classification, S.I and C. I. Engines, Two stroke and four strike engines. Boilers- classification, water tube and fire tube boilers. Steam Turbines: Classification, simple Impulse, and reaction turbines. Water Turbines: Classification, Impulse, and reaction Turbines. Gas Turbines: classification, open and closed gas turbine. Construction, working and applications of all these devices. **Power Absorbing Systems:** Compressors; Classification, Rotary, reciprocating air compressors, Blower, Pumps: Classification, Rotary, reciprocating pumps, Household refrigerator and window air conditioner.		
Unit-II	**Renewable and Non-Renewable Energy Systems**	(08 Hrs.)
Renewable energy systems: Solar- P-V Cells, collectors- Flat plate, Parabolic, Trough collector, Heliostat. Wind- Classification of wind Turbines, Horizontal and vertical axis. Biomass gasification, Biogas Plant, Geothermal, Tidal, micro-hydel plant. **Non-renewable energy systems:** Thermal power plant, hydroelectric power plant, Nuclear power plant, Gas Turbine plant, I.C engine power Plant,		
Unit-III	**Introduction to Mechanisms of Machines**	(08 Hrs.)
Kinematic link, Kinematic pair, Types of constrained motions, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom (Mobility), Kutzbach criterion, Grubler's criterion. Four bar chain and its inversions, Grashoff'slaw, Slider crank chain and its inversions, Double slider crank chain and its inversions. Geneva Mechanisms, Ratchet and Paul Mechanisms		
Unit-IV	**Power Transmitting Devices**	(08 Hrs.)
Types of Belts and belt drives, Chain drive, rope drive, Types of gears, Types of Couplings, Types of friction clutch, Power transmission shafts, axles, keys, types of Keys, Sliding Contact and Rolling Contact Bearing, Bush and ball bearings, Types of brakes.		
Unit-V	**Introduction to Machine Tools**	(08 Hrs.)
Demonstration of: Lathe machine, Centre lathe, wood working lathe, Drilling machine, types of drilling machine, milling machine, Power saw. Grinding machine, cylindrical grinder, and surface grinder. NC		

machine, CNC machine.		
Unit-VI	**Introduction to Robotics**	(08 Hrs.)
History of robotics, Definition of robotics and robot, laws of robotics and classification of robot, application of robot, robot anatomy, Degree of freedom, Degree of mobility, Kinematics, joints, work envelope, pay load, reach, speed, acceleration, accuracy, precision, repeatability, Mounting, Footprint, cycle time, Components of robots such as sensor, power conversion unit, Actuators, Manipulators, Controllers, Base and user interface, Future of robotics.		

Term work: Term work shall consist following experiments.

1. Study and demonstration of low-pressure boilers.
2. Study and demonstration of IC Engines.
3. Study and demonstration of Refrigeration and Air Conditioning.
4. Study and demonstration of Pumps and Compressors.
5. Study and demonstration of turbines.
6. Study and demonstration of Inversions of 4-bar, Single and Double Slider Crank Mechanisms.
7. Study and demonstration of power transmitting elements.
8. Study and demonstration of operations on center lathe.
9. Study and demonstration of operations on drilling machine.
10. Study and demonstration of robot anatomy.
11. Mini Project on Contents of Syllabus.

Assignment

1. Assignment on power producing and absorbing devices
2. Assignment on renewable and non-renewable energy
3. Assignment on mechanism of machines
4. Assignment on Power Transmitting Devices
5. Assignment on Machine Tools
6. Assignment on Robotics

Text Books

1. A Textbook of Production engineering” P.C. Sharma, S. Chand Publication, New Delhi, 2nd edition, 8th Edition (2014).
2. A Textbook of Manufacturing Technology: Manufacturing Processes, R. K. Rajput, Laxmi Publications (P) Ltd, 2nd Edition 2015
3. R S Khurmi and J K Gupta, Textbook of Thermal Engineering, S Chand publications.

Reference Books

1. V. Ganeshan, Internal Combustion Engine, Tata McGraw-Hill Publication, 4th Edition (2012).
2. R. K. Rajput, Thermal Engineering, Laxmi Publications
3. Ambekar A.G Mechanisms and Machine Theory,Prentice-Hall of India, Eastern Economy Edition (2007)
4. S.S. Ratan, Theory of Machines, , Tata McGraw Hill, 4th Edition
5. Introduction to robotics, S.K.Shah. McGraw Hill, 2nd Editi

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. To prepare chart of comparison among specification of various models of two wheeler available.
2. To develop demonstration model of low-cost household refrigerator
3. To develop demonstration model of low-cost air conditioner
4. To develop demonstration model of Biogas plant
5. To develop demonstration model of geothermal power plant
6. To develop demonstration model of wind power plant

7. To develop demonstration model of solar energy plant
8. To develop demonstration model of Whitworth quick return mechanism
9. To develop demonstration model of single slider crank chain mechanism with its inversion
10. To develop demonstration model of Ratchet and Paul mechanism
11. To develop demonstration model of mini conveyor using Geneva mechanism

Unit Test

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	**Electronics Engineering Systems**		
Course Code	**C111**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	Students should have the basic knowledge of Electrical Engineering
Course Objectives:-	1. To provide overview of electronics engineering that serve the foundation of advanced studies in the area of mechanical engineering. 2. This course provides comprehensive idea about working principle 3. Operation and characteristics of electronic devices, transducers, digital electronics, and communication systems.
Course Outcomes:-	On completion of the course, students will be able to– 1. **Understand** the basic electronics devices and linear ICs 2. **Understand and apply** the concepts of digital electronics. 3. **Understand** the methods of signal conditioning and its applications. 4. **Understand** concepts of Analog Communication & Digital communication 5. **Understand** the concept of transducer and data acquisition system with its application. 6. **Understand** the concept of Microprocessor & Microcontroller and its applications.

Course Contents

Unit-I	**Electronic Devices and Linear ICs**	**(08 Hrs.)**
Rectifiers: Half wave, Full wave and Bridge rectifiers - capacitor filter-wave forms-ripple factor regulation characteristics. Special semiconductor devices: FET, SCR. LED, MOSFET,DIAC, TRIAC,relays, VI characteristics – applications		
Unit-II	**Digital Electronics**	**(08 Hrs.)**
Number system – Binary, Decimal, Octal, Hela decimal, Digital Signal, Combinational and sequential logic circuits, clock signal, Boolean Algebra and Logic gates, Arithmetic Operations, Multiplexers, Demultiplexers, Encoders, Decoders, Flip-flop, Registers, Counters. Integrated circuits & logic families: – Logic levels, noise immunity, fan out, propagation delay, TTL logicfamily, CMOS logic family, comparison with TTL family		
Unit-III	**Signal Conditioning**	**(08 Hrs.)**
Operational amplifiers, Inverting, non-inverting, voltage follower, summing, subtractor, Instrumentation, 555 timer-operating modes: monostable, astable multivibrator, Analog to Digital & Digital to Analog Convertors		
Unit-IV	**Communication Systems**	**(08 Hrs.)**
Analog Communication & Digital communication: Block diagram of a basic communication system, Frequency spectrum, need for modulation, Methods of modulations- Principles of AM, FM, Pulse analog &pulsedigitalmodulation,AM/FMtransmitters&receivers,satellitecommunication–Radarsystem, data transmission and MODEM, Mobile communication systems: cellular concept, simple block diagram of GSM system		
Unit-V	**Transducers and Data Acquisition Systems**	**(08 Hrs.)**

Basic requirement of transducers, classification of transducers, passive transducers: Resistive, capacitive, inductive, LVDT, potentiometric strain gauge, thermistor, hall effect, proximity sensors. Active transducers:Piezoelectric,photoelectric&thermocouple.Staticcharacteristicsoftransducer,selectionoftransducer. Block diagram of data acquisition systems and its applications.		
Unit-VI	**Microprocessor & Microcontroller**	**(08 Hrs.)**
Overview of generic microprocessor, architecture & functional block diagram, comparison of Microprocessor& microcontroller. 8051 Architecture, ports, resisters, timers/counters. Serial communications interrupts. Interfacing of relay, stepper motor, LCD Display, Keyboard,ADC.		

Term Work:

Term work shall consist of Minimum Eight **Experiments.**

1. To study and plot regulation characteristics of half wave and full waverectifier.
2. To study of characteristics of SCR.
3. To study of characteristics of TRIAC
4. To study basic logic gates: AND, OR, NOT, NAND, NOR, Ex-OR,Ex-NOR.
5. Implementation of Boolean functions using logic gates.
6. To study Operational Amplifiers(Op-amps).
7. Study of Amplitude Modulation and Demodulation
8. Study of Frequency Modulation and Demodulation
9. To study characteristics of LVDT for displacement measurement.
10. To study of Microprocessor &Microcontroller

Assignment:

Assignment based on each unit.

Text Books:

1. K.P. Ramchandran, G.K. Vijyaraghavan, M.S. Balasundaram, Mechatronics: Integrated Mechanical Electronic Systems, Willey Publication,2008
2. W. Bolton, Mechatronics - A Multidisciplinary approach, 4th Edition, Prentice Hall,2009.
3. Dr. D.S.Kumar, Mechanical Measurement & Control, Metropolitan Book Co. Pvt.Ltd. New Delhi,2007
4. M.D. Singh and J.G.Joshi, Mechatronics, 3rd Edition, Prentice Hall, New Delhi,2009.
5. Mottershed Allen, Electronic Devices &Circuits,PHI
6. R. P. Jain, Modern Digital Electronics, M Graw

Reference Books

1. Thomas L. Floyd, Electronic Devices, Pearson Education (Sixthedition)
2. Millman&Halkis, Electronic Devices & Circuits,PHI
3. Malvino Leach, Digital Principles & Applications, Mc GrawHill
4. Millman&Halkis, Integrated Electronics,MGH

Project Based Learning:

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

To develop a demonstration model on;

1. Potential Divider and Variable DC bias circuit.
2. DC lighting circuit.
3. Automatic LED Emergency Light.
4. Flashing LED.
5. Dancing Light.
6. Voltage regulator using Zener diode.
7. Cascode amplifier using FET.

8. JFET as an analog switch.
9. FET used as a Multiplexer.
10. JFET acts as a current limiter.
11. LDR& Transistors based Light Detector.
12. LDR Based Smart Electronic Candle.
13. Smart Bulb Holder using LDR.
14. MOC3021 Opto-coupler as a solenoid/valve control.
15. Light controller switch using photo-transistor.

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	Computer Aided Machine Drawing		
Course Code	**C112**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work and Practical	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Fundamentals of Mathematics 2. Mechanical Engineering systems 3. Computer Aided Drafting and Visualisation
Course Objectives:-	3. To make the students understand and interpret drawings of machine components 4. To prepare assembly drawings both manually and using standard CAD packages 5. To familiarize the students with Indian Standards on drawing practices and standard components
Course Outcomes:-	The students will be able to 1. **Understand** fundamentals of machine drawing and conventional representation of machine elements. 2. **Understand** concept of Geometric Dimensioning and Tolerancing; and apply in machine drawing. 3. **Understand and drawing** of component assemblies of given part drawings. 4. **Understand and drawing** of part details with the help of assembly drawings.

Course Contents

Unit-I	**Fundamental of Machine Drawing and Conventional Representation**	**(10 Hrs)**
Introduction to Machine Drawing and its importance, Code of practice for Engineering Drawing, BIS specifications – Materials, Welding Joint and symbols, riveted joints, pipe joints, keys, and screwed fasteners. Conventional Representation of dimensioning and sectioning, breaks in pipes and shafts, Screw Threads, springs, gears, foundation bolts, Common features and machine components.		
Unit-II	**Geometric Dimensioning and Tolerancing (GD&T)**	**(10 Hrs)**
Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, types of fits with symbols and applications, Geometrical Tolerances on drawings. Standards followed in industry, Interpretation of given symbols on drawing. **Characteristics of Surface Roughness-** Machining Symbols, Indications of surface roughness and its characteristics, Symbols for directions of lay.		
Unit-III	**Details to Assembly Drawing**	**(14 Hrs)**
Classification of Drawings- Machine drawing, Production Drawing, Part Drawing, Assembly drawing, Drawings for catalogues and instruction manuals, patent drawings, Drawing Standards, Introduction to unit assembly drawing, steps involved in preparing assembly drawing from details and vice-versa, Blueprint Readings. **Preparation of Assembly Drawings:** Universal and Oldham's Couplings, Foot-Step Bearings, Lathe Tool Post, Machine Vice, Pipe Vice, Screw Jack, Single Tool post, Square tool post, Clapper block, Revolving Centre, C-Clamp.		
Unit-IV	**Assembly to Details Drawing and Production Drawing**	**(14 Hrs)**
Types of Production Drawings- Detail or Part Drawings, Working Assembly Drawings, Detailed Drawings and Manufacturing Methods. **Preparation of Detail or Part Drawings:** Plummer Block or Pedestal Bearings, Lathe Tail Stock, Drilling Jig, Piston and Connecting Rod, Gland and Stuffing Box Assembly, Gate valve, Globe valve, Non-Return Valve and Steam Stop Valve.		

Term Work

1. Three A2 size sheets of **Details to assembly** drawing using AutoCAD.
2. Three A2 size sheets of **Assembly to details** drawings using AutoCAD.

Assignments

Minimum **Five** Questions based on each unit in A2 size Sheets

Textbook

1. R.K. Dhavan, "A Textbook of Machine Drawing", S Chand Publication, New Delhi.
2. Gopalakrishna K.R., "Machine Drawing", 22nd Edition, Subhas Stores Books Corner, Bangalore, 2013

References

1. N. D. Bhatt and V.M. Panchal, "Machine Drawing", 48th Edition, Charotar Publishers,2013
2. Junnarkar, N.D., "Machine Drawing", 1st Edition, Pearson Education, 2004
3. N. Siddeshwar, P. Kanniah, V.V.S. Sastri, "Machine Drawing", published by Tata McGrawHill, 2006
4. S. Trymbaka Murthy, "A Text Book of Computer Aided Machine Drawing", CBS Publishers, New Delhi, 2007

Project Based Learning:

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

1. To develop chart to represent different types of nuts and bolts conventionally along with industrial real life application.
2. To develop chart to represent different types of springs conventionally along with industrial real life application.
3. To develop chart to represent different types of welded and riveted joints conventionally along with industrial real life application.
4. To develop chart to represent different types of gears conventionally long with industrial real life
5. To develop chart to represent different types of bearings conventionally along with industrial real life application.
6. To develop chart to represent different types of foundation bolt conventionally along with industrial real life application.
7. To collect different types of nuts and bolts available in market, to identify their specifications and application.
8. To obtain industrial drawings to identify the limit, fits, tolerances.
9. To demonstrate geometrical tolerances for different industrial/real life application.
10. To prepare assembly and detail drawing of a given machine tool component.
11. To prepare assembly and detail drawing of a given IC engine component.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Sheet Metal Operations		
Course Code	**C113**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical:- 02 Hours/ Week	Term Work	50 Marks	01
	Total	**50 Marks**	**01**

Course Prerequisites:-	The student should have, 1. Basic knowledge of workshop tools. 2. Basic knowledge of Materials
Course Objectives:-	1. The student should understand various tools, operations and use them for carrying out sheet metal operations.
Course Outcomes:-	The students should be able to– 1. **Understand** the knowledge of marking, cutting, holding tools and machines used in sheet metal industry. 2. **Understand** the types and use of rivets in sheet metal industry. 3. **Understand** the principle, construction of dies used in press working operations.

Course Contents

Unit-I	First Aid, Sheet Metal Equipment's and Rivets	(12 Hrs.)
General safety precautions and precautions for sheet metal industry. Measuring, marking, cutting and holding tools. Bench Work and Fitting Tools, Gauges, Introduction to machines in sheet metal Industry: shearing machine, bending machine, circular profile cutting machines. Different types of sheet metal folds. Rivets and its different parts, selection of rivet heads, types of rivets and its uses.		
Unit-II	**Introduction to Press Working**	**(12 Hrs.)**
Punching, blanking, shearing, bending and piercing. Punch & Die toleranceand clearance. **Introduction to Dies:** Simple Dies, Compound Dies, Progressive Dies. Types of presses.		

Term Work: List of Experiments

1. Cutting different types of shapes with hand snip.
2. Practical on bending machine
3. Practical on shearing machine
4. Practical on profile cutting machine.
5. Making hole with solid punch and round punch.
6. Practice for riveting.
7. Practical for making components from sheet metal.
8. Demonstrations of press working operations such as Punching, blanking operations.

Text Books:

1. Khanna O.P. and Lal. M., " Production Technology", Dhanpatrai Publications (P) Ltd., New Delhi.
2. Jain R.K., "Production Technology", Khanna Publishers, Delhi.
3. Choudhary Hajra S. k., Choudhary Hajra A. k. "Elements of Workshop Technology Vol 1 Manufacturing Processes, Publisher: Media Publishers & Promoters, India.
4. Choudhary Hajra S. k., Choudhary Hajra A. k. "Elements of Workshop Technology Vol 2 Machine Tools, Publisher: Media Publishers & Promoters, India.
5. Rajput R. K., "Manufacturing Technology", Laxmi Publications (P)Ltd, New Delhi.
6. Chapman W.A.J "Workshop Technology "volume I, II, III, ELBS.

Designation of Course	**Soft Computing- II**		
Course Code	**C114**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical: -02 hours/Week	Term Work and Practical	75 Marks	01
	Total	**75 Marks**	**01**

Course Prerequisites: -	Basic Mathematics
Course Objective: -	The goal of the course is that students should develop techniques for problem solving using a programming language.
Course Outcomes	Students should 1. **Understand** the concept of pointers and **apply** them to locate variables in memory. **2.** **Apply** the concepts of pointers in functions **3.** **Understand** the concept of one-dimensional arrays and **apply** them in writing programs **4.** **Understand** the concept of multidimensional arrays and **apply** them in writing programs **5.** **Understand** the concept of classes and **apply** them in writing programs **6.** **Understand** the concept of objects and **apply** them in writing programs

Course Contents

Unit-I	**Pointers I**	(04 Hrs.)
Data Variables and memory; Address operator: &		
Unit-II	**Pointers II**	(04 Hrs.)
Pointers; Functions, pointers and Indirection Operators		
Unit-III	**Arrays**	(04 Hrs.)
Arrays Fundamentals; Arrays and Functions; Character Arrays		
Unit-IV	**Multidimensional Arrays**	(04 Hrs.)
Multidimensional Arrays; Multidimensional Arrays and Functions; Array filling from data files		
Unit-V	**Classes I**	(04 Hrs.)
Objects and classes; Class members; Class Destructors		
Unit-VI	**Classes II**	(04 Hrs.)
Array of objects; Overloaded operators and objects		

Term Work

Term work shall consist programs (not limited to)listed below based on syllabus.

1. C++ Program to Calculate Average of Numbers Using Arrays
2. C++ Program to Find Largest Element of an Array
3. C++ Program to Calculate Standard Deviation
4. C++ Program to Add Two Matrix Using Multi-dimensional Arrays
5. C++ Program to Multiply Two Matrix Using Multi-dimensional Arrays
6. C++ Program to Find Transpose of a Matrix
7. C++ Program to Multiply two Matrices by Passing Matrix to Function
8. C++ Program to Access Elements of an Array Using Pointer
9. C++ Program to Swap Numbers in Cyclic Order Using Call by Reference
10. C++ Program to Find the Frequency of Characters in a String
11. C++ Program to Find the Number of Vowels, Consonants, Digits and White Spaces in a String
12. C++ Program to Remove all Characters in a String Except Alphabets.

13. C++ Program to Find the Length of a String
14. C++ Program to Concatenate Two Strings
15. C++ Program to Copy Strings
16. C++ Program to Sort Elements in Lexicographical Order (Dictionary Order)
17. C++ Program to Store Information of a Student in a Structure
18. C++ Program to Add Two Distances (in inch-feet) System Using Structures
19. C++ Program to Add Complex Numbers by Passing Structure to a Function
20. C++ Program to Calculate Difference Between Two Time Period
21. C++ Program to Store and Display Information Using Structure
22. Increment ++ and Decrement -- Operator Overloading in C++ Programming
23. C++ Program to Subtract Complex Number Using Operator Overloading

TextBooks

2. "Let Us C++", KanetkarYashavant, BPB Publications

Reference Books

1. “C++ programming Today”, Barbara Johnston, Prentice Hall of India, New Delhi.
2. “C++ how to program”, Paul Deitel and Henry Deitel, Prentice Hall of India, New Delhi.
3. "Accelerated C++: Practical Programming by Example", Andrew Koenig and Barbara E. Moo, Addison-Wesley Publications
4. "C++: The Complete Reference", Herbert Schildt, McGraw Hill Publications.
5. "C++ Primer"; Barbara E. Moo, JoséeLajoie and Stanley B. Lippman; Addison-Wesley Professional
6. "Programming: Principles and Practice Using C++", BjarneStroustrup, Addison-Wesley Professional

B. Tech. Mechanical
Sem.-III

Designation of Course	Thermodynamics Principles		
Course Code	C201		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:	1. Engineering Mathematics. 2. Engineering Physics.
Course Objectives: -	To provide knowledge about 1. Laws of thermodynamics & their applications. 2. Properties of pure substances & vapor processes. 3. Fuels and concepts of combustion.
Course Outcomes: -	On completion of the course, students will be able to– 1. **Understand** concepts of first law of thermodynamic and its application. 2. **Understand** concepts second law of thermodynamics, entropy and availability. 3. **Apply** the knowledge of Properties of steam for different vapor Processes. 4. **Apply** the knowledge of properties of steam for different power cycles. 5. **Understand** the different air standard cycles and **analyze** it. 6. **Understand** the different type of fuels, concepts of combustion and analyze exhaust gas composition.

Course Contents

Unit-I	**First Law of Thermodynamics**	**(08 Hrs.)**
Introduction of thermodynamics, Review of basic definitions, (State, Process, Cycle, Path, Quasi- static process, path fiction and point function, Equilibrium), energy and work transfer, zeroth law of thermodynamics, statement of first law of thermodynamics, Joule's experiment, Limitations of first law of thermodynamics. Reversibility and Irreversibility, Applications of first law to flow and non-flow processes and cycles. Steady flow energy equation and its application to different devices (Boiler, Diffuser, Turbine, Compressor, Condenser, throttling process), PMM-I.		
Unit-II	**Second Law of Thermodynamics, Entropy and Availability**	**(08 Hrs.)**
Heat engine, refrigerator and heat pump, Kelvin-Planck's statement & Clausius statement, equivalence of Kelvin-Planck's and Clausius statements, perpetual motion machine of second kind (PMM-II), Carnot cycle & Carnot heat engine. **Entropy:** Clausius Theorem, Entropy as a property, second law analysis for entropy, Clausius inequality, principle of increase of entropy, irreversibility, Temperature – Entropy relation, Third law of thermodynamics. **Availability:** High- and low-grade energy, available and unavailable energy, loss of available energy due to heat transfer through a finite temperature difference.		
Unit-III	**Properties of Pure Substances and Vapor Processes**	**(08 Hrs.)**
Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-v, T-s and Mollier diagram for steam, use of P-V, T-S, H-S diagrams for Pure substance, Dryness fraction and its determination, Study of steam calorimeters (Barrel, Separating, Throttling, and combined). Non flow and steady flow vapor processes, constant Pressure Process, constant volume Process, constant temperature Process, Isentropic Process, Polytrophic Process, Hyperbolic Process, work transfer & heat		

transfer.		
Unit-IV	**Vapor Power Cycles**	**(08 Hrs.)**
Carnot cycle, Rankine cycle, Comparison of Carnot cycle and Rankine cycle, Efficiency of Rankine cycle, Relative efficiency, Performance parameters of vapor power cycle, Effect of operating variables on Rankin cycle (Superheating, Boiler pressure, condenser pressure).		
Unit-V	**Air Standard Cycles**	**(08 Hrs.)**
Analysis of Air standard cycle, Efficiency and Mean Effective Pressure, Carnot Cycle, Otto Cycle, Diesel cycle, Dual cycle, Comparison of cycles, Atkinson Cycle, Ericsson Cycle, Brayton cycle, Sterling Cycle		
Unit-VI	**Fuels and Introduction to Combustion**	**(08 Hrs.)**
Solid- Biomass, Coal types, liquid: petrol, diesel, bio-oil, their Application, Gas: Bio-gas, low calorific value gases, LPG, CNG, and their application. Properties of fuels, Mass fraction, mole fraction, combustion equation, theoretical air, excess and deficient air, stoichiometric and actual air to fuel ratio, Measurement of calorific value of fuels, analysis of products of combustion, gravimetric and volumetric analysis and their conversions, method to determine flue gas analysis - CO, CO_2, O_2, HC, NO_x, smoke.		

Term Work

Term work shall consist of following **eight** experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. First laws of thermodynamics apply to steady flow energy equation.
2. Study of different types of steam calorimeters.
3. Determination of dryness fraction using any commercially available test rig.
4. Determination of calorific value using bomb calorimeter.
5. Study of Boy’s gas calorimeter.
6. Study and demonstration of exhaust gas analysis by using any commercially available test rig.
7. Demonstration of smoke meter
8. Study of Orsat apparatus.
9. Study and Demonstration of Flash Point.
10. Study and Demonstration of Pour Point.

Assignment:

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

3. Steady flow energy equation with applications
4. Concept of second law of thermodynamics, entropy.
5. Vapour processes.
6. Rankine cycle and vapour power cycle.
7. Air standard cycles.
8. Combustion of fuels.

Text Books

1. V. P. Vasandani and D. S. Kumar, Heat Engineering Metropolitan Book Company, New Delhi.
2. R S Khurmi and J K Gupta, Textbook of Thermal Engineering, S Chand publications.

Reference Books

1. P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publications.
2. Y. A. Cengel & M.A. Boles, Thermodynamics -An engineering approach, Tata McGraw Hill Publications.

3. Rayner Joel, Engineering Thermodynamics, ELBS Longman.
4. R. K. Rajput, Engineering Thermodynamics, Laxmi Publications.
5. Kothandarman & S. Domkundwar, “Thermal Engineering” Dhanpat Rai and Sons.
6. P. L. Ballaney, Thermal Engineering, Khanna Publications.

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. To demonstrate steady flow energy equation for engineering applications such as heat exchangers, turbo machinery, boiler, etc.
2. To demonstrate first law of thermodynamic by using Joule’s experiment.
3. To demonstrate first law of thermodynamic through real life application such as heating of water using a cook stove, operation of a boiler, operation of a turbo machinery, etc.
4. To demonstrate second law of thermodynamic through real life application. (Kelvin-Planck's statement)
5. Demonstration second law of thermodynamic through real life application. (Clausius statement)
6. To demonstrate Boyle's law.
7. To demonstrate Charles's law.
8. To prepare a chart on identification of gas/vapour processes in various real-life applications such as boiler, steam turbine, gas turbine, IC engine cylinder, etc.
9. To prepare a chart on comparison among different air standard cycles for given conditions.
10. To determine calorific values of different types of solid and liquid fuels.

Unit Test

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	Mechanics of Fluids		
Course Code	**C202**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work and Practical	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites: -	1. Engineering Mathematics 2. Engineering Physics 3. Engineering Mechanics
Course Objectives: -	To provide knowledge about 1. Properties of fluids, concepts of fluid statics, kinematics & dynamics 2. Concepts of laminar & turbulent fluid flows 3. Flow around immersed bodies and boundary layer flow 4. Dimensional analysis
Course Outcomes: -	On completion of the course, students will be able to– 1. **Understand** properties of fluids and analyze concepts of fluid statics. 2. **Understand** concepts related to fluid kinematics and analyze practical problems. 3. **Understand** concepts related to fluid dynamics and analyze practical problems. 4. **Understand** concepts related to laminar flow, flow around immersed bodies and analyze practical problems. 5. **Understand** concepts related to flow through pipes, dimensional analysis and **analyze** practical problems. 6. **Understand** concepts related to turbulent flows, boundary layer theory and analyze practical problems.

Course Contents

Unit-I	Properties of Fluids & Fluid Statics	(08 Hrs.)
Properties of Fluid: - Definition of fluid, concept of continuum, Density, Specific Weight, Specific Gravity, Dynamic Viscosity, Kinematic Viscosity, Newton's law of viscosity, types of fluid, Rheological diagram, Surface Tension, Capillarity, Compressibility, Vapour pressure, Classification of fluid. **Fluid Statics:** Hydrostatic law, Pascal's Law, Pressure at a point, Total Pressure, Centre of pressure, Liquid pressure on a plane (Horizontal, Vertical, Inclined) & Curved surfaces, Archimedes Principle, Buoyancy and stability of floating and submerged bodies, Metacentric height.		
Unit-II	**Fluid Kinematics**	**(08 Hrs.)**
Description of fluid motion- Eulerian and Langragian approach, Types of flow (steady, unsteady, uniform, non-uniform, laminar, turbulent, One, Two and Three dimensional, compressible, incompressible, rotational, Irrotational), Continuity equation in Cartesian co-ordinates, flow net, Control volume, Material derivative and acceleration, Visualization of flow field (Stream, Path and Streak line), velocity in two-dimensional flow, stream function and velocity potential function.		
Unit-III	**Fluid Dynamics**	**(08 Hrs.)**
Linear momentum Equation using differential Approach, Introduction to Navier-Stoke's Equation, Euler equation of motion. Derivation of Bernoulli's equation along a streamline, application of Bernoulli's equation to Pitot tube, Venturimeter, Orifice meter, Triangular Notch & Rectangular Notch (Without considering Velocity of Approach), Concept of HGL and THL or TEL.		
Unit-IV	**Laminar Flow & Flow around Immersed Bodies**	**(08 Hrs.)**
Definition, relation between pressure and shear stresses, laminar flow through round pipe, fixed parallel plates. Introduction to CFD Methodology (Elementary Treatment). Forces on immersed bodies: -Lift and		

Drag, Classification of Drag, Flow around circular cylinder and Aerofoil, Development of lift on Aerofoil.		
Unit-V	**Flow Through Pipes & Dimensional Analysis**	**(08 Hrs.)**
Energy losses through pipe-Major and Minor losses, Pipes in series and parallel, Darcy-Weisbach equation, Moody diagram, Syphon, Transmission of power, Water hammer in pipes **Dimensional Analysis:** Dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham pi Theorem, Important dimensionless numbers, Model analysis (Reynolds, Froude and Mach).		
Unit-VI	**Turbulent Flow, Boundary Layer Flow**	**(08 Hrs.)**
Boundary layer, Laminar and Turbulent flow, Velocity distribution, Development of boundary layer on a flat plate, Boundary layer thickness-displacement, Momentum and Energy, Laminar sub layer, Separation of boundary layer and Methods of controlling, Introduction to compressible fluid flow.		

Term Work

Term work shall consist of following **eight** experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Study of Pressure Measuring Devices.
2. Measurement of Viscosity using Redwood Viscometer.
3. Stability of Floating Bodies and Optimum Loading Capacity.
4. Verification of Modified Bernoulli's Equation.
5. Calibration on Venturi meter.
6. Calibration of Orifice meter.
7. Laminar and Turbulent Flow by Reynold's Apparatus.
8. Discharge over Notches.
9. Study of Minor Losses due to Pipe Fitting.

Assignment:

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Fluid statics
2. Fluid kinematics.
3. Venturimeter & orifice meter.
4. Laminar flow and flow around Immersed bodies.
5. Flow through pipes and Dimensional analysis.
6. Boundary conditions for the velocity profiles.

Text Books

1. Dr. R.K. Bansal, A Textbook of Fluid Mechanics and Hydraulic Machines ", Laxmi Publication Pvt. Ltd., New Delhi.
2. R.K. Rajput, A Textbook of Fluid Mechanics and Hydraulic Machines, S. Chand & Company Ltd. New Delhi.

Reference Books:

1. Streeter V. L. and Wylie E. B. Fluid Mechanics McGraw Hill International Book Co.
2. Yunus Cengel, Jhon Cimbala, Fluid Mechanics, Tata McGraw Hill, New Delhi.
3. Streeter & Wylie, Fluid Mechanics, Tata McGraw Hill.
4. Frank White, Fluid Mechanics, McGraw Hill.
5. Dr. P.N. Modi and Dr. S.M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House.

6. Garde R. J. and Mirajgaonkar, Engineering Fluid Mechanics, Nem Chand & Bros, Roorkee, SCITECH, Publication (India) Pvt. Ltd.

Project Based Learning:

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. To demonstrate Pascal's law through real life application such as hydraulic jack, hydraulic press, hydraulic lift, etc.
2. To demonstrate Archimedes's Principle through real life application.
3. To prepare an experimental setup for measurement of viscosity of different oils.
4. To demonstrate different types of fluid flow through Reynold's experiment.
5. To prepare a chart on real life application of different types of fluid flows and its characteristics.
6. To measure the flow velocity using Pitot tube.
7. To prepare a chart on real life application on fluid flow measuring devices.
8. To develop demonstration model for turbulent and laminar flow.
9. To develop demonstration model of simple viscous damper for earthquake resistance.
10. To prepare a chart for industrial applications of Pascal's law.

Unit Test –

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	ITC-I: Manufacturing Technology		
Course Code	**C203**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
	Internal Assessment	40 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites:-	The student should have basic knowledge of 1. Manufacturing Processes. 2. Machining Processes.
Course Objectives:-	The student should 1. To acquire the knowledge of Foundry Technology. 2. To acquire the knowledge of hot working and cold working processes. 3. To acquire the knowledge of lathe, drilling, milling, and abrasive machining.
Course Outcomes:-	The students should be able to– 1. **Understand** the pattern making and mold making. 2. **Understand** the **v**arious casting processes and **apply** the best casting process for a specific product. 3. **Understand** the hot working and cold working processes and **apply** them in Manufacturing. 4. **Understand** different operations on lathe machine and **apply** them to create the job. 5. **Understand** different operations of drilling machine and milling machine and **apply** them to create the job. 6. **Understand** various grinding machines and plastic moulding machine and **apply** them for create the shape.

Course Contents

Unit-I	Pattern and Mould Making	(06 Hrs.)
Introduction to casting, Foundry Layout, Foundry departments and sections, Pattern and pattern making, Design and allowances for patterns, Colour codes for patterns, Storage of patterns. Moulding sand and core sands, Sand control Test, Core and core making –Introduction, Core making Procedure, Types of cores, Core print, Core boxes. Mould and mould making- Moulding Methods, Moulding processes, Design of Gating System.		
Unit-II	**Sand Casting and Die Casting Practice**	**(06 Hrs.)**
Sand Casting Practice: Melting furnaces and their selection, Cupola furnace, Induction melting furnaces, Advantages, Limitations, applications, pouring practice and equipment's, Ladle technology, Strike out, Fettling, Cleaning and Surface preparation of castings, Defects in castings. Die Casting Practice: Pressure and gravity die casting, Shell mould casting, Investment casting, Continuous casting, centrifugal casting, Applications, Merits and limitations.		
Unit-III	**Hot and Cold Working Processes**	**(06 Hrs.)**
Hot Working Processes: Principle rolling, forging - drops, press, upset. Rolling, forging- extrusion, drawing, spinning, Angle of Contact of rolling, effect of hot working. Cold Working Processes: Cold rolling, swaging, forges extrusion- forward backward impact. Roll forging, tube drawing, wire drawing, spinning, shot peening, high energy rate forming, Stresses in wire drawing operations		
Unit-IV	**Theory of Metal Cutting**	**(06 Hrs.)**
Introduction, function, types, construction, accessories, operations, thread cutting, single and multi-start thread cutting, different tools, tool materials, Tool Geometry- Single Point cutting tool, Tool		

Wear and Tool Life, Mechanics of Metal cutting- Merchant's Circle Diagram, concept of speed, feed, depth of cut. Introduction to Boring Machines- general arrangement and nature of work done.		
Unit-V	**Drilling and Milling Machines**	**(06 Hrs.)**
Drilling Machines: Fundamentals of drilling process, twist drill geometry, tool holders, Types of drilling machines, drilling operations. Types of drills, reaming process. Milling Machines: Fundamentals of milling process, cutters-types and geometry, Operations performed on milling machines. Dividing head, methods of indexing.		
Unit-VI	**Abrasive Machining Processes, Plastics & Plastic Moulding**	**(06 Hrs.)**
Abrasive Machining Processes: Abrasive machining, abrasives -types, size and geometry, Grinding, grinding wheels, wheel marking, wheel selection. Wheel mounting. Types of grinding machines, grinding faults, Honing, lapping, super finishing, buffing, burnishing process. Plastics & Plastic Moulding: Moulding characteristics of plastic, Moulding process- compression, transfer and injection blow moulding. Mould design- Materials and construction, bulk factor, shrinkage, moulding parameters, moulding machines, extruders.		

Assignments:

1. Pattern and Mould Making.
2. Sand Casting and Die Casting Practice.
3. Hot Working processes and Cold Working Processes.
4. Turning, boring related process.
5. Drilling Machines.
6. Milling Machines.
7. Abrasive Machining Processes and superfinishing processes.
8. Plastics & Plastic Moulding.

Text Books:

1. O. P. Khanna, A text book of Foundry Technology, Dhanpat Rai and Sons
2. P. C. Sharma, Production Engineering, S. Chand Publications
3. R. K. Jain, Production Technology, Khanna Publishers

Reference Book

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technologyp, Vol- II, McGraw Hill Education (India) Private Limited
3. G. R. Nagpal, Tool Engineering and Design, Khanna Publishers
4. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai & Co.
5. Hajra Chaudhari, Workshop Technology, Vol.-II
6. Roy A. Lindberg, Process & Materials of Manufacture, PHI
7. E. P. DeGrmo, J. T. Black and A. Kosher, Material and processes in manufacturing, PHI
8. HMT Handbook, Production Technology, TMH

Project Based Learning:

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1 To develop a pattern of a any component using different types of material.
2 To develop a core part by using different types of materials.
3 To develop a demonstration model of gating system for any mechanical component.
5 To develop a demonstration model of Cupola furnace
6 To develop a demonstration model of pouring equipment's.
7 To prepare a flowchart for investment casting process
8 To develop a demonstration model of centrifugal casting
9 To develop a demonstration model of wire drawing process

10 To develop a demonstration model of mechanical press
11 To develop a demonstration model of short penning process
12 To develop a demonstration model of different types of rolling mills
13 Case study on different types of tools for thread cutting operations
14 To prepare a chart on concept of single point cutting tools & its geometry
15 To develop a demonstration model of mini bench tapping machine
16 To develop a demonstration model of milling mechanisms for vertical/horizontal movement
17 To develop a demonstration model of indexing mechanism
19 To develop a demonstration model of plastic molding machine
20 To develop a demonstration model of buffing machine
21 To develop a demonstration model of abrasive belt grinder

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	Strength of Machine Components		
Course Code	C204		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Assignments Internal	40 Marks	
Tutorial: - 01 Hours/ Week	Term Work	25 Marks	01
	Tutorial	-	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	1. Engineering Mathematics 2. Engineering Mechanics 3. Engineering Science
Course Objectives:-	1. Understand simple and principal stress and strain 2. Able to find principal stresses on any oblique plane by analytical and graphical method. 3. Able to draw shear force and bending moment diagram and find slope and deflection of beam 4. Able to draw bending stress and shear stress diagram at different cross section in I, C and T section beam. 5. Able to find stresses in shaft in torsional, combined torsional and bending, combined torsional and axial loading. 6. Able to solve problems on strain energy and Euler's column.
Course Outcomes:-	1. **Understand** the concept of simple stress and strain and apply to find it for simple component. 2. **Understand** the concept of principal stress analytical and graphical by Mohr's circle; and apply it to find stresses on any oblique plane inclined to principal plane. 3. **Understand** the concept of shear force and bending moment and apply it to find shear force diagram and bending moment diagram for any loading condition on simply supported beam and cantilever beam. 4. **Understand** the concept of slope and deflection and apply it to find for any loading condition on simply supported beam and cantilever beam by maculays double integration method 5. **Understand** the concept of pure bending and shear and apply it to find bending stress and shear stress diagram of I, C and T section of beam. 6. **Understand** the concept of column theory and strain energy and apply it for loading condition.

Course Contents

Unit-I	Simple Stress and Strain	(06 Hrs)
Load, Direct or normal stress ,Direct strain, Sign convention for direct stress and strain ,Elastic materials, Hooke's law, Modulus of elasticity - Young's modulus, Tensile test, Ductile materials, Brittle materials, Poisson's ratio, Application of Poisson's ratio to a two-dimensional stress system, Shear stress, Shear strain, Modulus of rigidity, Relationship Between E , G and K, Double shear, Allowable working stress -factor of safety, Load factor, Thermal stresses,		
Unit-II	**Principal Stresses, Theories of Failure**	**(06 Hrs)**
Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses, and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses. Theories of Elastic failure: Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory.		

Unit-III	Shear Force and Bending Moment Diagram, Slope and Deflection	(06 Hrs)
Types of supports and beams, shear force (S.F.), bending moment (B.M.), S.F. and B. M. sign convention, S.F. and B.M. diagrams for beams carrying different loading conditions. Points of contra flexure, Relationship between S.F, B.M. and intensity of loading. Introduction, Simple bending theory, Neutral axis, Section modulus, second moment of area, Relationship between loading, S.F., B.M., slope and deflection, Double integration method, Macaulay's method for all loading conditions.		
Unit-IV	**Stresses in Beams, Thin and Thick cylinders**	**(06 Hrs)**
Bending stresses: Theory of simple bending, assumptions, derivation of flexural formula, second moment of area of common cross sections (rectangular, I,T,C) with respect to centroidal and parallel axes, bending stress distribution diagrams, moment of resistance and section modulus. Shear stresses: Concept, derivation of shear stress distribution formula, shear stress distribution diagrams for common symmetrical sections, maximum and average shears stresses, shear connection between flange and web. Concept of shear centre, Stresses and deformation in Thin Cylindrical and Spherical shells subjected to internal pressure.		
Unit-V	**Torsion**	**(06 Hrs)**
Simple torsion theory, Polar second moment of area, Shear stress and shear strain in shafts, Section modulus, Torsional rigidity. Principal stresses, Strain energy in torsion, Variation of data along shaft length-torsion of tapered shafts, Power transmitted by shafts. Stresses in solid circular shaft- Torsional load only, bending load only, combined torsional and bending, Combined Torsion and axial loading.		
Unit-VI	**Euler's Columns and Strain Energy**	**(06 Hrs)**
Concept of buckling of columns, derivation of Euler's formula for buckling load for column with hinged ends, concept of equivalent length for various end conditions, limitations of Euler's formula, Rankine's formula, safe load on columns. Strain energy: Strain energy due to axial load (gradual, sudden and impact), Strain energy due to self-weight.		

Term Work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Tension test for ductile materials
2. Tension test for brittle materials
3. Compression test for ductile materials
4. Compression test for brittle materials
5. Shear test for ductile materials
6. Shear test for brittle materials
7. Torsion test for ductile materials
8. Torsion test for brittle materials
9. Impact Test- IZOD and Charpy
10. Strain Gaugeand rosettes theory
11. Testing of hardness by Rockwell
12. Graphical simulation of
    a. Shear force and bending moment diagrams with different end conditions.
    b. Slope and deflection.
    c. Principal stresses through graphical and analytical method.

List of Assignments

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Simple stress and strain.
2. Principal stresses and strain.
3. Shear force and Bending moment diagram and slope and deflection
4. Stresses in beams, thickand thin cylinder
5. Torsion
6. Euler's column and strain energy method

List of Tutorial

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

1. Stresses in simple bar, Elastic modulus and two-dimensional stress systems.
2. Normal, tangential and resultant stresses on any oblique plane inclined to normal plane by analytical and graphical method.
3. Shaft diameter and factor of safety by using theories of failure.
4. Shear and bending moments on cantilever and simply supported beam and draw SFD and BMD.
5. Slope and deflection at any section between beams by using Macaulay's method.
6. Stresses in beam and draw shear stress diagram and bending stress diagram.
7. Shaft diameter and stresses when shaft subjected to torsion, bending combined torsional and bending, combined torsional and axial loads.
8. Euler's column theory and strain energy.

Textbooks

1. A textbook of strength of material by R.K.Bansal

Reference Books

1. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publication
2. J. E. Shigley, Mechanical Engineering Design, McGraw Hill
3. R. Subramanian strength of Material
4. S Ramamrutham, Strength of Material
5. R.K Rajput, Strength of materials

Project Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on syllabus contents:

1. To prepare demonstration model of cantilever beam for the study of deflection in it.
2. To prepare demonstration model of simply supported beam for the study of deflection in it.
3. To prepare demonstration model of fixed beam for the study of deflection in it.
4. To prepare demonstration model of Overhang beam for the study of deflection in it.
5. To prepare the chart on relation between E, G, K with derivation.
6. To prepare demonstration model for studying strain energy with consideration of various conditions like impact load, sudden load, gradual load.
7. To prepare the chart on various concepts used in Principal Stresses& planes.
8. To prepare the chart on concept use in Mohr's Circle method using graphically & analytically.
9. To prepare the chart on Rules and guidelines use for drawing SFD & BMD.
10. To prepare the chart on finding bending stress for I cross-sections.
11. To prepare the chart on finding bending stress for T cross-sections.
12. To prepare the chart on finding bending stress for C cross-sections.
13. To prepare the chart on concepts used in solid &hollow shafts.
14. To prepare the chart and demonstration model of Euler's formula for buckling load.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Mechanisms of Machines		
Course Code	C205		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Engineering Mathematics 2. Engineering Physics 3. Engineering Mechanics
Course Objectives:-	1. To make the students conversant with kinematic analysis of mechanisms applied to real life and industrial applications. 2. To develop the competency to analyse the velocity and acceleration in mechanisms using analytical and graphical approach. 3. To develop the competency to analyse the friction clutches, Brakes, dynamometer and flywheel.
Course Outcomes:-	1. **Understand** the fundamental concept of Lower pair mechanisms and **apply** to real life and industrial applications. 2. **Understand** the basic concept of kinematic analysis and **evaluate** forces acting on reciprocating engine by graphical and analytical method. 3. **Understand** the concept of velocity and acceleration of any planar mechanism and **analyze** it graphically by using relative velocity - acceleration method and ICR method, Coriolis component of acceleration. 4. **Understand** the concept of friction and apply it in application of clutches. 5. **Apply** the concept of friction to **analyse** different parameter in Brakes and Dynamometer 6. **Understand** the fundamental concept of Turning moment diagram and flywheel; and **evaluate** coefficient fluctuation speed and energy.

Course Contents

Unit-I	Mechanisms with Lower Pair	(08 Hrs.)
Introduction, Pantograph, Straight line mechanisms- Exact and Approximate, Hook Joint, Double Hook's Joint, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism. Theory and analysis of Compound Pendulum, Concept of equivalent length of simple pendulum, Bifilar suspension, Trifiler suspension.		
Unit-II	**Inertial Forces in Reciprocating Parts**	**(08 Hrs.)**
Analytical method for displacement, velocity and acceleration analysis of slider cranks Mechanism. Klein's construction. Dynamics of Reciprocating Engines: Two mass statically and dynamically equivalent system, Correction couple, static and dynamic force analysis of reciprocating engine mechanism, Torque Exerted on crankshaft.		
Unit-III	**Kinematic Analysis of Mechanisms: Graphical Methods**	**(08 Hrs.)**
Relative Velocity Method: Relative velocity of a point on a link, Angular velocity of a link, Sliding velocity, Velocity polygons for simple mechanisms. Relative Acceleration Method: Relative acceleration of a point on a link, Angular acceleration of a link, Acceleration polygons for simple mechanisms. Coriolis component of acceleration. Instantaneous Centre of Rotation (ICR)Method(limit to only 6 link mechanisms)- Kennedy's Theorem, Body and space centrode.		
Unit-IV	**Friction Clutches**	**(08 Hrs.)**
Friction: Friction in turning pair, friction circle, friction axis, friction in slider crank mechanism.		

Pivot and collar friction. Friction clutches- design considerations, Classification of Clutches, torque transmitting capacity of – Single plate and multi-plate clutch, cone clutch and centrifugal clutch		
Unit-V	**Brakes and Dynamometers**	**(08 Hrs)**
Brakes-Introduction, Classification of brakes, material for brake lining, types of brakes, braking torque of - shoe brakes, internal shoe brake, disc brake. Dynamometer-Types of dynamometers, brake power of absorption and transmission type dynamometers – prony brake, rope brake, belt transmission.		
Unit-VI	**Turning Moment Diagrams and Flywheel**	**(08 Hrs.)**
Introduction, Turning Moment Diagrams for different types of Engines, Fluctuations of Energy and Speed of Crankshaft, Coefficient of fluctuation of Energy and speed. Flywheel-Introduction, Coefficient of fluctuation of speed, Energy stored in flywheel, dimensions of flywheel rim, Flywheel in punching press.		

Term Work

The following experiments shall be performed

1. Compound Pendulum
2. Bifilar Suspension Method and Trifilar Suspension Method
3. Hook Coupling Experiment
4. Velocity and acceleration analysis using Graphical methods by Polygon method.
5. Velocity and acceleration analysis using Graphical methods by Klein's construction
6. Velocity analysis using Graphical methods by ICR.
7. Velocity and acceleration analysis using Graphical methods i.e., polygons involving Coriolis component.
8. To determine Coriolis Component of Acceleration at various speeds of rotation and water flow rates.
9. To measure torque transmitting capacity of friction clutch experimentally or To study of different types of friction Clutches.
10. To study the various types of Brakes and dynamometers with their practical applications.
11. Study of Turning Moment diagrams and to calculate the experimental and theoretical moment of inertia of different type of Flywheel.
12. Mini-project based on contents of Syllabus.

Assignment

Numerical and/or theory questions on each unit from previous year question papers of GATE/ESE Mechanical Engg. examinations.

Reference Books

1. Thomas Bevan, "Theory of Machines", CBS Publishers & Distributors, Delhi.
2. Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw Hill, Inc.
3. Ghosh Amitabh and Malik A.K., "Theory of Machines and Mechanisms", East-west Press.
4. Hall A.S., "Kinematics and Linkages Design", Prentice-Hall.
5. Erdman, A. G. & Sandor, G.N., "Mechanism design, Analysis and synthesis", Vol 1, Prentice – Hall of India.

Text Books

1. Rattan S. S., "Theory of Machines", Tata McGraw Hill.
2. Ballaney P. L., "Theory of Machines", Khanna Publishers, Delhi.
3. R. S. Khurmi, "Theory of Machines', S Chand Publication.

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. To develop demonstration model of Pantograph mechanism
2. To develop demonstration model of Ackerman steering gear mechanism.
3. To develop demonstration model of Davis steering gear mechanism.
4. To develop demonstration models of exact straight line motion mechanism.
5. To develop demonstration model to understand Coriolis Effect.
6. To prepare chart on comparison among different types of clutches with their application.
7. Case study on real life application of clutches used in automobile.
8. To develop demonstration model of Prony brake dynamometer
9. Case study on real life application of Brakes used in automobile.
10. To prepare chart on comparison among different types of dynamometer.
11. To develop demonstration model of flywheel energy storage system.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Python Programming-I		
Course Code	**C206**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical: - 04 Hours/ Week	Term Work and Practical	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:-	Basics of C and C^{++}Programming
Course Objectives:-	The students should be able to 1. Readily use the Python programming language 2. Apply various data types and control structure. 3. Understand and begin to implement code
Course Outcomes:-	Upon completion of the course, students will be able to 1. **Understand** how to install and run python 2. **Understand** flow control 3. **Understand** complex datatypes 4. **Understand** and **Apply** functions 5. **Understand** various modules 6. **Understand** and **Apply** NumPy module

Course Contents

Unit-I	Python introduction	(08 Hrs.)
Learn to install and run Python on your computer, Keywords and Identifiers, Statement, Indentation and Comments, Variables, Constants and Literals, Data Types, Type Conversion and Type Casting, Input, Output and Import		
Unit-II	**Python Flow Control**	**(08 Hrs.)**
Learn to install and run Python on your computer, Keywords and Identifiers, Statement, Indentation and Comments, Variables, Constants and Literals, Data Types, Type Conversion and Type Casting, Input, Output and Import		
Unit-III	**Datatypes**	**(08 Hrs.)**
Numbers, Type Conversion and Mathematics, List, Tuple, Strings, Sets, Dictionary		
Unit-IV	**Python Functions**	**(08 Hrs.)**
Function Arguments, Recursion, Anonymous/Lambda Function, Global, Local and Nonlocal variables, Global Keyword		
Unit-V	**Python Modules**	**(08 Hrs.)**
Modules in Python, import modules in Python, import statement, Import with renaming, from...import statement, Import all names, Python Module Search Path		
Unit-VI	**NumPy Module**	**(08 Hrs.)**
Python Matrix, Add Two Matrices, Transpose a Matrix, Multiply two matrices		

Term Work

1. Basic Exercise for Beginners
   Practice and quickly learn Python's necessary skills by solving simple questions and problems. Topics: Variables, Operators, Loops, String, Numbers, List
2. Python Loop Exercise
   This Python loop exercise aims to help developers to practice branching and Looping techniques in Python.
   Topics: If-else statements, loop, and while loop.
3. Python Functions Exercise
   Practice how to create a function, nested functions, and use the function arguments

effectively in Python by solving different questions.
Topics: Function’s arguments, built-in functions.

4. Python String Exercise
   Solve Python String exercise to learn and practice String operations and manipulations.
5. Python Data Structure Exercise
   Practice widely used Python types such as List, Set, Dictionary, and Tuple operations in Python
6. Python List Exercise
   This Python list exercise aims to help Python developers to learn and practice list operations.
7. Python Dictionary Exercise
   This Python dictionary exercise aims to help Python developers to learn and practice dictionary operations.
8. Python Tuple Exercise
   This exercise aims to help Python developers to learn and practice tuple operations.

Text Books

1. Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher,
2. Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd., 2015.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt.Ltd., 2016.

Reference Books

1. Python Programming using problem solving Approach by ReemaThareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173.
2. Data Structures and Algorithms in Python by Michael T Goodrich and RoberttoThamassia, Micheal S Goldwasser, Wiley Publisher(2016)
3. Fundamentals of Python first Programmes by Kenneth A Lambert, Copyrighted material Course Technology Inc. 1st edition (6th February2009)

Supplementary Resources:

1. http://www.w3schools.com
2. http://docs.python.org
3. http://www.tutorialspoint.com
4. http://www.learnpython.org

Designation of Course	Vocational Course I: Automobile Servicing- I		
Course Code	**C207**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
	Term Work and Oral	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:	1. Inclination for taking up Two-Wheeler Repairs and Service as a self-employment occupation 2. Knowledge of Mechanical Engineering System
Course Objectives: -	1. To perform skilled mechanical work in diagnosing, repairing and maintaining all major vehicle systems of two-wheeler 2. To provide knowledge on automotive industry and job-related activities as an automotive service technician. 3. To work safely and responsibly within all shop standards and environmental guidelines.
Course Outcomes: -	1. **Understand** the suspension system of two-wheeler and **apply** it to diagnosing, repairing and maintaining. 2. **Understand** the braking and steering system of two-wheeler and **apply** it to diagnosing, repairing and maintaining. 3. **Understand** the transmission system of two-wheeler and **apply** it to diagnosing, repairing and maintaining clutch and gear box. 4. **Understand** the engine system of two-wheeler and **apply** it to diagnosing, repairing and maintaining. 5. **Understand** the ignition system of two-wheeler and **apply** it to diagnosing, repairing and maintaining. 6. **Understand** the electrical system other accessories of two-wheeler and **apply** it to diagnosing, repairing and maintaining.

Course Contents

Unit-I	Suspension System in Two Wheelers	(08 Hrs.)
Safety, Hand Tools and Equipment's, Nomenclature of different parts of vehicle and their locations,Introduction & Function of various parts & System of Two-Wheeler **Suspension System:** Introduction, Objectives of suspension, Basic requirement, Function of suspension springs, Types of suspension springs, Suspension system trouble shooting.		
Unit-II	**Brake and Steering Systems**	**(08 Hrs.)**
Brake System: Principle, Braking requirements, Types of brakes, Drum brakes Disk brakes, Mechanical Brakes, Hydraulic brakes, Brake fluid, Disc brake pads, Braking system trouble shooting. **Steering:** Steering system & their use, Inspect and adjust rake of front fork, dismantle trailing link, adjust heavy duty thrust races.		
Unit-III	**Transmission system in Two Wheelers**	**(08 Hrs.)**
Gear Box: Function of transmission, Necessity of transmission, Types of transmission, Manual transmission, sliding mesh gear box, constant mesh gear box, synchromesh gear box, **Clutch:** Definition, Requirements of clutch, Principle of friction clutches, Dry friction clutches (Single plate clutch, Multiplate clutch, Centrifugal clutch) Preliminary inspection of clutch, clutch adjustment, Clutch overhaul, clutch trouble shooting. Chain & chain Drive, sprocket (chain, sprocket, shafts)		
Unit-IV	**Engine system of Two Wheelers**	**(08 Hrs.)**
Basic engine terminology, Types of engine, Constructional details, working of 2-stroke and 4-stroke engine, Classification of 2-stroke & 4-Stroke Engine & their difference, Engine servicing, Repairing method of Engine, engine removal, engine installation, General theory of Carburetion & Silencer.		
Unit-V	**Ignition Systems of Two Wheelers**	**(08 Hrs.)**
Ignition System: Function, Requirement of an ignition system, Types of ignition system, Battery ignition, Magneto ignition Electronic ignition, Components of battery and electronic ignition system,		

Testing and servicing of ignition system components, Ignition system trouble shooting,Kick-starting system of 2 wheelers.		
Unit-VI	**Electrical Systems and Accessories in Two-Wheeler**	**(08 Hrs.)**
Electrical and electronic components used in auto electrical, auto electrical parts wiring, battery inspection and maintenance, testing of battery voltage, testing of electrical parts such as head lamp, horn side indicator,brake light etc. Use ofECM bike scanner.		

List of Experiments-

1. **Introduction:** Importance of safety and general precaution, Elementary First Aid, Identify the parts &general servicing of Two-Wheeler, washing, cleaning, oiling, greasing and lubricating.
2. **Suspension Work:** Servicing of suspension changing bush, checking shock absorbers. Cleaning, Checking and oil filling of shock absorbers. Cleaning & checking the wheel bearings and greasing.
3. **Break Work:** Adjusting brake pedal play, servicing the brake system, cleaning, checking, greasing and assembling. Inspecting the shoes and wheel drums, changing of brake lining. Repairing and maintenance of hydraulic disc brake used in Motorcycles.
4. **Transmission:** Adjusting clutch lever free play, removing clutch assembly from Two-wheeler, cleaning and inspecting parts. Replacing defective parts. Fitting clutch assembly. Repair work of Automatic clutch and automatic transmission used in motor vehicle
5. Checking, adjusting and replacing defective parts (chain, sprocket, shafts) in power transmission from engine to driving wheel.
6. **Engine Work:** Dismantling the unserviceable engine, cleaning and inspecting the parts, checking engine bore piston rings, connecting rod, bearings, crankshaft, assembling all the parts and measures the gaps. Engine Timing setting and Valve Timing setting of 4 -S Engine. Dismantling a four-stroke engine of two-wheeler cleaning, inspecting and assembling parts.
7. Dismantling the air cleaner, cleaning, inspecting, cleaning fuel tank, servicing carburetor, rectifying causes for engine not starting, and high fuel consumption.
8. Starting engine, tuning for slow speed, checking smoke, and setting for exhaust gas emission measurement as per norms.
9. **Ignition System:** Dismantling the C.B. point cleaning electronic Ignition system & inspecting and replacing the pitted points. Making wiring harness and check different Electrical circuits used in Two-wheelers.
10. **Steering work:** Inspect and adjust rake of front fork, dismantle trailing link, adjust heavy duty thrust races.
11. **Electrical accessories repair:** Tracing the A.C /D.C electrical circuit in a two-wheeler, checking horn, head light, indicator and replacing if necessary.
12. Practice on how to read job-card, General Servicing & road testing of Two-Wheeler.

Text Books

1. Automobile Mechanics, A.K. Babu, S.C.Sharma, T.R. Banga, Khanna Publishing House

Reference Books

1. Automobile Engineering by Kirpal Singh Standard Publishers Distributors.
2. Automotive Engines, A.K. Babu, Khanna Publishing House

B. Tech. Mechanical
Sem.-IV

Designation of Course	Thermodynamics Applications		
Course Code	C209		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Mechanical Engineering System. 2. Thermodynamic principals
Course Objectives:-	1. Steam generator and their performance analysis. 2. Reciprocating air compressors, Gas turbines & jet propulsion. 3. Various systems and phenomenon of combustion in I.C. Engine; and Performance analysis of I.C. Engine.
Course Outcomes:-	On completion of the course, students will be able to– 1. **Understand** construction working of steam generators and **analysis** their performance. 2. **Understand** construction working of Reciprocating air compressors and **analysis** their performance. 3. **Understand** fundamentals of gas turbine, **analysis** their performance and application of gas turbines & jet propulsion. 4. **Understand** I.C. Engine systems viz. ignition, cooling, lubrication, and governing. 5. **Understand** phenomenon of combustion in S.I and C.I. Engine. 6. **Understand** terms related to I.C. Engine testing and **analysis** their performance.

Course Contents

Unit-I	**High pressure Boilers and Performance of Boilers**	**(08 Hrs.)**
Classification of boilers Features of high-pressure boiler, construction and working of high-pressure boilers, Fluidize bed combustion, boiler mountings and Accessories. Boiler performance calculations- Equivalent evaporation, Boiler efficiency, Energy balance, boiler controls, Boiler draught.		
Unit-II	**Reciprocating Air Compressors**	**(08 Hrs.)**
Uses of compressed air, classification, constructional details of single stage reciprocating compressor, computation of work done, isothermal work done, isothermal efficiency, effect of clearance, volumetric efficiency, FAD, theoretical and actual indicator diagrams, method of improving volumetric efficiency. Need of multi staging, multistage compressor, work done, volumetric efficiency, condition for maximum efficiency, intercooling, actual indicator diagram		
Unit-III	**Gas Turbines & Jet Propulsion**	**(08 Hrs.)**
Theory and fundamentals of gas turbine, Principals, Classification, Assumption for simple gas turbine cycle analysis, Work ratio, Concepts of maximum and optimum pressure ratio, Actual cycle, Effect of operating variable on thermal efficiency, Regeneration, Intercooling. Reheating and their effect on performance, Closed cycle and Semi-Closed cycle gas turbine plant, Application of gas turbines. **Jet Propulsion:** Introduction, Theory of jet propulsion, Types of jet engines, Energy flow through jet engine, Thrust, Thrust power, Propulsive, Thermal and overall efficiency, Turbojet, Turboprop, Turbofan and Ducted fan engines, Pulse jet and Ram jet engines, Application of jet engines, Methods of thrust augmentation, Introduction to rocket engines.		
Unit -IV	**I. C. Engine Systems**	**(08 Hrs.)**

Fuel supply system for S.I and C.I. Engines, M.P.F.I. system for modern automobile engines, CRDI. **Ignition and injection System:** Battery & coil ignition system, Magneto ignition system, Electronic ignition system, Advantage over mechanical contact breaker point system. Spark-Advance Mechanisms. **Engine Cooling System**: Necessity of cooling system, effect of overcooling, Air cooling, Water cooling, Thermostatic radiators. **Lubrication System**: Mist lubrication system, Dry sump lubrication, Wet sump lubrications, Comparison between Wet sump and Dry sump systems, Oil pump **Governing System**: Function of Governor, Quality governing, Quantity governing, Hit & miss governing **Supercharging:** Objects of supercharging, Effects on performance, Limitations, Methods of supercharging & turbocharging, Limitation of turbocharging,		
Unit-V	**Combustion in I. C. engines**	**(08 Hrs.)**
Combustion in S. I. Engines: Valve timing Diagram for S.I. engine, Ignition Limit, Stages of combustion, Effect of engine variables on ignition lag & flame propagation, Abnormal combustion: Theories, Effects & Controlling measures, Combustion chambers for S. I. engines Combustion in C. I. Engines: Valve timing Diagram for C.I. engine, Air-fuel ratio for C.I engines, Stages of combustion, Ignition delay & factors influencing delay period, Diesel knock & its control, Combustion chambers for C. I. engines		
Unit-VI	**Performance Characteristics & Testing of I.C. Engines**	**(08 Hrs.)**
Introduction to Indian standards for testing of I.C. Engines, Performance characteristics, Determination of brake power, indicated power, Friction power, Methods to determine power and efficiency, Determination of break thermal efficiency, Mechanical efficiency, volumetric efficiency, Variables affecting performance of engine, Mean Effective Pressure, SFC, Air consumption, Energy balance. Engine Emission and their controls.		

Term Work:

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Study and demonstration of boiler mountings.
2. Study and demonstration of boiler Accessories.
3. Trial on steam power plant.
4. Test on reciprocating air compressor.
5. Performance test on rotary air compressor.
6. Trial on multi cylinder petrol engine – Morse Test.
7. Trial on multi-cylinder diesel engine.
8. Study of superchargers & turbochargers
9. Study of I. C. Engine emission norms.
10. Visit to Boiler House
11. Visit to Automobile service station.
12. Mini-Project on the contents of the syllabus

Assignment:

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Boiler performance.
2. Single and multistage reciprocating air compressors
3. Gas turbine performance
4. I C engine systems
5. I C engine combustions
6. Performance of I C engines.

Text Books

1. V. P. Vasandani and D. S. Kumar, Heat Engineering Metropolitan Book Company, New Delhi.

2. R S Khurmi and J K Gupta, Textbook of Thermal Engineering, S Chand publications.

Reference Books

1. R. K. Rajput, Thermal Engineering, Laxmi Publications
2. Y. Cengel & Boles, “Thermodynamics -An engineering approach”, Tata McGraw Hill Publications
3. S. Domkundwar, “Thermodynamics & Heat Engines” Dhanpat Rai and Sons
4. P. K. Nag, “Engineering Thermodynamics”, Tata McGraw Hill Publications
5. P. L. Ballany, “Thermal Engineering”, Khanna Publications
6. Ganesan V, “Internal Combustion Engines”, Tata McGraw Hill Publishing House
7. R. K. Rajput, “Internal Combustion Engines”, Laxmi Publications.
8. M. L. Mathur & R. P. Sharma, “A Course in I. C. Engines”, Dhanpat Rai & Sons
9. V. M. Domkundwar, “A Course in I. C. Engines”, Dhanpat Rai & Co.
10. Shrinivasan, “Automobile Engines”, Tata McGraw Hill Publishing House – CBS Publication

Project Based Learning

Following is the list of Topics for project based learning (Not Limited to) based on the syllabus contents:

1. To prepare a chart on performance testing of boilers.
2. To prepare a chart on comparison among various types of boilers.
3. To prepare a chart on comparison between open and closed cycle gas turbines.
4. To prepare a chart on comparison among various turbo machinery.
5. To prepare a chart on comparison among different types of jet engines.
6. To prepare demonstration model of ignition system.
7. To prepare demonstration model of engine cooling system.
8. To prepare demonstration model of lubrication system.
9. To prepare demonstration model of governing system.
10. To prepare a chart on different processes of combustion in IC engines.
11. Case study on different IC Engine systems used in cars available in market.
12. To prepare a chart on various performance characteristics of IC engines.

Unit Test –

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	Theory of Machines		
Course Code	C210		
Teaching Scheme	Examination Scheme		Credits Allotted
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical: - 02 Hours/Week	Internal Assessment	40 Marks	
Tutorial: - 01 Hour/Week	Term Work and Oral	50 Marks	01
	Tutorial	Internal Evaluation	01
	Total	**150 Marks**	**05**

Course Prerequisites:-	1. Engineering Physics and Mathematics 2. Engineering Mechanics 3. Mechanisms of Machines
Course Objectives:-	1. To develop competency in understanding of theory of spur and helical gear. 2. To develop competency in different types of gear train. 3. To develop understanding of static and dynamic balancing, cam and follower, gyroscopic forces; and moments.
Course Outcomes:-	1. **Understand** the gear theory which will be the prerequisite for gear design. 2. **Understand** torque transmitting capacity in gear trains which will be the prerequisite for gear box design. 3. **Apply** the principles of balancing of masses to various links, mechanisms and engines 4. **Understand** the concept of different types of governor and its applications. 5. **Analyze** various types of cam and followers with different kinds of follower motion. 6. **Apply** the principles of gyroscopic effects and stabilization on various transport vehicles.

Course Contents

Unit-I	**Spur Gears**	**(06 Hrs)**
Classification, Spur gear: definition, terminology, fundamental law of toothed gearing, involute and cycloidal profile, path of contact, arc of contact, conjugate action, contact ratio, minimum number of teeth, interference and under cutting, Friction in gears. **Helical gears:** nomenclature, Center Distance		
Unit-II	**Gear Trains**	**(06 Hrs)**
Types of Gear Trains, analysis of epicyclic gear trains, Holding torque – Simple, compound and epicyclic gear trains, torque on sun and planetary gear train, compound epicyclic gear train, Bevel epicyclic Gear train. Types of gearboxes.		
Unit-III	**Balancing**	**(06 Hrs)**
Static and dynamic balancing, balancing of rotating masses in single and several planes, primary and secondary balancing of reciprocating masses, balancing in single cylinder engines, balancing in multi-cylinder in-line engines, direct and reverse cranks method -radial and V-engines.		
Unit-IV	**Governors**	**(06 Hrs)**
Introduction, Classification, Centrifugal Governor, Terminology, Watt Governor, Porter Governor, Proell Governor, Hartnell Governor, Wilson-Hartnell Governor.Sensitiveness, Stability, Isochronous, Hunting. Effort and Power of Governor, Controlling Forces, Friction and insensitiveness.		
Unit-V	**Cam and Follower**	**(06 Hrs)**
Types of cams and followers, analysis of standard motions to the follower, Determination of cam profiles for different follower motions, analysis of circular arc cam with flat face follower. Methods of control pressure angle, radius of curvature and undercutting. Jump phenomenon of Eccentric cam, Introduction to advanced cam curves (3-4-5 Polynomial cam only)		
Unit-VI	**Gyroscope and Step–Less-Regulation**	**(06 Hrs)**
Gyroscopes- Gyroscopic forces and Couples, Gyroscopic stabilisation for ship and Aeroplane,		

Stability of four-wheel drive vehicle moving on curved path, Stability of a two-wheel vehicle.
Continuous Variable Transmissions - Geometry, Velocity and torque analysis of Faceplate variators, Conical variators, Spheroidal and cone variators, Variators with axially displaceable cones, PIV drives. (Theoretical Treatment Only)

Term Work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. To draw conjugate profile for any general type of gear tooth
2. To generate involute gear tooth profile and to study the effect of undercutting and rack shift using model.
3. To study various types of gearboxes- constant mesh, sliding mesh, synchromesh gear box, Industrial gearbox, differential gearbox.
4. To measure holding torque of the epicyclic gear train.
5. To find the percentage of slip of belt material
6. To perform the experiment of Balancing of rotating parts and find the unbalanced couple and forces.
7. To perform experiment on various types of Governors to prepare performance characteristics curves, and to find stability and sensitivity.
8. To perform experiment on Cam Analysis Machine to find out cam and follower behaviour at different follower moment and jump phenomenon.
9. To draw the cam profiles and study the effect of Different follower motions, and Different follower (roller) dimensions
10. To determine gyroscopic couple on Motorized Gyroscope.
11. Study of Continuous Variable Transmission and Infinite Variable Transmission.
12. Mini Project based on the contents of the syllabus.

Assignments

Numerical and/or theory questions on each unit from previous year question papers of GATE/ESE Mechanical Engg. examinations.

Tutorial

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Spur Gears
2. Gear Trains
3. Balancing
4. Gyroscope
5. Cam and Follower
6. Governors

Reference Books

6. Thomas Bevan, “Theory of Machines”, CBS Publishers & Distributors, Delhi.
7. Shigley J.E. and Uicker J.J., “Theory of Machines and Mechanisms”, McGraw Hill, Inc.
8. Ghosh Amitabh and Malik A.K., “Theory of Machines and Mechanisms”, East-west Press.
9. Hall A.S., “Kinematics and Linkages Design”, Prentice-Hall.
10. Hartenberg and Denavit, “Kinematic Analysis and Synthesis of Mechanisms”.
11. Erdman, A. G. & Sandor, G.N., “Mechanism design, Analysis and synthesis”, Vol 1, Prentice – Hall of India.

Text Books

4. Rattan S. S., “Theory of Machines”, Tata McGraw Hill.
5. Ballaney P. L., “Theory of Machines”, Khanna Publishers, Delhi.
6. R. S. khurmi, “Theory of Machines’, S Chand Publication.

Project Based Learning

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

12. To prepare a chart on comparison among different types of gears
13. To prepare a chart to understand various terminology of spur gear.
14. To prepare a chart to understand different methods to avoid interference in spur gear.
15. To develop a mechanical system using simple gear train.
16. To develop a mechanical system using compound gear train.
17. To develop a mechanical system using reverted gear train.
18. To develop a mechanical system using epicyclic gear train.
19. To prepare a chart comparison among different types of gear trains.
20. To develop demonstration model of static and dynamic balancing systems.
21. To develop demonstration model of balancing of rotating masses.
22. To develop demonstration model of balancing of reciprocating masses.
23. Case study on real life applications of various types of governors.
24. To develop demonstration model of a Watt Governor/Portal Governor/Proell Governor.
25. To prepare a charton compression among different types of governors.
26. To prepare a chart to understand various terminology of Cam profile.
27. To prepare a chart on comparison among different types of followers.
28. To prepare a chart on comparison among different types of follower motions.
29. To develop demonstration model on real life applications of gyroscopic effect such as Ship, aeroplane,automobile, etc.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Science of Engineering Materials		
Course Code	**C211**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: -04 Hours/Week	End Semester Examination	60 Marks	04
	Internal Assessment	40 Marks	
	Total	**100 Marks**	**04**

Course Prerequisites:-	The student should have 1. Basic knowledge of physics and chemistry 2. Basic information of engineering materials 3. Basic knowledge of manufacturing processes
Course Objectives:-	The student should acquire the knowledge of 1. The scope, objective and application of materials, engineering properties. 2. Material testing to determine the mechanical properties and its applications in mechanical systems. 3. Different methods to change the mechanical properties.
Course Outcomes:-	The students should be able to 1. **Understand** basics of plastic deformation, annealing, re- crystallization and apply in mechanical engineering applications. 2. **Understand and evaluate** different types of mechanical properties. 3. **Understand and apply** fundamental concept of equilibrium diagrams in selections of alloys for different applications. 4. **Understand and apply** the different types of heat treatment processes on steels. 5. **Understand** the different types of alloy steels, tool steels and stainless steels and its applications in mechanical engineering. 6. **Understand** the concept of powder metallurgy and **apply** in manufacturing of components.

Course Contents

Unit-I	Plastic Deformation, Recrystallization and Strengthening Mechanism	(08 Hrs.)
Mechanism of plastic deformation, Critical resolve shear stress, Deformation of single crystal and polycrystalline metals, Mechanism of plastic deformation at high temperature, effect of grain size, Work Hardening, Cold and hot working, Annealing and re- crystallization, strengthening Mechanism,		
Unit-II	**Mechanical Testing of Metals**	**(08 Hrs.)**
Study of destructive testing Tensile test, Engineering stress and true stress strain, evolution of properties, Numerical based Tensile test, Hardness testing such as Brinell, Rockwell, Vickers and Micro hardness test, Impact test, Fatigue test, Creep test, Cupping test, **Non-Destructive testing** such as Liquid dye penetrate test, Magnaflux test, Eddy current test, Ultrasonic testing and Radiography testing.		
Unit-III	**Equilibrium Diagrams**	**(08 Hrs.)**
Related terms and their definitions, Hume Ruther's rule of solid solubility, solidification, Dendritic growth, cooling curves, Plotting of Equilibrium diagrams, Lever rule, Coring, Isomorph's system, Eutectic system, Partial eutectic and eutectoid system, non-Equilibrium cooling and its effects, Fe- Fe3 C equilibrium diagram.		
Unit-IV	**Heat Treatment of steels**	**(08 Hrs.)**
Transformation products of austenite, Martensite transformation & characteristics of martensite, Time – Temperature Transformation curve, Critical Cooling rate, Heat treatment of steels - Annealing, Normalizing, Hardening, Hardenability, Martempering, Austempering, Retained austenite, tempering, Ausforming, Secondary hardening, Quench cracks.		

Unit-V	Cast Irons, Alloy Steels & Tool Steels	(08 Hrs.)
Classification of alloying elements, Types of cast irons, Properties of different cast irons, Effect of alloying elements on properties, Specifications of steels, Various alloy steels, Stainless steels – Classification, Applications & properties, Tool Steels – Classification, Applications & properties, heat treatment of tool steels.		
Unit-VI	**Powder Metallurgy**	**(08 Hrs.)**
Introduction, Advantages and limitations of powder metallurgy, Production of metals powder, Characteristics of powder, Powder conditioning, Powder Compacting, Hot compacting methods, Sintering and sintering furnaces, Production of powder metallurgical parts such as self-lubricating bearings, ferrites, electric contact materials, Carbide cutting tools etc.		

Term Work

Term work shall consist of following experiments

1. Preparation of polystyrene/phenol-formaldehyde/urea-formaldehyde resin.
2. To determine molecular weight/radius of macromolecule polystyrene/ polyvinyl alcohol by viscosity measurement.
3. Estimation of percentage of Iron in Plain Carbon Steel by Volumetric Method.
4. Study of corrosion of metals in medium of different pH.
5. Determination of rate of corrosion of aluminium in acidic and basic medium.
6. Determination of percentage of Ca in given cement sample
7. Preparation of phenol-formaldehyde resin/ urea-formaldehyde.
8. Estimation of copper in brass solution.
9. Determination of rate of corrosion of aluminium in acidic and basic medium.
10. To obtain metallic coating on base metal by using Electroplating and Electroless plating method.

Assignment

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. examinations.

1. Mechanism of Plastic deformations
2. Mechanism of recrystallizations
3. Tensile test, Hardness testing
4. calculations a phase and its percentages
5. Heat treatment of steels
6. Cast irons applications
7. Stainless steels
8. Heat treatment of tool steels
9. Production of powder productions
10. Production of powder metallurgical parts

Text Books

1. Material Science and Physical Metallurgy", Dr.V.D. Kodgere, Everest Publication, Pune.
2. "Material science and Metallurgy", O P Khanna, Khanna Publication,Delhi
3. "Material Science and Engineering", R K Rajput, S K Kataria and Sons Publication, Delhi

Reference Books

1. "Physical Metallurgy", S H Avner, Tata Micro hill Publication, Delhi
2. "Physical Metallurgy" RaghwanV, PHI Learning Pvt. Ltd,Delhi
3. Polymer Science, V. R. Gowarikar, N. V. Viswanathan, jayadevSreedhar, Wiley Eastern Limited
4. Polymer Science and technology (2nd Edition), P. Ghosh, Tata McGRAW Hill, 2008

5. Polymers: Chemistry & Physics of Modern Materials (2nd edition) J.M.G. Cowie, Blackie Academic & Professional, 1994.
6. Engineering Chemistry by Dr. A. K. Pahari and Dr. B. S. Chauhan, Laxmi Publications (P) Ltd, New Delhi.
7. Engineering Chemistry (16th Edition) Jain, Jain, DhanpatRai Publishing Company, 2013.

Project Based Learning

Following is the list of Topics for Project Based Learning (Not Limited to) based on the syllabus contents:

1. To develop demonstration model of crystal structure.
2. To prepare a chart on different material and its recrystallization temperatures.
3. To develop a tensile test specimen as per the standards and find its U T S and Y S
4. To find the hardness ofany one component by Brinel or Rockwell hardness testing machine
5. To identify flaws and defects in different materials by any NDT methods
6. Case study on case hardening of any mechanical component
7. To perform annealing on any mechanical component
8. To perform hardeningoperation by either oil quenching or water quenching on any mechanical component.
9. To prepare a chart on properties of different cast irons by using microscope, hardness testing or spark testing.
10. To prepare a flowchart on processing of tool steels
11. To developdemonstrations model of manufacturing of metal powder by atomization technique
12. To develop demonstrations model of different type of powder compacting methods
13. To prepare a flow chart of production process of carbide tools, ferrites, clutch plates and elastic contact materials.
14. To prepare a flow chart of any mechanical component manufactured by powder metallurgy technique

Unit Test

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	ITC-II: Entrepreneurship Development Skills		
Course Code	**C212**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
	Internal Assessment	40 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites: -	The student should have 1. Introduction to all engineering subjects 2. Passion to become an entrepreneur. 3. Ambition to create employment.
Course Objectives: -	The student should 1. Acquire knowledge of behavioral sciences and develop positive attitude. 2. Enjoy process of learning and develop habits of language skills. 3. Learn success and failure stories. 4. Acquire basic knowledge of Functional Managements and leadership lessons.
Course Outcomes: -	The students should be able to– 1. **Understand**and develop personality traits. 2. **Understand** and use communication and interpersonal skills for grooming. 3. Developing habits of life skills books its review and learnings. 4. **Understand** and **analyze** case studies of various organizations. 5. **Understand** basics of entrepreneurship and its allied elements. 6. **Understand** role of functional management and processes of running business.

Course Contents

Unit-I	Grooming Personality	(06 Hrs.)
Personality types, attitude, developing positive attitude, Effects of Personality management aptitude (PMA), Behavior of human being, under challenging conditions, qualities needed at top level, traits for top executives, enthusiasm, Never give up attitude.		
Unit-II	**Developing Skills**	**(06 Hrs.)**
Communication skills, Interpersonal skills, positive reinforcement, recognition, qualities of a leader, who is leader, behavior of leader, assume infinite responsibility, requirement for professional success.		
Unit-III	**Reviews and learning's from life skill books.**	**(06 Hrs.)**
Books Review and learnings, Seven habits of highly effective people, Rich dad poor dad, Seven divine laws, Power of Positive thinking, You Can win, Leader without title, Think and grow rich.		
Unit-IV	**Case Studies**	**(06 Hrs.)**
Case studies its introduction, types of case studies its relevance and importance, format, and steps of case studies. Mrs Lata Khare, Mericom, Dangal Girl, M S Dhoni, Helen Keller. Ravindra Jain, Arunima Sinha, Study of a successful athlete, Mohammad Ali, Major Dhyanchand, leadership lessons.		
Unit-V	**Entrepreneurship and its allied elements**	**(06 Hrs.)**
Introduction to Entrepreneurship, working capital, introduction to sales, finance, risks and rewards, understand customers, how to develop market, use of social media. Types of marketing, innovation, understand statutory requirements, scaling up, managing vendors, managing employees and contractors, managing banking relations. Ways of raising fund. Understand functional management.		
Unit-VI	**Functional management and business processes**	**(06 Hrs.)**
Process of sales, Ethics in selling, Sale with integrity, Sale with honesty, law of familiarity, sale with passion and integrity, upselling and cross selling. Cash flow, definition of business, managing		

payables, managing commitments in tough times.

List of Assignments

1. What are different types of personalities? What make them stand themselves different from each other? Choose one type of personality and make an analysis of your personality traits.
2. What different behavioral aspects are important to be a good leader? Analyze and prepare the design thinking model for inculcating behavioral aspects of a leader.
3. Communication is lubricant to run an organization smoothly. State your suitable reasoning in concern to the statement and prepare the model to implement it in your organization.
4. What are different interpersonal skills? why do they play significant role in developing business at peak. Elucidate with suitable examples.
5. Choose a like skills book of your choice and prepare review of it and implement the learning lessons for your business model.
6. Why do books on life skills important for a businessman? State your reasoning with appropriate examples.
7. What is meant by case studies? What is its relevance in the business world? Choose a topic from the enlisted and prepare a case study on it.
8. What is meant by Entrepreneurship? State the importance of functional management in it with suitable examples.
9. What are different business ethics and how do they help you in developing the appropriate policy for your organization?
10. Illustrate the different business process and their roles in developing a successful business.

Text Book

1. Dynamics of Entrepreneurial Development & Management -Vasant Desai Himalaya Publishing House.

Reference Books

1. Principles of Management -P. C. Tripathi, P. N. Reddy; Tata McGraw Hill, 4th Edition, 2010.
2. Entrepreneurship Development -Small Business Enterprises -Poornima M Chrestomathy Pearson Education – 2006.
3. Communication Skills by Pushpa Lata and Sanjay Kumar published Oxford University Press.
4. Developing Communication Skills By Meera Banerjee published by Oxford University Press
5. The Third Wave: An Entrepreneur's Vision of the Future (Hardcover)by Steve Case
6. Losing the Signal: The Untold Story Behind the Extraordinary Rise and Spectacular Fall of BlackBerry by Jacquie McNish
7. The 16 Personality Types: Profiles, Theory, & Type Development by A.J. Drenth

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents. Group of students should meet entrepreneur and complete the case studies.

1. Company history, establishment.
2. Type of Industry
3. Entrepreneur personality & his approach.
4. Behavioral aspects (leadership quality)
5. Communication skills & Interpersonal skills
6. Correlation of reference books Review and learnings, seven habits of highly effective people, Rich dad poor dad, Seven divine laws, Power of Positive thinking, You Can win, Leader without title, Think and grow rich. with respect to entrepreneur
7. How the working capital work developed

8. Functioning of Production department,
9. Marketing department
10. Financial department

Unit Test –

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Designation of Course	Machine Design and Analysis-I		
Course Code	**C213**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Practical: -02 Hours/Week	Internal Assessment	40 Marks	
	Term Work and Oral	50 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites: -	1. Computer Aided Drafting and Visualization 2. Computer Aided Machine Drawing 3. Strength of Machine Components
Course Objectives: -	1. To study basic concepts of machine design. 2. To design and analysis different types of machine elements 3. To design of machine component for finite and infinite life and subjected to fluctuating load.
Course Outcomes: -	1. **Understand** the basic concept of machine design and **evaluate** dimensions of simple components. 2. **Understand** the fundamental concepts for design of shaft, keys and coupling and **evaluate** forces and dimensions. 3. **Understand** the concept of designing of Power Screws and Mechanical spring and **analyze** it for various applications. 4. **Understand** the basic concept of fluctuating loads and **Analyze** design of components under fluctuating loads. 5. **Understand** the concept of fasteners and threaded joints; and **analyze** when it is subjected to different loading conditions. 6. **Understand** the Design concept of welded & riveted joint and **analyze** when it is subjected to different loading conditions.

Course Contents

Unit-I	Introduction to Design and Design against Static Load	(08 Hrs)
Introduction to Design: Need for component design, design process, Introductions to concurrent engineering, Design consideration for casting, forging & machined parts, hot & cold worked parts and welded assembly, Introduction to design for manufacture & assembly, **Design against Static Load:** Modes of failure, Factor of safety, Service factor, stress strain relationship, shear stress & strain, stress due to bending moment, Eccentric axial loading. Design of simple machine parts - Cotter joint, Knuckle joint and Levers, curved beam.		
Unit -II	**Shafts, Keys and Coupling**	**(08 Hrs)**
Introduction, Transmission Shafts, Shaft Design on Strength Basis, Shaft Design on Torsional Rigidity Basis, ASME Code for Shaft Design, Design of Hollow Shaft on Strength Basis, Design of Hollow Shaft on Torsional Rigidity Basis, Flexible Shafts **Keys**– saddle, sunk, feather, woodruff, square, flat, Kennedy key, key design, Types of keys, splines. **Couplings-** types of couplings, Design of rigid and flexible couplings.		
Unit-III	**Power Screws and Mechanical Spring**	**(08Hrs)**
Power Screws, Forms of Threads , Multiple Threaded Screws, Terminology of Power Screw, Torque Requirement—Lifting Load, Torque Requirement—Lowering Load, Self-locking Screw, Efficiency of Square Threaded Screw, Efficiency of Self-locking Screw, Trapezoidal and Acme Threads, Collar Friction Torque, Overall Efficiency, Coefficient of Friction, Design of Screw and Nut, Design of Screw Jack, Differential and Compound Screws, Re-circulating Ball Screw. **Mechanical Spring:** Types of Springs, Terminology of Helical Springs, Styles of End, Stress and Deflection Equations, Series and Parallel Connections, Design of Helical Springs, Concentric Springs,		

Helical Torsion Springs, Surge in Spring, Multi-Leaf Spring, Nipping of Leaf Springs, Shot Peening		
Unit-IV	**Design for Fluctuating Loads**	**(08 Hrs)**
Stress concentration factor and its Reduction, Stress concentration factor for various machine parts, Cyclic stresses, Fatigue and endurance limit, Notch sensitivity, Cumulative Damage in Fatigue, Design for finite and infinite life, Soderberg, Goodman, Modified Goodman& Gerber criteria.		
Unit-V	**Threaded Joints**	**(08 Hrs)**
Basic Types of Screw Fastening, Cap Screws &Setscrews, Bolt of Uniform Strength, Locking Devices, Terminology of Screw Threads, ISO Metric Screw Threads, Bolt under tension, Eccentrically Loaded Bolted Joints in Shear, Eccentric Load Perpendicular to Axis of Bolt, Eccentric Load on Base plate, Torque Requirement for Bolt Tightening, Dimensions of Fasteners, Design of Turnbuckle.		
Unit-VI	**Welded and Riveted Joints**	**(08 Hrs)**
Welded Joints- Welding Processes, Strength of Butt and Fillet Joints, Strength of Parallel Fillet Welds, Strength of Transverse Fillet Welds, Axially Loaded Unsymmetrical Welded Joints, Eccentric Load in the Plane of Welds, Welded Joint Subjected to Bending Moment and Torsional Moment, Welding Symbols **Riveted Joints-** Types of Rivet Heads and riveted Joints, Rivet Materials, Types of Failure, Strength Equations, Efficiency of Joint, Caulking and Fullering, Eccentrically Loaded Riveted Joint		

Term work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Symbolic representation of common machine components using Auto-CAD.
2. Design of machine components such as knuckle joint, cotter joint and lever (anyone) using CAD software.
3. Design of coupling system using CAD software.
4. Design of screw jack using CAD software.

Assignment

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

1. Static loading
2. Design of shafts
3. Power screw
4. Mechanical springs
5. Design of fluctuating load
6. Design of threaded joints
7. Design of welded
8. Riveted joints.

Note: Design data book should be used extensively.

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. To develop Industrial/Real life application demonstration model of different types of Joints. (Cotter joint and Knuckle joint)
2. To observe the system where transmission of power takes place through shaft, Keys, coupling, like Transmission of power from motor to pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the shaft, key and coupling. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials.

9. To develop a demonstration model of different types of couplings.
10. To develop a demonstration model of different types of keys.
11. To observe the system where transmission of power takes place through power Screws. (e.g. Lead screw of lathe, feed screws of machine tools, Clamping screws, Toggle Jack screw, etc.) Get the required information regarding effort, clamping force, etc., and selecting suitable materials design screw, nut and different simple components in assembly. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials.
12. To develop demonstration models of different types of springs.
13. To develop demonstration models of different types of threaded joints.
14. To develop demonstration models of different types of fasteners.
15. To develop demonstration models of different types of welded joints.
16. To develop demonstration models of different types of riveted joints.

Textbooks

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.
2. R. S. Khurmi and J.K. Gupta "Machine Design", S Chand Publication.
3. Shigley J. E. and Mischke C. R., "Mechanical Engineering Design", McGraw Hill Publication Co. Ltd.
4. Spotts M. F. and Shoup T.E., "Design of Machine Elements", Prentice Hall International.

Reference Books

1. Black P.H. and O. Eugene Adams, "Machine Design", McGraw Hill Book Co. Inc.
2. Willium C. Orthwein, "Machine Components Design", West Publishing Co. and Jaico Publications House.
3. Hall A. S., Holowenko A. R. and Laughlin H. G, "Theory and Problems of Machine Design", Schaum's Outline Series.
4. Sharma C. S. and Purohit Kamlesh, "Design of Machine Elements", PHI LearingPvt. Ltd.
5. D. K. Aggarwal & Sharma P. C., "Machine Design", S.K Kataria and Sons
6. Gope P. C., "Machine Design: Fundamentals and Applications", PHI Learing Pvt. Ltd.
7. "Design Data- P. S. G." College of Technology, Coimbatore.
8. V. B. Bhandari, "Design Data Book", Tata McGraw Hill Publication Co. Ltd.

Unit Tests

Unit Test-I	Unit-I, II, III
Unit Test-II	Unit-IV, V, VI

Designation of Course	Solid Modelling		
Course Code	**C214**		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Practical:- 04 Hours/Week	Term Work and Practical	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites: -	1. Computer Aided Drafting and Visualisation 2. Computer Aided Machine Drawing
Course Objectives: -	1. To introduce students to the basic concepts of CAD modelling. 2. To develop the skills in Reading and Interpretation of Engineering Drawings. 3. To familiarize students with SolidWorks Software to Crate 2D and 3D model, Assembly, Drafting and Sheet metal modelling.
Course Outcomes: -	The students will be able to 1. **Understand** the concepts of CAD modelling. 2. **Creating** 3D machine components using SolidWorks Software. 3. **Creating** Assembly of machine components using SolidWorks Software. 4. **Creating** surface model of Automobile Components using SolidWorks Software. 5. **Creating** detail drawing and generating Bill of Material using SolidWorks Software. 6. **Understand** the basic concepts of Sheet metal Modelling and **Create** a machine component using SolidWorks Software.

Course Contents

Unit-I	Introduction to CAD	(08Hrs.)
Introduction to CAD and CAE Features of SolidWorks, Various products available in SolidWorks for Product Design, Simulation, Communication SolidWorks Graphical User Interface - Feature manager design tree, Callouts, Handles, Confirmation corner, mouse buttons, keyboard shortcuts, Command Manager. Sketch Entities, Sketch Tools, Block, Relation and Dimensioning		
Unit-II	**Basic Part Modelling**	**(08 Hrs.)**
Part Modelling Tools, Creating Extrude features, Creating Revolve features, Creating Swept features, Creating Loft features, Creating Reference, Creating curves, Fillet features, Inserting Hole types, Creating Chamfer, Shell, rib, pattern and advanced modelling tools.		
Unit-III	**Assembly Modelling**	**(08 Hrs.)**
Introduction to Assembly Modelling & Approaches, Applying Advanced Mates and Mechanical Mates, Manipulating Components, Creating Pattern, Creating Explode Views.		
Unit-IV	**Surface Modelling**	**(08 Hrs.)**
Surface Modelling tools Creating Extrude, Revolve, Swept, loft, Boundary surface. Inserting Planar Surface, Offset Surface, Radiate Surface. Extending a surface, Surface fill, Ruled Surface, Trimming Surface, Mid surface, Replace Face, Delete face, Un-trim surface, Knit surface, Thickening a Surface, Move Face.		
Unit-V	**Drafting of Mechanical Systems**	**(08 Hrs.)**
Generating Views, Creating Dimensions, Inserting Annotations and Bill of Materials.		
Unit-VI	**Sheet Metal Modelling**	**(08 Hrs.)**
Constructing the base flange and miter Flange, addition of an Edge Flange, closing corner, Adding Jog, Unfolding the bends, Adding hem and vent.		

Term Work

Term work shall consist of A-3/A4 size printouts of the problems solved in practical’s using Solid Works Software.

1. Sketcher drawings

2. Part modelling
3. Parametric Modelling
4. Assembly Modelling
5. Exploded view of Assembly
6. Surface Modelling
7. Drafting of Mechanical Systems
8. Sheet metal modelling

Text Books

1. Kuang-Hua Chang, "Motion Simulation and Mechanism Design with SOLIDWORKS Motion 2018", SDC Publishers, 2018

Reference Books

1. Ibrahim Zeid and R. Siva-Subramaniam – "CAD/CAM- Theory and Practice", Tata McGraw Hill, Publishing Co. 2009.
2. Rao P. N., "CAD/CAM", Tata McGraw Hill.
3. Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", Second edition, Addison–Wesley, 2000.
4. Martenson, E. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.
5. Ronald E. Barr, DavorJuricic, Thomas J. Krueger, "Engineering & Computer Graphics Workbook Using SolidWorks 2014", SDC Publication, 2014.
6. John Willis, Sandeep Dogra, "SOLIDWORKS 2019: A Power Guide for Beginners and Intermediate User", published by CADArtifex, 2019.

End Semester Practical/Oral examination:

1. Practical examination duration is Two hours, based on the Term work.
2. Questions provided for practical examination should contain minimum five and not more than ten parts.
3. Evaluation of practical examination to be done based on the performance of students work in laboratory.

***Oral examination should also be conducted to check the knowledge of conventional and SolidWorks drawing.**

Designation of Course	**Python Programming-II**		
Course Code	**C215**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Practical:- 04 Hours/ Week	Term Work and Practical	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:-	1. Soft Computing I 2. Soft Computing II 3. Python Programming-I
Course Objectives:-	The students should be able to 1. Readily use the Python file handling 2. Apply array to solve engineering problems. 3. Understand data visualization techniques
Course Outcomes:-	Students will be able to 1. **Understand** file handling. 2. **Understand** concept of arrays. 3. **Understand** array manipulation. 4. **Understand** and Apply random numbers. 5. **Understand** matplotlib modules. 6. **Understand** and **Apply** visualization techniques

Course Contents

Unit -I	**Python Files**	**(08 Hrs.)**
Python File I/O, Directory and Files Management, Errors and Built-in Exceptions, Exception Handling Using try, except and finally statement, Custom Exceptions		
Unit -II	**NumPy Array**	**(08 Hrs.)**
Create a NumPy and array Object, Dimensions in Arrays, 0-D Arrays, 1-D Arrays, 2-D Arrays, 3-D arrays, Access Array Elements, Access 2-D Arrays, Access 3-D Arrays, Negative Indexing		
Unit -III	**NumPy Slicing Arrays**	**(08 Hrs.)**
Array Slicing, slicing 2-D Arrays, Shape of an Array, Array Reshaping, Iterating Arrays, Iterating 2-D Arrays, Joining NumPy Arrays, Splitting NumPy Arrays, Sorting Arrays		
Unit -IV	**NumPy Random**	**(08 Hrs.)**
Pseudo Random and True Random, Generate Random Number, Generate Random Float, Generate Random Array, Generate Random Number from Array, Normal Distribution, Visualization of Normal Distribution, Binomial Distribution, Poisson Distribution, Uniform Distribution, Exponential Distribution		
Unit -V	**Matplotlib**	**(08 Hrs.)**
Install matplotlib, Pyplot API, Figure Class, Axes Class, Multiplot, Subplots () Function, Formatting Axes, Setting Limits, Setting Ticks and Tick Labels		
Unit -VI	**Two Dimensional and Three-Dimensional Visualization**	**(08 Hrs.)**
Bar Plot, Histogram, Pie Chart, Scatter Plot, Pie Chart, Contour Plot, 3D Contour Plot, 3D Wireframe plot, 3D Surface plot		

Term Work

1. Read and write given text file (1exercises)
2. Python NumPy Exercise (2exercises)
3. Practice NumPy questions such as Array manipulations, numeric ranges, Slicing, indexing, Searching, Sorting, and splitting, and more.

4. Random Data Generation Exercise (2exercises)
5. Practice and Learn the various techniques to generate random data in Python.
6. Python Matplotlib Exercise (3exercises)
7. Practice Data visualization using Python Matplotlib. Line plot, Style properties, multi-line plot, scatter plot, bar chart, histogram, Pie chart, Subplot, stack plot.

Text Books:

1. Introduction to Computation and Programming using Python, by John Guttag, PHI Publisher,
2. Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd.,2015.
3. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python:AnInter-disciplinaryApproach,PearsonIndiaEducationServicesPvt.Ltd.,2016.

Books of References

1. Python Programming using problem solving Approach by ReemaThareja, Oxford University, Higher Education Oxford University Press; First edition (10 June 2017), ISBN-10: 0199480173.
2. Data Structures and Algorithms in Python by Michael T Goodrich and Robertto Thamassia, Micheal S Goldwasser, Wiley Publisher(2016)
3. Fundamentals of Python first Programmes by Kenneth A Lambert, Copyrighted material Course Technology Inc. 1st edition (6th February2009)

Supplementary Resources:

1. http://www.w3schools.com
2. http://docs.python.org
3. http://www.tutorialspoint.com
4. http://www.learnpython.org

Designation of Course	**Vocational Course I: Automobile Servicing- I**		
Course Code	**C217**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
	Term Work and Oral	50 Marks	02
	Total	**50 Marks**	**02**

Course Prerequisites:	Basic knowledge of automobile engineering and servicing
Course Objectives: -	1. To perform skilled mechanical work in diagnosing, repairing and maintaining all major vehicle systems of four-wheeler 2. To provide knowledge on automotive industry and job-related activities as an automotive service technician. 3. To work safely and responsibly within all shop standards and environmental guidelines.
Course Outcomes: -	Students will be able to 1. **Understand and apply** different types of tools and workshop equipment in the workshop for servicing. 2. **Understand and apply** dismantle and reassemble of engines, cooling and transmission of different vehicles 3. **Understand and apply** dismantle and reassemble of fuel supply system, Steering Mechanism, Wheel Balancing and Wheel Alignment. 4. **Understand and apply** dismantle and reassemble of Battery, Ignition and Starting System 5. **Understand and apply** dismantle and reassemble of Tyre Repairer/Inspection, Auto Body Repair, Denting & Painting 6. **Understand and apply** overhaul of electrical wire harness, lighting, ignition, electronic and air-conditioning systems etc.

Course Contents

Unit-I	**Introduction to Four-wheeler Servicing:**	**(08 Hrs.)**
Familiarization of workshop manual. Practice on how to read job-card. Identification of different types of vehicle. Identification of Vehicle Identification Number, Chassis no. & Engine no identification of different types of engine components, Lubrication and Maintenance Schedule Necessity for routine maintenance, Importance of service manuals, Specification of engines- petrol and diesel vehicles(a) Engine (b) Clutch (c) Gear Box (d) Propeller shaft (e) Universal joints (f) Differential (g) Axles and hubs (h) Suspension system (i) Steering system (j) Tyre (k) Chassis (l) Brake-drum and disc Battery (m) Self-starter (n)Dynamo, Checking of compression and vacuum, Car wash – before & after servicing using different types of nozzles Check / replenish / top up – lubricating oil, engine coolant, power steering hydraulic oil, wind screen wiper water. Replace – air cleaner, oil filter & fuel filter Apply Grease to parts / through greasing points (if necessary).		
Unit-II	**Engine Servicing, Cooling and Power Transmission**	**(08 Hrs.)**
Engine Service: Introduction, Engine removal, cylinder head, Valve and Valve mechanism, piston connecting rod assembly, cylinder block, crankshaft and main bearing, engine reassembly. Engine tuning: Meaning and scope of engine tuning. Necessity of engine tuning, Engine analysis and tuning with the help of diagnostic computer, Diesel engine injection timing checking. **Engine cooling systems:** Necessity, Methods of cooling, Radiator, Cooling system trouble shooting. **Power Transmission:** Remove & refit vehicle body parts (bonnet, front bumper & door) Check / replenish/top up brake fluid, transmission oil. Adjust Hand brake and replace hand brake cable Adjust clutch and brake pedal plays Replace propeller shaft, wheel hub bearings & brake pads.		
Unit-III	**Engine Fuel Supply System, Steering, wheel Balancing and Alignment**	**(08 Hrs.)**
Petrol and Diesel Engine Fuel Supply System: Fuel Supply Systems, Fuel pump, Fuel injection, Fuel pump testing, troubleshooting and service, Fuel supply system troubleshooting, Fuel filters and air cleaners. Maintenance Schedule of diesel engine fuel injector, hot plugs, rotary and reciprocating type of fuel injection pump, fuel injection pump of single cylinder engines, hoses & pipelines, priming unit, tanks.**Front Axle and Steering:** Introduction, Front axle, steering geometry, Steering mechanism, power steering, steering adjustment, Steering trouble shooting. **Wheel Balancing:** Remove tyre from vehicle. Check tyre & rim and check for run out. Fit the tyre assembly to the vehicle. **Wheel Alignment**: Check tyres, ride height, wheel bearings, ball joints, control arms bushings and sway bars, shock absorbers, struts & power steering. Identify components, brief working principle & operation of computerized wheel		

aligner Procedure to make the aligner ready to check wheel alignment. Procedure for taking readings, interpreting alignment readings and rectify steering geometry with wheel aligner – take a printout. Procedures for test drive to confirm the repairs.		
Unit-IV	**Battery, Ignition and Starting System**	**(08 Hrs.)**
Battery and Ignition System: Remove and refit head lamp assembly. Check power plug and inspect H.T. cables Clean, Check and Adjust spark plug Cleaning and topping up of a lead acid battery, testing battery with hydrometer, battery tester, connecting battery to a charger for battery charging. **Starting System:** Starting motor, Starting drives, Electronic starter control, **i**dea of engine starting-system circuit. Testing the starting system and troubleshooting.**Ignition System:** Idea of Battery-and-coil ignition circuit and its working. Compression ignition of diesel engines.		
Unit-V	**Tyre Repairer/Inspection, Auto Body Repair, Denting & Painting**	**(08 Hrs.)**
Tyre Repairer/Inspection: Removal & re-fitting of wheel from light & heavy vehicle. Measurement of tread wear. Dismantling tyre & tube, checking puncture, assembling, inflate it to correct pressure. Vulcanizing of tubes & tyres. Repair tubeless tyre puncture. Air inflation with nitrogen gas inflator according to the manufacturer's recommendation. Practice on Tyre rotation as per vehicle manufacturers recommendation. **Auto body repair:** Identification of different types of body, chassis and drive lines, Identification of location of parts and panels, Practice on operating the air compressor, Practice on periodical maintenance of air compressor Inspect and decide whether it can be repaired or replaced Remove and refit body panels, doors, floors, wheel boxes and fenders Practice on removing and refitting wind shield glasses. **Auto body painting:** Consumable's clothing safety, Practice on removing paint from the damaged area Practice on mixing and applying body filler Practice on sanding (block) Practice on mixing and applying putty Practice on applying primer Practice on feather edge sanding and masking Base coat application Surface cleaning and degreasing Second and third coat application Preheating the vehicle and cooling Cutting, scuffing, rubbing and polishing.		
Unit-VI	**Modern Electric and Hybrid Vehicles**	**(08 Hrs.)**
Introduction to electric and hybrid electric vehicles, History of hybrid and electric vehicles, Social and environmental importance of electric and hybrid electric vehicles, Electrical basics, Motor and generator basics, Electric and Hybrid Electric Drive Trains Basic concept of electric and hybrid traction, Introduction to various electric and hybrid electric drive train topologies, Advantages, and disadvantages. **Power Flow:** Power flow control in electric and hybrid electric drive train topologies. **Electric Drive Components:** Electric drive components used in electric and hybrid vehicles, Electric motor requirements, Direct Current (DC) motors (Brushed and Brushless), Power converters, Drive controllers.		

List of Experiments-

1. To Follow standard operating procedures for using workshop tools and equipment for fault diagnosis or troubleshoot problem in a vehicle.
2. To Understand the auto component manufacturer specifications related to the various components/ aggregates in the vehicle (including major aggregates like engine. gear box, transmission systems propeller shaft etc.)
3. To Service, repair and overhaul of steering system.
4. To Service, repair and overhaul of suspension system.
5. To Service, repair and overhaul of tyres.
6. To Service, repair and overhaul of wheels.
7. To Service, repair and overhaul diesel Engines and its fuel system.
8. To Service, repair and overhaul petrol Engines and its fuel system.
9. To Service, repair and overhaul of cooling system and radiator
10. To Service, repair and overhaul of emission and exhaust system.
11. To Service, repair and overhaul of gearbox, drive-train assembly, and transmission systems (manual, automatic etc.)
12. To Service, repair and overhaul of brake system.
13. To Service, repair, and overhaul of clutch assembly.
14. Repair and overhaul of electronic control unit
15. To Repair and overhaul of electrical wire harness, lighting, ignition, electronic and air-conditioning systems etc.

Text Books

1. Automobile Mechanics, A.K. Babu, S.C.Sharma, T.R. Banga, Khanna Publishing House

Reference Books

1. Automobile Engineering by Kirpal Singh Standard Publishers Distributors.
2. Automotive Engines, A.K. Babu, Khanna Publishing House

B. Tech. Mechanical
Sem.-V

HEAT TRANSFER PRINCIPALS AND APPLICATIONS
(Course No. 301)

Designation of Course	**Heat Transfer Principals and Applications**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**05**

Course Prerequisites: -	The students should have knowledge of 1. Fundamentals of Thermodynamics Principles and applications. 2. Fundamentals of Fluid Mechanics.
Course Objectives:-	1. To provide the knowledge of basic principles and applications of heat transfer. 2. Analyze the performance of heat transfer equipment 3. Apply principles to heat transfer for different applications
Course Outcomes: -	The students should be able to– 1. Understand basic concepts of heat transfer and apply them to solve engineering problems 2. Analyze problems based on one dimensional steady state heat conduction 3. Analyze problems based on extended surfaces and also on unsteady heat conduction 4. Analyze problems based on the concepts of heat transfer by forced and natural convection 5. Understand concepts of heat transfer by thermal radiation and apply them to solve engineering problems 6. Analyze performance of heat exchangers and understand concepts of condensation & boiling.

Course Contents

Unit I	**Basic concepts of Heat Transfer**	**(08 Hrs.)**
Overview of subject, Modes of heat transfer, Applications of heat transfer in different fields of engineering, Fourier's law of conduction, Newton's law of cooling, Stefan- Boltzmann's law of radiation, Isotropic and anisotropic materials, Three dimensional heat conduction equation in Cartesian coordinate for anisotropic material for steady state condition, and reduction to Fourier equation, Laplace equation and Poisson's equation, Three dimensional heat conduction equation in cylindrical and spherical coordinates (no derivation), Thermal diffusivity. Purpose of insulation, critical radius of Insulation, Economic thickness of Insulation, Thermal contact resistance, thermal conductivity and it's variation with temperature for metals, non-metallic solids, gases and liquids, one dimensional problems of variable thermal conductivity.		
Unit II	**One dimensional steady state heat conduction**	**(08 Hrs.)**
One dimensional steady state heat conduction through a plane wall, cylindrical wall and sphere, Analogy between heat flow and electricity, heat conduction through a composite slab, cylinder and sphere, Overall heat transfer coefficient, Concept of thermal resistance and conductance. Symmetrical boundary condition in plane wall, conduction in solid, hollow cylinder and sphere, practical problems of heat generation.		

Unit III	Extended surfaces and Unsteady Heat Conduction	(08 Hrs.)
Extended surfaces: Heat transfer through extended surfaces, Classification of fins, Derivation of differential equation for fins with constant cross sectional area with insulated tip boundary conditions, Effectiveness and efficiency of a fin, design of thermo well. **Unsteady Heat Conduction**: System with negligible internal resistance, Biot & Fourier numbers, Criteria for neglecting internal temperature gradient, Concept of time constant		
Unit IV	**Convection**	**(08 Hrs.)**
Introduction to hydrodynamic**,** thermal boundary layer, Laminar & turbulent flow over & closed conducts, convection heat transfer coefficients & order of magnitude, Dimensional analysis of free & forced convection, physical significance of the dimensionless ,parameters, Nusselt's number, Reynold's number, Prandtl's number, Grashoff's number, Stanton number, Rayleigh number. **Forced Convection:** Empirical correlations for heat transfer in laminar and turbulent flow over a flat plate and in a circular pipe, Concept of hydraulic diameter, reference temperature. **Natural Convection:** Flow patterns, Empirical correlations for free convection, heat transfer over horizontal, vertical plate.		
Unit V	**Thermal Radiation**	**(08 Hrs.)**
Fundamental principles - Gray, White, Opaque, Transparent and Black bodies, Spectral emissive power, Wien’s, Rayleigh-Jeans’ and Planck’s laws, Hemispherical Emissive Power, Stefan-Boltzmann law for the total emissive power of a black body, Emissivity and Kirchhoff’s Laws, View factor, Net radiation exchange in a two-body enclosure, Typical examples for these enclosures, Radiation Shield.		
Unit VI	**Heat Exchangers**	**(08 Hrs.)**
Classification, Applications of heat exchangers, Heat exchanger analysis, Logarithmic Mean Temperature Difference for parallel and counter flow heat exchangers, LMTD correction factors, fouling factor. The effectiveness: NTU method for parallel and counter flow heat exchangers, design considerations for heat exchangers. Film and drop-wise condensation, heat transfer coefficient for laminar film condensation on vertical and inclined plate(descriptive treatment), Correlations for condensation on and inside tubes, modes of pool boiling, critical heat flux, pool boiling.		

Term Work

Any ten experiments from the following:

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of metal rod.
3. Determination of thermal conductivity of different materials in composite wall.
4. Temperature distribution along a length of a fin and determination of fin effectiveness and fin efficiencies.
5. Determination of film heat transfer coefficient on a hollow vertical tube heated from inside.
6. Determination of film heat transfer coefficient for turbulent flow inside a pipe.
7. Determination of emissivity of a non-black surface.
8. Determination of Stefan-Boltzmann constant.
9. Performance of a parallel flow and counter flow heat exchanger.
10. Calibration of thermocouple.
11. Demonstration of a heat pipe.

Project Based Learning

1. Demonstration of conduction heat transfer through Plane Slab
2. Demonstration of conduction heat transfer through Composite Slab/ Sphere/ Cylinder.
3. Demonstration of different types of fins

4. Demonstration of Natural Convection mode heat transfer
5. Demonstration of forced Convection mode heat transfer
6. Demonstration of radiation mode heat transfer
7. Design of heat exchanger for domestic application

Reference Books

1. Incropera F. P., Dewitt D. P., "Fundamentals of Heat and Mass Transfer", John Wiley.
2. Cengel Y. A. and Ghajar A. J., "Heat and Mass Transfer – Fundamentals and Applications", Tata McGraw Hill Education Private Limited.
3. Holman J. P., "Fundamentals of Heat and Mass Transfer", McGraw – Hill publication.
4. Mills A. F., "Basic Heat and Mass Transfer", Pearson

Text Books

1. Sukhatme S. P., "A Textbook on Heat Transfer", Universities Press.
2. Nag P. K., "Heat & Mass Transfer", McGraw Hill Education Private Limited.
3. Thirumaleshwar M., "Fundamentals of Heat and Mass Transfer", Pearson Education India.
4. Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", New Age Science
5. S.C Arora, S. Domkundwar," A Course in Heat and Mass Transfer" Dhanpat Rai & co
6. Introduction to Heat Transfer - S. K. Som

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

TURBO MACHINERY
(Course No. C302)

Designation of Course	Turbo Machinery		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites: -	The students should have knowledge of 1. Fundamentals of Thermodynamics Principles and applications. 2. Fundamentals of Fluid Mechanics.
Course Objectives:-	1. To provide the knowledge of basic principles and applications of turbo machinery. 2. Analyze the performance of turbo machines. 3. Apply thermodynamics and kinematics principles to turbo machines.
Course Outcomes: -	The students should be able to– 1. Analyze the impact of jet and velocity triangles. 2. Analysis of Impulse water turbine. 3. Analysis of Reaction water turbine. 4. Analysis of rotary and axial flow compressor. 5. Analysis of centrifugal pump and velocity triangles. 6. Study and analysis of reciprocating pump.

Course Contents

Unit I	**Impact of Free Jets**	**(08 Hrs.)**
Impulse-momentum principle, fixed and moving flat plates, curved vanes , with jet striking at the center of vane and jet striking tangentially on to the vane, Impact of jet on hinged plates, Impact of jets on series of flat plates and vanes, water wheels, velocity tri-angles and their analysis, work done and efficiency calculations.		
Unit II	**Impulse Water Turbines**	**(08 Hrs.)**
Main components and constructional features of Pelton wheel, Concept of centrifugal head, general energy equation for turbine, Velocity diagrams and analysis, Important non-dimensional parameters such as speed ratio, jet ratio, flow ratio, Condition for maximum hydraulic efficiency, working Proportion of Pelton wheel, Design of Pelton turbine runner, Performance characteristics.		
Unit III	**Reaction Water Turbines**	**(08 Hrs.)**
Classifications, Construction and working of Francis, Propeller, Kaplan Turbines, construction features, velocity diagrams and analysis, working proportion of Francis, Propeller, Kaplan Turbines, Degree of reaction (DOR), draft tubes- types and analysis, cavitation causes and remedies, specific speed, performance characteristics and governing of reaction turbines, selection of turbines.		
Unit IV	**Centrifugal Pumps**	**(08 Hrs.)**
Centrifugal Pumps: Classification, components of centrifugal pump, various terms associated with centrifugal pump, various heads, velocity triangle and their analysis, effect of outlet blade angle, cavitation, NPSH, Thomas Cavitation factor, priming of pumps, installation, specific speed, Performance characteristics of centrifugal pump, Axial thrust, maintenance, trouble and remedies, series and parallel operation of pumps system, water hammer problem in pumping system, selection of pumps.		

Unit V	Reciprocating Pumps	(08 Hrs.)
Reciprocating Pumps: Classification, Main Components, Working of Single and double acting reciprocating pumps, discharge, work done, and Power required to drive the reciprocating pump, coefficient of discharge and slip of Reciprocating Pumps, Energy analysis, Performance characteristics.		
Unit VI	**Rotary Air Compressor**	**(08 Hrs.)**
Centrifugal Compressor: Classification, Construction, flow process on T-S Diagram, velocity diagram and Euler's work, slip factor and its effect on work input, actual work input. Axial Flow Compressor: Construction, stage velocity triangles and its analysis, enthalpy-entropy diagram, Degree of reaction, flow through the blade rows, pressure rise across the stage, stage losses and efficiencies, performance characteristics		

Term Work

Any ten experiments from the following:

1. Study and application of impulse momentum principle.
2. Study and trial on a Pelton wheel and plotting of main / operating characteristics.
3. Study and trial on a Francis turbine and plotting of main / operating characteristics.
4. Study and trial on a Kaplan turbine and plotting of main / operating characteristics
5. Study and trial on a Centrifugal pump and plotting of operating / and variable speed characteristics.
6. Study and trial on reciprocating Pump.
7. Study of axial flow compressors/ centrifugal air blower.
8. Assembly and disassembly of pumps.
9. Trial on centrifugal air compressor.
10. Design of a complete pumping system installation using standard tables, charts supplied by pump manufacturers.
11. Visit to Hydroelectric power stations and writing a report based on the visit.
12. Visit to water pumping station and writing a report based on visit.

Reference Books

1. Maneesh Dubey, BVSSS Prasad, Archan Nema, "Turbomachinery", Tata-McGraw Hill.
2. S.M. Yahya, "Turbines, Compressors & Fans", Tata-McGraw Hill.
3. B. U. Pai, "Turbomachines", Wiley India.
4. Dr. Onkar Singh, "Thermal Turbo machines", Wiley India.

Text Books

1. P. N. Modi and Dr. S. M. Seth, "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi.
2. R. K. Rajput, "Hydraulic Machines", S. Chand Publishers, New Delhi.
3. R. K. Bansal, "Fluid Mechanics and Hydraulic Machines", Laxmi Publications (P) LTD.
4. S.C. Gupta, "Fluid Mechanics & Hydraulic Machines", Pearson Education.

Project based learning

Demonstration model of

1. water wheel with flat blades
2. water wheel with curved blades
3. Pelton wheel
4. Francis turbines
5. Propeller turbines
6. Kaplan Turbines

7. Rotary compressor
8. Preliminary design of Centrifugal pump- single stage/multistage.
9. Reciprocating pump.

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

HYBRID AND ELECTRIC VEHICLES
(Course No. C303)

Designation of Course	**Hybrid and Electric Vehicles**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- --Hours/ Week	Term Work	-- Marks	--
	Oral/Practical	-- Marks	
	Total	**100 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1. Basic of Internal combustion engines, 2. Electrical and electronics engineering
Course Objectives:-	To study the basic concepts of 1. Hybrid Electric Vehicles, Vehicle Performance and their drive trains. 2. Electric Vehicle Architecture design and different energy storage systems. 3. Electric Drives, Energy Management Strategies and INDIAN and GLOBAL Scenario
Course Outcomes: -	Students should be able to 1. Understand basics of hybrid and electric vehicle and analysis their performance. 2. Understand Concept of Hybrid Electric Drive Trains 3. Understand Electric Vehicle Architecture Design 4. Understand different Types of Storage Systems 5. Understand construction and working of electric drives and analyze their performance. 6. Understand Energy Management Strategies and INDIAN /GLOBAL Scenario

Course Contents

Unit I	**Introduction to Hybrid, Electric Vehicles**	**(08 Hrs.)**
History, Components of Electric Vehicle, Comparison with Internal combustion Engine: Technology, Comparison with Internal combustion Engine: Benefits and Challenges, EV classification and their electrification levels, EV Terminology. Configurations of Electric Vehicles Performance of Electric Vehicles, Traction Motor Characteristics, Tractive Effort and Transmission Requirement, Vehicle Performance.		
Unit II	**Drive Trains**	**(08 Hrs.)**
Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel Hybrid Electric Drive Trains, Torque-Coupling Parallel Hybrid Electric Drive Trains, Speed-Coupling Parallel Hybrid Electric Drive Trains Torque-Coupling and Speed- Coupling Parallel Hybrid Electric Drive Trains.		
Unit III	**Electric Vehicle Architecture Design**	**(08 Hrs.)**
Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV), Plug-in hybrid vehicle (PHEV, Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles		

Unit IV	Types of Storage Systems	(08 Hrs.)
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices, Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE)		
Unit V	**Electric Drives**	**(08 Hrs.)**
Basic concept of electric traction, introduction to various electric drive- train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.		
Unit VI	**Energy Management Strategies: Global Scenario**	**(08 Hrs.)**
Introduction, classification of energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Introduction to various charging techniques and schematic of charging stations. Technology Scenario, Market Scenario, Policies and Regulations, Payback and commercial model, Payback and commercial model, Polices in India		

Project Based Learning

Following is the list of Topics for project based learning (Not Limited to) based on the syllabus contents:

1. To prepare a chart on Components of Electric Vehicle.
2. To prepare demonstration model of electric Vehicle terminology.
3. To prepare demonstration model of Series Hybrid Electric Drive Trains.
4. To prepare demonstration model of Parallel Hybrid Electric Drive Trains.
5. To prepare demonstration model of
6. To prepare demonstration model of Photovoltaic solar based electric Vehicle design / Battery Electric vehicle (BEV)
7. To prepare a chart on Types of Storage Systems
8. To prepare demonstration model of Storage Systems
9. To prepare demonstration model of Configuration and control of DC Motor drives/Induction Motor drives/ Permanent Magnet Motor drives.
10. To prepare a chart on energy management strategies used in hybrid and electric vehicles.
11. To prepare a chart on comparison of different energy management strategies
12. To prepare a chart on INDIAN and GLOBAL Scenario

Reference Books:

1. James Larminie, J. Lowry, “Electric Vehicle Technology Explaned”, John Wiley & Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
3. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.
4. Iqbal Hussein, “Electric and Hybrid Vehicles: Design Fundamentals”, CRC Press, 2003.
5. Mehrdad Ehsani, Yimin Gao,Sebastien E. Gay and Ali Emadi, “Modern Electric, Hybrid Electric and Fuel Cell Vehicles Fundamentals, Theory and Design”

6. Chris MI, M. Abul and David Wenzhong Gao "Hybrid Electrical Vehicle Principles and Application with Practical Perspectives"

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

COMPUTER INTEGRATED MANUFACTURING

(Course No. C304)

Designation of Course	**Computer Integrated Manufacturing**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**04**

Course Prerequisites: -	The student should have basic knowledge of 1. Manufacturing Processes.
Course Objectives: -	1. To acquire the knowledge of Machining Processes and CNC technology. 2. To acquire the knowledge of Additive manufacturing processes and Computer integration for Manufacturing. 3. To acquire the knowledge of Flexible Manufacturing Systems and Computer Aided Process Planning.
Course Outcomes: -	The students should be able to– 1. Understand the manufacturing processes and apply them. 2. Understand the various CNC Programming and apply same for manufacturing of components. 3. Understand the various Additive Manufacturing processes and apply them to create the jobs. 4. Understand the Computer integration for Manufacturing apply them in manufacturing. 5. Understand the use of Flexible Manufacturing Systems for manufacturing. 6. Understand the use of Computer aided process planning and apply it for manufacturing purpose.

Course Contents

Unit I	**Machining Processes**	**(06 Hrs.)**

Mechanical Processes: Ultrasonic machining (USM), Abrasive Jet Machining (AJM), Water Jet machining (WJM), Abrasive water Jet Machining (AWJM) processes-Process principle and mechanism of material removal, Process Parameters; Applications; Operational characteristics; Limitations.

Electro Chemical Processes: Electrochemical Machining Process (ECM) principle; Mechanism of material removal; Process Parameters; Process Capabilities; Applications, Tool Design, Electro Chemical Deburring (ECDE).

Thermal Processes: Electro discharge Machine (EDM), Wire Electro Discharge Machining (WEDM), Laser Beam Machining (LBM),Electron Beam Machining (EBM), Plasma Arc machining (PAM) processes–Process principle and mechanism of material removal; Process parameters and characteristics; Surface finish and accuracy, Applications; Limitations.

Unit II	**CNC Technology**	**(06 Hrs.)**

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning Centre, machining Centre, CNC controllers, characteristics, interpolators– Computer Aided Inspection, CNC Programming: Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming,

machining cycles, programming for machining Centre and turning Centre for well-known controllers such as Fanuc, Siemens. Introduction to CMM.		
Unit III	**Additive Manufacturing**	**(06 Hrs.)**
Introduction to Additive Manufacturing (AM): Need for Additive Manufacturing, Generic AM process, Distinction between AM and CNC, Classification of AM Processes, Steps in AM process, Advantages of AM, Major Applications. **Vat Photopolymerization AM Processes:** Stereolithography (SL), Materials, SL resin curing process, Micro-stereolithography, Process Benefits and Drawbacks, Applications of Photopolymerization Processes. **Extrusion-Based AM Processes:** Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.		
Unit IV	**Computer Integration for Manufacturing**	**(06 Hrs.)**
Manufacturing Systems: Concept Objectives, Types and Trends; Concepts of Mechanization, Automation and Integration. Concept of CAD/CAM and CIMS; Software Technology for CIM System: Business Database System: File processing, Data Processing and Database Design, File Organization and Relational Analysis; Decision Support System, Personal/Distributed Computing and Local Area Network.		
Unit V	**Flexible Manufacturing Systems**	**(06 Hrs.)**
Fundamentals of Group Technology and Flexible Manufacturing Systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, computer control systems, FMS planning and design issues, Automated Storage and Retrieval Systems, AS/RS and Automatic parts identification systems and data capture.		
Unit VI	**Computer Aided Process Planning**	**(06 Hrs.)**
Process Planning and Production Planning, manual experience-based planning, Decision table and decision trees, Process capability analysis, Variant and Generative process planning approach, Process planning systems like CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP. Introduction to total integrated process planning systems.		

Term Work

1. Study and demonstration of EDM Machine.
2. Study and demonstration of ECM Machine.
3. Manual part programming using G and M codes for Turning, Step turning, Taper turning, turning, Facing.
4. Manual part programming using G and M codes for Drilling.
5. Component to be manufactured on CNC machine.
6. CNC Milling program involving linear motion and circular interpolation.
7. A study on group technology method utilized in FMS
8. Measurements of geometric parameters of parts using Coordinate Measuring Machine (CMM).
9. Manufacturing of Component using Additive manufacturing Technique
10. Generating G and M code using Delcam and Mastercam
11. Simulation of Tool using Delcam and Mastercam.

Textbooks:

1. P. C. Sharma, Production Engineering, S. Chand Publications
2. R. K. Jain, Production Technology, Khanna Publishers

Reference Book

1. P. N. Rao, Manufacturing Technology- Vol 1, McGraw Hill Education (India) Private Limited
2. P. N. Rao, Manufacturing Technologyp, Vol- II, McGraw Hill Education (India) Private Limited
3. Tai ran Hsu, “MEMS & Microsystem: Design & Manufacture” , Tata McGraw Hill Publisher, 2002.
4. B. S. Raghuwanshi, Workshop Technology, Vol-II, Dhanpat Rai & Co.
5. Julian W. Gardner & Vijay K. Varadan, “Microsensors, MEMS and smart Devices”, John Wiley & Sons, 2001.
6. Roy A. Lindberg, Process & Materials of Manufacture, PHI
7. E. P. DeGrmo, J. T. Black and A. Kosher, Material and processes in manufacturing, PHI
8. HMT Handbook, Production Technology, TMH
9. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing”, 2ndEdition, Springer, 2015.
10. PatriK. Venuvinod and Weiyin Ma, “Rapid Prototyping: Laser-based and Other Technologies”, Springer, 2004.
11. S. R. Deb. “Robotics”, Tata McGrawHill Publishing Co. Ltd., ISBN 0-07-460090-
12. M. P. Grover, M. Weiss, R. N. Nagel, N. G. Odrey, “Industrial Robotics Technology”,ISBN 0-07-100442-
13. Computer Integrated Manufacturing and Engineering- U.Rembold, Addison Wesley Publishers, 1993 edition.
14. Quick Responsive Manufacturing – Rajan Suri, Productivity Press, 1998.
15. Principles of computer integrated manufacturing- S, Kant Vajpayee, PHI Learning Private Limited, New Delhi, 2012.

Project Based Learning:

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. Make Working model of non-conventional machining processes
2. To show the use of controller for CNC applications
3. Select a Industrial drawing, and prepare CNC program and implement it on CNC.
4. Make a Prototype Model for Tool changer for CNC.
5. Make a Prototype Model for Clamping and decamping of job on CNC
6. Make a model using additive Manufacturing
7. Prepare processes plan for industrial component
8. Make model for automated storage and retrieval system
9. Prepare system for automatic part identification and data capture
10. Prepare Process Plan for industrial components.

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

MACHINE DESIGN AND ANALYSIS-II
(Course No. C305)

Designation of Course	**Machine Design and Analysis-II**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- 01 Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**05**

Course Prerequisites: -	The students should have knowledge of 1. Computer Aided Drafting and Visualization 2. Computer Aided Machine Drawing 3. Strength of Machine Components 4. Machine Design and Analysis-I
Course Objectives: -	1. To study basic concepts of design of machine elements. 2. Impart design skills to the students to apply these skills for the problems in real life industrial applications. 3. To Enable students to attain the basic knowledge required to understand, analyze, design and select machine elements required in transmission systems
Course Outcomes: -	The student should be able to – 1. Apply the concepts of spur gear design for solving engineering problems. 2. Apply the concepts of helical gear design for solving engineering problems. 3. Apply the concepts of bevel gear, worm and design for solving engineering problems. 4. Develop capability to analyze rolling contact bearing and its selection from manufacturer's catalogue. 5. Achieve an expertise in design of sliding contact bearing in industrial applications. 6. Inculcate an ability to design belt drives and to select belt, rope and chain drives.

Course Contents

Unit I	**Design of Spur Gears**	**(06 Hrs.)**
Introduction to gears: Gear Selection, material selection, Basic modes of tooth failure, Gear Lubrication Methods, Introduction to Gear design standards like AGMA, IS. **Spur Gears:** Number of teeth and face width, Force analysis, Beam strength (Lewis) equation, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength (Buckingham's) equation, Estimation of module based on beam and wear strength, Estimation of dynamic tooth load by velocity factor and Buckingham's equation.		
Unit II	**Design of Helical Gears**	**(06 Hrs.)**
Transverse & normal module, virtual number of teeth, Force analysis, Beam & wear strength, Effective load on gear tooth, Estimation of dynamic load by velocity factor, Spott's equation, Buckingham's equation.(No numerical on force analysis of helical Gear)		
Unit III	**Design of Bevel Gears and Worm Gears**	**(06 Hrs.)**

Bevel Gears-Introduction, Terminology, Virtual number of teeth, and force analysis of Straight Bevel Gear. Design of Straight Bevel Gear based on Beam Strength, Wear strength and estimation of effective load based on Velocity factor (Barth factor) and Buckingham's equation. **Worm Gears**–Introduction, terminology and proportions of worm and worm gears, Force analysis of worm gear drives, Friction in Worm gears, efficiency of worm gears, Strength and wear ratings of worm gears (Bending stress factor, speed factor, surface stress factor, zone factor)		
Unit IV	**Rolling Contact Bearing**	**(06 Hrs.)**
Equivalent bearing load, Load life relationship, Selection of bearing life, Selection from manufacturer's catalogue, Design for cyclic load & speed, Bearing with probability of survival other than 90%, Lubrication & mounting, construction materials, Selection of oil seals & gaskets, Types of failure of bearings and its remedies. Taper roller bearing: Force analysis and selection criteria. (Theoretical Treatment only)		
Unit V	**Sliding Contact Bearing**	**(06 Hrs.)**
Basic modes for lubrication, Viscosity, Effect of temperature on viscosity, Viscosity index, Additives, Greases, Selection of lubricants. Viscous flow through rectangular slot, Load carrying capacity & flow requirement of hydrostatic step bearing, Energy losses, Hydrodynamic lubrication, Reynolds equation, Summerfield number, Raimondi & Boyd's method, Parameters of bearing design, Length to diameter ratio, Unit bearing pressure, Radial clearance, Minimum oil film thickness, Constructional details of bearings, Bearing materials & their selection, Comparison of rolling& sliding contact bearing.		
Unit VI	**Belt, Rope and Chain Drives**	**(06 Hrs.)**
Belt drive: Materials and construction of flat and V belts, geometric relationships for length of belt, power rating of belts, concept of slip & creep, initial tension, effect of centrifugal force, maximum power condition, Selection of Flat and V-belts from manufacturer's catalogue, belt tensioning methods, relative advantages and limitations of Flat and V- belts, **Wire Ropes** (Theoretical Treatment Only): Construction of wire ropes, lay of wire rope, stresses in wire rope, selection of wire ropes. **Chain Drives** (Theoretical Treatment Only): Types of chains and its Geometry, selection criteria for chain drive, Polygon effect of chain, Modes of failure for chain, Lubrication of chains		

Term work

Term work shall consist of following experiments. Hand calculations must be confirmed through a computer programme using any programming language.

1. Design Project on single stage Spur gear box design
2. Design of single stage helical Gearbox
3. Calculation of module for bevel gear
4. Calculation of module for worm gear
5. Selection of Bearing by using manufacturers catalogue
6. Calculation of belt drive parameters

Assignment

Numerical and/or theory questions on following topics from previous year question papers of GATE/ESE Mechanical Engg. Examinations.

1. Spur Gears
2. Helical Gears
3. Bevel and Worm Gears
4. Rolling Contact Bearing
5. Sliding Contact Bearing
6. Belt, Rope and Chain Drive

Note: Design data book should be used extensively.

Project Based Learning

Following is the list oftopics for project based learning (Not Limited to) based on the syllabus contents:

1. To develop Industrial/Real life application demonstration model of different types of Gears.
2. To develop a demonstration models for any practical applications where spur gears are used.
3. To design the gearbox for wind mill application.
4. To design the in-line gearbox for Automobile application
5. To design the gearbox for building Elevator.
6. To design the gearbox for building Hoist.
7. To design the gearbox for Worm gear box for Sugar Industry.
8. To develop a demonstration models for any one practical applications where helical gears are used.
9. To develop a demonstration models for any one practical applications where bevel gears are used.
10. To develop a demonstration models for any one practical applications where worm and worm gears are used.
11. To observe the mechanical system where transmission of power or motions takes place through gears like Transmission of power from motor to pump/generator/lathe machine/drilling machine. By selecting suitable materials, design the gears. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials using any CAD software.
12. To develop demonstration models of different types of bearings.
13. Case study on Selection of Bearing from Manufacturer's Catalog.
14. Case study Mounting of machine elements on transmission shaft (like Bearings, gears, Pulley, Sprocket, etc).
15. To observe the mechanical system where different types of bearings are used. By selecting suitable materials, design a sliding contact bearing. To prepare design report and assembly drawing indicating overall dimensions, tolerances, and surface finish. Also to prepare bill of materials using any CAD software.

Textbooks

1. V. B. Bhandari, "Design of Machine Elements", Tata McGraw Hill Publication Co. Ltd.
2. R. S. Khurmi And J.K. Gupta "Machine Design", S Chand Publication.
3. Shigley J. E. and Mischke C. R., "Mechanical Engineering Design", McGraw Hill Publication Co. Ltd.
4. Spotts M. F. and Shoup T.E., "Design of Machine Elements", Prentice Hall International.

Reference Books

1. Black P.H. and O. Eugene Adams, "Machine Design", McGraw Hill Book Co. Inc.
2. Willium C. Orthwein, "Machine Components Design", West Publishing Co. and Jaico Publications House.
3. Hall A. S., Holowenko A. R. and Laughlin H. G, "Theory and Problems of Machine Design", Schaum's Outline Series.
4. Sharma C. S. and PurohitKamlesh, "Design of Machine Elements", PHI LearingPvt. Ltd.
5. D. K. Aggarwal & Sharma P. C., "Machine Design", S.K Kataria and Sons
6. Gope P. C., "Machine Design: Fundamentals and Applications", PHI LearingPvt. Ltd.
7. "Design Data- P. S. G." College of Technology, Coimbatore.
8. V. B. Bhandari, "Design Data Book", Tata McGraw Hill Publication Co. Ltd.

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

VOCATIONAL COURSE III: LOGISTICS & STORES MANAGEMENT
(Course No. C306)

Designation of Course	Vocational Course III: Logistics & Stores Management		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	02
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**02**

Course Prerequisites:-	The student should have 1. Inclination for taking up Logistics & Stores Management as a Professional Career option or as a self-employment occupation. . 2. Computer literacy
Course Objectives:-	1. Aware of the Logistics & Stores Functions in any industry. 2. Improve their self-confidence, in interview process and further in their training/working in any industry's stores and/or logistics departments. 3. Aware of various stores layouts
Course Outcomes:-	The students should be able to– 1. Acquire knowledge of different types of Stores / Warehouses, related to various industries. 2. Understand SOP's and implement them for store management 3. Design store layout and infrastructure 4. Understand various types of stores and distribution of warehouses 5. Solve inventory management problems in store 6. Apply new technologies & Hybrid Computerized Systems in modern trade and industry.

Course Contents

Unit I	**Introduction to logistics**	**(04 Hrs.)**
Introduction to Logistics & Stores Management. It's History, importance in Industry/Trade/Agriculture, etc. Types of Logistics Activities. Types of Stores/Warehouses, etc.		
Unit II	**Fundamentals of stores**	**(04 Hrs.)**
Various types of stores and their differentiation: E-Com Stores, Big Retail Stores, Factory Stores, Distribution Warehouses, Libraries, etc..		
Unit III	**Store Layout and Infrastructure**	**(04 Hrs.)**
Introduction to stores layout and stores infrastructure: Various Material Storage Systems, Material Handling Systems, various tools & gadgets used in stores, safety processes for stores, etc.		
Unit IV	**Store Management**	**(04 Hrs.)**
Introduction to Stores Management. Basics of Stores Management. Various Activities carried out in a store (general awareness). Various types of stores in an industry. Various SOPs in stores management.		
Unit V	**Inventory Management**	**(04 Hrs.)**
Introduction to Inventory Management, its Importance (General Awareness). Methods of Inventory Management, FIFO/LIFO, and Documentation for Inventory Management, Inventory Verification Processes, what is Inventory Reconciliation & its methodology, etc. Inventory Replenishment & Methods adopted for the same.		

Unit VI	Advancements in Logistics Technology	(04 Hrs.)
Transportation & Logistics. What is First Mile/Second Mile/ Last Mile Logistics/Delivery. Importance of Logistics & Transport in Modern Trade. Advancements & improvements due to use of new technologies & Hybrid Computerized Systems in modern trade and industry. Brief intro to WMS-ERP, etc.		

Term Work

1. Physical Introduction to a Store, actual visit to an industrial store or College Library, which is a classic example of book storage, within college premises.
2. Stores Layout Study
3. Introduction to various Material Handling Equipment's, Material Storage Systems and tool + gadgets used in stores. For Example: Fork Lift, Stacker & Pallet Trucks, various types of Racking Systems, Various types of Pallets & Bins, Weighing machines, packaging tools, etc.
4. Introduction to stores processes / activities, like:
5. Receiving: Unloading, stacking, receiving documentation, offer to QC & finally send to main stores area.
6. Storage of materials in various designated locations.
7. Issues: Receive issue list, check availability of various items/parts, prepare pick list, actual pick-up, compile at issue place, Issue documentation.
8. Dispatch: Prepare dispatch documentation, actual dispatch thro vehicle, etc.
9. Industrial, multi-location stores visits. (Total 2 industry visits)
10. Actual working in a Store / Library for Inventory Management Study.
11. Visit to a Commercial Stores, like Big Bazar, to observe their layout, storage methods, etc.
12. Self-study Assignment: Visit any 2 big commercial stores & note down observations and compare the stores.
13. Know various common, printed documents/formats used in industrial stores
14. Introduction to various specialty stores, like: Cold Storage, Hazardous Chemicals, Paints & Fuel Storage, Fertilizers & Grains Stores, Silos for Grains, Open Yards for Steel Coils & Heavy Items, Bonded Goods Stores, etc.

Text Books:

1. Supply Chain Management by Janat Shah.
2. Logistics Management by S.K.Bhattacharya S.Chand

Reference Book

1. Operations Management by Heizer and Render.
2. Supply Chain Management by Chopra and Meindl.
3. Operations Management by Evans and Collier

COMPUTER ORIENTED NUMERICAL METHODS

(Course No. C307)

Designation of Course	**Computer Oriented Numerical Methods**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisites:-	The students should have knowledge of 1. Basic Mathematics 2. Programming Language
Course Objectives:-	1. The goal of the course is that students should develop techniques for problem solving using a numerical method.
Course Outcomes:-	The students should be able to– 1. Find roots of equation of single variable equations 2. Find solutions of simultaneous linear equations 3. Find the data that fits the given equations by curve fitting 4. Find the data that fits the given equation by interpolation 5. Integrate a given equations 6. Find the solution of ODE

Course Contents

Unit I	**Roots of equations**	**(04 Hrs.)**
Bracketing methods-Bisection and False position method		
Unit II	**Linear Algebraic Equation:**	**(04 Hrs.)**
Navie Gauss elimination, pitfalls of Gauss Elimination, techniques of improving solutions		
Unit III	**Curve Fitting:**	**(04 Hrs.)**
Least-Square Regression-Linear regression		
Unit IV	**Interpolation**	**(04 Hrs.)**
Newtons Forward and Backward Interpolation		
Unit V	**Numerical Integration**	**(04 Hrs.)**
Trapezoidal rule, Simson's 1/3 and 3/8 rule		
Unit VI	**Ordinary Differential Equations**	**(04 Hrs.)**
Ordinary Differential Equations: Euler's method		

Term work

1. Term work shall consist of any eight programs described in syllabus and listed below.
2. Program on Bisection Method
3. Program on False Position Method
4. Program on Gaussian Method
5. Program on Curve fitting by least square method
6. Program on Newton’s Forward Method
7. Program on Newton’s Backward Method
8. Program on Trapezoidal Rule

9. Program on Simpson’s 1/3 rule
10. Program on Simpson’s 3/8 rule
11. Program on Euler’s Method.

Textbooks/ Reference Books

1. Numerical Methods for engineers, Steven Chapra and Raymond Canale, McGraw Hill
2. Ordinary Differential Equations**:** Euler's method, improvement of Euler's method, Runge-Kutta method, system of equations, B. S. Garewal, Khanna Publisher
3. Numerical Recipes: The art of scientific computing, William H Press, CambridgeUniversity Press

B. Tech. Mechanical
Sem.-VI

INTRODUCTION TO CFD AND FEA

(Course No. C310)

Designation of Course	**Introduction To CFD And FEA**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites:-	The students should have knowledge of 1. Engineering Mathematics 2. Engineering Mechanics 3. Strength of Materials 4. Heat Transfer 5. Fluid Mechanics 6. Mechanical Vibration
Course Objectives:-	1. Analyze a physical problem 2. Develop finite element procedures for accurately investigating the problem, and effectively perform and document findings. 3. Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach 4. Impart knowledge to solve complex fluid flow problems using computational fluid dynamics. 5. Familiar with modern trends in computational fluid dynamics
Course Outcomes:-	The students should be able to– 1. Apply Rayleigh-Ritz, Galerkin and weighted residual method to solve engineering problems and understand the role and significance of shape functions in finite element formulations. 2. Derive governing equations by understanding flow physics and mathematical behavior. 3. Understand the formulation of element stiffness matrix, load vector by potential energy approach for 1D and 2D problems 4. Create grid and improve mesh quality using advanced tools and techniques 5. Derive the shape functions for bar, rectangle and higher order elements as well as able to apply numerical methods to solve numerical integration and evaluate the Eigenvalues and Eigenvectors for stepped bar and beam. 6. Develop turbulence models and understand its approaches.

Course Contents

Unit I	**Pre-processing**	**(08 Hrs.)**
Philosophy of CFD, Governing equations of fluid dynamics and their physical meaning, Simple CFD techniques, Upwind and downwind schemes, Simple and Simpler schemes, Higher order methods, Implicit and explicit methods, Steady and transient solutions, Introduction to FVM and FDM.		

Unit II	Processing	(08 Hrs.)
Surface mesh generation, Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms, grid clustering and quality checks for volume mesh. Adaptive, Moving and Hybrid Grids, Need for adaptive and, moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination.		
Unit III	**Post-processing**	**(08 Hrs.)**
Introduction and background of Turbulence Modeling, Algebraic models, One equation models, Two equation models, Near wall treatment, Reynolds stress models, Introduction to multi-phase flows		
Unit IV	**Introduction to FEA**	**(08 Hrs.)**
Introduction to FEM, Stress strain relations, shape functions- linear and quadratic, Triangular, Quadrilateral, Higher order elements, Variational methods of approximation-Rayleigh Ritz Method, Methods of Weighted Residuals-Least Square Method, Subdomain Method, Collocation Method, Garlekin's method.		
Unit V	**One Dimensional Problems**	**(08 Hrs.)**
Finite element modeling, Convergence of results, Potential energy approach, Global stiffness matrix, properties of stiffness matrix, load vector, Penalty approach, Elimination approach, Finite Element Analysis of 2-D truss structure and Constant strain triangle.		
Unit VI	**Isoparametric Elements**	**(08 Hrs.)**
Isoparametric formulation – Natural Co-ordinate system, Lagrangian interpolation polynomials, Isoperimetric element, Numerical Integration Newton Cotes formula, Guass Quadrature formula in two and three dimensions, triangular elements, rectangular elements. Dynamic Analysis, Formulation of Dynamic problems, Consistent and Lumped Mass Matrices. Solution of Eigen Value Problems. Transformation Method, Jacobi Method, Vector Iteration Method, Subspace Iteration Method.		

Term Work

Term work shall consists of

1. Four computer program assignments to be developed for FEA. (Using any programming language.)
2. Two assignments on structural and on modal Analysis Analysis using FEA Software
3. Two assignments on fluid flow analysis using CFD software.
4. Two assignments on solid thermal analysis using CFD software.
5. Two assignments on structural plus thermal analysis using CFD software.

Text Books/ Reference Books

1. K. J. Bathe, "Finite Element Procedures", PHI
2. R. D. Cook, D. S. Malus, M. E. Plesha, "Concepts and Applications of Finite Element Method Analysis", John Wiley
3. J. N. Reddy, "An introduction to Finite Element Method Analysis", MGH
4. Desai & Abel, "Introduction to Finite Element Methods"
5. D. L. Logan, "A course in the Finite Element Method", Third Edition, Thomson Learning
6. T. R. Chandrupatia, A. D. Belegundu, "Introduction to Finite Elements in Engineering", Third Edition, PHI
7. John D. Anderson, "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill, 1995
8. V. V. Ranade, "Computational Flow Moeling for Chemical Reactor Engineering", Process Engineering Science, Volume 5, 2001

9. Patrick Knupp and Stanly Steinberg, “Fundamentals of Grid Generation”, CRC Press, 1994
10. D. C. Wilcox, “Turbulence Modelling for CFD”, 1993
11. Pieter Wesseling, “An Introduction to Multigrid Methods”, John Wiley & Sons, 1992
12. J. F. Thompson, Z. U., A. Warsi and C. W. Mastin, “Numerical Grid Generation: Foundations and Applications”, North Holland, 1985
13. S. V. Patankar, “Numerical Heat Transfer and Fluid Flow”, McGraw-Hill,1981
14. Thomas B. Gatski, M. YousuffHussaini, John L. Lumley,, “Simulation and Modelling of Turbulent Flows”, Eds., Oxford University Press, 1996
15. Laney, C. B., “Computational Gas Dynamics”, Cambridge Uni. Press, 1998

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. Structural analysis of any mechanical component.
2. Thermal analysis of any mechanical component.
3. Modal analysis of any mechanical component.
4. Heat transfer & fluid flow analysis using various models.

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

REFRIGERATION AND AIR CONDITIONING
(Course No. C311)

Designation of Course	Refrigeration and Air Conditioning		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- 01Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**04**

Course Prerequisites:-	The students should have knowledge of 1. Fundamentals of Thermodynamics Principles and applications. 2. Fundamentals of Heat Transfer.
Course Objectives	1. To provide the knowledge of basic principles and applications of RAC **2.** Analyze the performance of Refrigeration and A/C systems.
Course Outcomes:-	The students should be able to– 1. Understand the methods of refrigeration systems. 2. Analyze the simple vapour compression system 3. Analyze the different multi-pressure systems 4. Analyze various psychrometric processes used in air conditioning systems. 5. Understand the components of refrigeration and air conditioning systems 6. Analyze the air distribution systems.

Course Contents

Unit I	Methods of Refrigeration	(06 Hrs.)
Ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, vapour refrigeration system, steam jet refrigeration system, refrigeration by using liquid gases, Thermoelectric and ultrasound refrigeration. **Air refrigeration system:** Definition, refrigeration load, unit of refrigeration, Introduction to heat pump, Reverse Carnot cycle, Bell Coleman cycle, Methods of air refrigeration systems, simple air-cooling system, boot strap system, reduced ambient system, regenerative system.		
Unit II	**Simple Vapour Compression Systems**	**(06 Hrs.)**
Limitations of air refrigeration system, development of vapour compressor cycle, effect of operating parameters on VCC, use of P-H charts, actual vapour compression cycle. **Refrigerants** Desirable properties of refrigerants, classification of refrigerants, secondary refrigerants, alternative refrigerants for CFC's, HCFC'S, ozone depletion potential (ODP), Global warming Potential (GWP).		
Unit III	**Multi pressure Vapour compression system, Vapour absorption systems**	**(06 Hrs.)**
Multi Pressure Systems Introduction to multistage compression, two stage compression with flash gas removal, with liquid intercooler, Cascade systems. **Vapour absorption systems** Introduction, Simple Vapour absorption system, practical vapour absorption system, COP of an ideal vapour absorption system, Water ammonia system, Electrolux refrigerator, Lithium-Bromide absorption System, Comparison between VCC and VAC (no mathematical treatment).		

Unit IV	Psychrometry and Human comfort	(06 Hrs.)
Introduction, Psychrometric terms, Use of Psychrometric charts, Psychrometric processes, adiabatic saturation temperature, evaporative cooling, by pass factor of coil, efficiency of coil, adiabatic mixing of two air streams, Air washers, Thermodynamics of human body with environment effective temperature, comfort chart, factors influencing human comfort.		
Unit V	**Air Conditioning Systems and Components**	**(06 Hrs.)**
Definition, factors, equipment used, classification, all air system, all water system, air water system, unitary and central air conditioning, in filtration and ventilation loads, concepts of SHF, RSHF, ERSHF, ADP. Compressors, condensers, evaporators, expansion devices such as capillary tubes, automatic expansion valves, thermostatic expansion valves and controls such as thermostats, humidistat, Solenoid, Installation, charging, testing and maintenance, study of modern trends in RAC		
Unit VI	**Air distribution system**	**(06 Hrs.)**
Introduction, classification of ducts, duct material, pressure in ducts, flow through duct, pressure losses in duct, friction losses, dynamic losses, air flow through simple duct system, equivalent diameter, for determination of duct size **Food Preservation:** Cold storage, control and modified atmosphere (CAMA) storages, mobile refrigeration and air conditioning, refrigerant piping selection, pressure drop, valves, fitting, insulating materials.		

Term Work

Any ten experiments from the following:

1. Test on Computerized vapour compression test rig
2. Test on Computerized air conditioning test rig
3. Test on Computerized ice plant test rig.
4. Study of non-conventional refrigeration system.
5. Determination of cooling load of air conditioning system (case study).
6. Determination of refrigeration load in cold storage (case study / visit).
7. Study of installation /operation/maintenance practices for refrigeration system.
8. Visit to any refrigeration or air conditioning plant.
9. Trial on Computerized heat pump test rig
10. Test on vapour absorption test rig.
11. Market survey of various components of refrigerating& air conditioning systems.
12. Determination of energy efficiency of refrigeration or air conditioning system.

Reference Books

1. Dossat Ray I, “Principal of Refrigeration”, Wiley Eastern Limited
2. Stocker W. F. and Jones J. W., “Refrigeration and Air Conditioning”, McGraw Hill

Text Books

1. Arora C. P., “Refrigeration and Air Conditioning”, Tata McGraw Hill
2. Arora S. C., Domkundwar S., “Refrigeration and Air Conditioning”, Dhanpat Rai and Company
3. Khurmi R. S. and Gupta J. K., “Refrigeration and Air Conditioning”, S Chand Publication

Project Based Learning

1. Demonstration models of non-convection refrigeration systems
2. Demonstration models of conventional system for domestic application
3. Demonstration models of vapor absorption systems

4. Finding applications of RAC
5. Demonstration models of air conditioning systems
6. Load calculations for any application
7. Design of duct and calculation of losses in ducts
8. study of modern trends in RAC
9. Assembly and disassembly of RAC components.
10. Preliminary design of refrigeration system for real life problem.
11. Preliminary design of air conditioning system for real life problem.

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

INDUSTRIAL ENGINEERING & MANAGEMENT
(Course No. C312)

Designation of Course	**Industrial Engineering & Management**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- -- Hours/ Week	Term Work	-- Marks	--
	Oral/Practical	-- Marks	
	Total	**100 Marks**	**03**

Course Prerequisites:-	The student should have basic knowledge of 1. Basic concept of Management 2. Basic information of Industrial engineering 3. Man machine interaction.
Course Objectives	1. The student should understand the scope, objective and application of industrial engineering tools and management practices in manufacturing.
Course Outcomes:-	The students should be able to– 1. Understand definition, principles and functions of management and apply in organization 2. Understand organization structures and business organizations and select for their organization. 3. Understand functioning of Production, Personnel, Marketing and Finance Department. 4. Understand method study tool and apply for standardizing the method 5. Understand work measurement tool and apply for standardizing the time. 6. Understand ergonomically accepts, safety and industrial laws in manufacturing organization.

Course Contents

Unit I	**Introduction to Industrial Management**	**(06 Hrs.)**
Management- Meaning and Definitions, Management, Administration, and Organization concepts, Management as an Art and Science and a profession, contribution of various thinkers to management thought, Types and Functions of Management. Different approaches to management – scientific, operational, human and system approach.		
Unit II	**Industrial Organization**	**(06 Hrs.)**
Different forms of business Organization –Individual proprietorship, Partnership, Joint stock company, Co-Operative enterprise, Public Sector, Undertakings, organizational structures in Industries, Line, Functional ,Line and functional , Project, Matrix Organization and Committees		
Unit III	**Departments of Industrial Management**	**(06 Hrs.)**
Production Management: Production/Operations Management, Materials / SCM & Logistics Management, Maintenance & Plant Engg., Planning, R & D ,Quality Management Personnel Management-Definitions Recruitment, Selection and training of the employees, Job valuation and Merit rating, wage administration different methods of wage payments, incentives.		

Marketing Management-Definitions, Marketing and Selling concept, market segmentation, distribution channels, Market Research, Advertising and sales promotion and Sales forecasting. Financial Management-Capital structure, Fixed capital, working capital, sources of finance, cost analysis, Break even analysis, Depreciation and Financial statement		
Unit IV	**Method Study**	**(06 Hrs.)**
Steps in method study, tools and techniques used, process chart symbols, flow diagrams, two handed chart, multiple activity chart, use of motion pictures and its analysis. SIMO charts, chorno & cycle graph, developing, presentation, installation and maintenance of improved methods. Layouts Planning, Workflow Planning, Work Balancing for multi person assembly/production lines.		
Unit V	**Work Measurement**	**(06 Hrs.)**
Time Study: Aim and objectives , terminology and tools, use of stop watch procedure in making a time study, elements, selection of operations time study forms, handling of foreign elements. Performance rating. Allowances: Personal, Fatigue and other allowances. Analysis and calculation of Standard Time. Determination of number of cycles time study for indirect functions such as Maintenance, Marketing etc., Most Technique. Works Sampling: Definition, Objectives, theory of Work Sampling. Other applications of work sampling, errors in work sampling study. Synthetic and Standard data Methods: Concepts, introduction to PMTS, MTM-1, WF, Basic motion time, MTM-2, and other second – generation methods timing of group operations.		
Unit VI	**Industrial Engineering Tools**	**(06 Hrs.)**
Ergonomics: Definitions, importance in industry, basic anatomy of human body, anthropometrics, bio mechanical factors environment effects. Industrial Safety: Importance of safety, planning, training, safety precautions, safety equipment's, Government regulations on safety. Industrial Acts: Factory Act, AIR Act, Boiler Act, Workers Compensation Act. Kaizen, Kanban, 5S, Poke-Yoke, Cross-functional team, The 5 M's of Lean, TQM		

Textbooks

1. O. P. Khanna, Industrial Engineering & Management, Dhanapat Rai & Sons.
2. M. C. Shukla, Business Organization and Management, S. Chand & Co. Ltd, New Delhi.
3. Harold Koontz & Heinz Enrich, Essentials of Management, McGraw Hill International.
4. M. N. Mishra, Organizational Behavior, Vikas publishing New Delhi.
5. Dale Yoder, Personnel Management.
6. Work Study, ILO.
7. S. S. Patil, Industrial Engineering & Management, Electro tech Publication.
8. Mansoor Ali &Dalela, Industrial Engineering & Management System, Standard Publisher distributions.
9. R. M. Currie, Work Study, ELBS.
10. Management by James A. F. Stoner, R. Edward Freeman, PHI

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

QUANTITATIVE TECHNIQUES, COMMUNICATION AND VALUES
(Course No. C313)

Designation of Course	**Industrial Engineering & Management**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- 01 Hours/ Week	Internal Assessment	40 Marks	
Practical:- -- Hours/ Week	Term Work	-- Marks	01
	Oral/Practical	-- Marks	
	Total	**100 Marks**	**04**

Course Prerequisites:-	The student should have basic knowledge of 1. Basic math's and reasoning, and comprehensive ability 2. Basic knowledge of communication process, soft skills 3. Basic knowledge and idea about leaders and leadership qualities, ethics, etiquettes and values
Course Objectives:-	1. The Quantitative Techniques, Communication and Values aims to augment students to face the campus recruitment test and train them on applying short techniques/ tricks to solve questions of Maths, reasoning and English in very less amount of time. The communication and values section focuses on the aspects of communication and soft skills such as grooming personality for leading team, presentation, business communication which would enable graduates to project themselves as a professionals in the corporate sector and/or otherwise.
Course Outcomes:-	The students should be able to– 1. Solve the aptitude test in the recruitment and competitive exam by applying short techniques and solve the question in less amount of time 2. Apply the short mnemonics and techniques to solve the questions of logical reasoning in the placement and competitive exam in lesser time. 3. Develop the verbal ability to communicate effectively using suitable vocabulary and proper sentence pattern 4. Understand the concept of soft skills and its implication at workplace 5. Build up the ability to study employment business correspondences and its proper implications 6. Understand business ethics, etiquettes and values and apply them in the professional ventures.

Course Contents

Unit I	**Quantitative Aptitude**	**(06 Hrs.)**
Number system, Percentage, profit and loss, Simple Interest and Compound Interest, Ratio, Proportion and Average, Mixture and Allegation, Time, Speed & Distance, Time & Work , Permutation & Combination, Probability, Pipes and Cisterns.		
Unit II	**Non-Verbal Reasoning**	**(06 Hrs.)**
Coding, Decoding, Number series, Blood relation Directions, cubes & dices , Data Interpretation, Data Sufficiency, Set Theory & Syllogisms, Matching, Selection & Arrangement, Clocks & Calendars, Visual Reasoning, Input, Output & Flow Chart.		
Unit III	**Verbal Reasoning**	**(06 Hrs.)**

Sentence Patterns, Sentence correction and spotting errors, Vocabulary, antonyms and synonyms and analogy, Phrasal Verbs, idiomatic expressions, reading comprehension, closest, sentence rearrangement and theme detection		
Unit IV	**Self-Awareness And Soft Skills Development**	**(06 Hrs.)**
Concept of SWOT, Importance of SWOT, Individual & Organizational SWOT Analysis, Soft skills, meaning, need and importance, difference between soft skills and hard skills, life skills and personal skills, Leadership skills,-Importance ,Types, Attributes of good leader Motivational theories and leadership ,Emotional intelligence in personal and professional lives its importance need and application, Team Building and conflict resolution Skills ,Problem solving skills, Time Management and Stress Management Skills Pareto Principle(80/20) Rule in time management, Time management matrix, Creativity and result orientation, working under pressure, stress management.		
Unit V	**Communication and Honing Employment Skills**	**(06 Hrs.)**
Communication process, Non-verbal codes in communication, importance of LSRW in communication, Barriers to communication, Principles of effective Technical writing, Email writing and Netiquettes, Letter writing – formal letters, job application letter, cover letter, structure of technical report writing, Building Resume and CV, Tips to build an effective Resume Group discussion, Skills required for Group Discussion Interview skills, Ways of handling telephonic interviews, Importance of body language, grooming &etiquettes for getting right impression in PI&GD , Extempore, Introduction to PowerPoint presentation, ,Structure & flow of presentation,.		
Unit VI	**Business Ethics, Etiquettes and Values**	**(06 Hrs.)**
The Importance of Ethics and Values in Business World, Respect for Individuality and diversity at workplace values of a good manager Key features of corporate etiquette, Corporate grooming & dressing, etiquettes in social & office Setting-Understand the importance of professional behavior at the work place, Corporate social responsibility (CSR) its importance and need.		

Project Based Learning

1. Prepare mock Tests on Unit –I and solve it in given time(use of PSD lab manual)
2. Prepare mock Tests on Unit –I and solve it in given time(use of PSD lab manual)
3. Prepare online model test based on Unit-II and solve it in specific time(use of PSD lab manual)
4. Prepare online model test based on Unit-II and solve it in specific time(use of PSD lab manual)
5. Form a model for spoken and written communication skills which avoid grammar mistakes and common errors
6. Develop various activity models for enriching and developing vocabulary
7. Preparing strategies by using SWOT and TWOS analysis
8. Analysing differences between Soft Skills, Hard skills, and Personal skills
9. Develop Bruce Tuchman's Team Building Models with classmates/Teammates
10. To study different personalities of Leaders from various sectors and find out their attributes and success stories
11. Preparing a model for Time Management Skills and Stress Management and conduct activities for effective implementation of it.
12. Form a model to develop LSRW and communication Skills
13. Conduct mock interview and practice GD activities to build competencies for actual selection process
14. Preparing a model for evaluating Values and Ethics of Good Managers
15. Preparing a model of dress codes and attire for different professional situations Corporate etiquettes and its implications

16. Develop some good activities to understand the importance and need of Corporate social responsibility (CSR)

Reference Books

1. Quantitative Aptitude by R. S. Agarwal published by S. Chand
2. The Book of Numbers by Shakuntala Devi
3. A Modern Approach To Logical Reasoning by R. S. Agarwal published by S. Chand
4. A New Approach to Reasoning Verbal & Non-Verbal by IndüSijwali
   Business Communication by Meenakshi Raman, Prakash Singh published by Oxford University press, second edition
5. Communication Skills by Sanjay Kumar, PushpLata, published by Oxford University press, second edition
6. Technical Communication by Meenakshi Raman, Sangeeta Sharma published by Oxford University press
7. Developing Communication Skills by Krishna Mohan, Meera Banerji published by Macmillan India Pvt Ltd
8. Soft Skills by Meenkashi Raman, published by Cengage publishers
9. Soft Skills by Dr. K Alex published by Oxford University press
10. Soft skills for Managers by Dr. T. KalyanaChakravarthi and Dr. T. LathaChakravarthi published by biztantra

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

MECHANICAL SYSTEM DESIGN
(Course No. C314)

Designation of Course	Mechanical System Design		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial:- -- Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**05**

Course Prerequisites:-	The students should have knowledge of 1. Statics and dynamics 2. Computer Aided Machine Drawing 3. Machine design & Analysis I & II 4. Theory of machine
Course Objectives:-	To provide the knowledge of 1. To study basic concepts of vibration analysis 2. To acquaint with the principles of vibration measuring instruments 3. To develop competency for system visualization and design. 4. To enable student to design pressure vessels and to use IS code. 5. To introduce student to optimum design and use optimization methods to design mechanical components.
Course Outcomes:-	The students should be able to– 1. Understand the concept of free undamped single DOF and evaluate vibrating parameters. 2. Understand the concepts of force single DOF and evaluate transmissibility and critical speed of shaft. 3. Understand the concept of free undamped multi DOF vibration system and analyze it for vibration parameters 4. Understand the various stresses in different components of pressure vessels and apply it to design different types of pressure vessels 5. Understand the design consideration of Machine tool Gear box and evaluate speed at each stage by using ray diagram. 6. Understand optimum design with normal specifications and apply optimum design method for different machine components.

Course Contents

Unit I	Free Undamped Single Degree of Freedom Vibration System	(08 Hrs.)
Vibration classification, Steps involved in vibration analysis Longitudinal, transverse, torsion vibration system, Methods for formulation of differential equations by Newton, Energy, and Rayleigh’s Method.		
Unit II	**Forced Single Degree of Freedom Vibratory System**	**(08 Hrs.)**
Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper) Vibration Isolation and Transmissibility Force Transmissibility, Motion Transmissibility Typical isolators& Mounts Rotor Dynamics: Critical speed of single rotor, undamped and damped.		
Unit III	**Free Undamped and Damped Vibration System**	**(08 Hrs.)**

Viscous damped system – under damped, critically damped, over damped; Logarithmic decrement; Coulomb's damping; Combined viscous and coulomb's damping. Two rotors, Three rotors and geared system; Dunkerley's and Rayleigh's method for transverse vibratory system. Vibration Measurement: Vibration measuring devices: Accelerometers, Vibration exciters, FFT analyzer Introduction to signal analysis: Time domain & Frequency domain analysis of signals. Noise measurement		
Unit IV	**Pressure Vessels**	**(08 Hrs.)**
Introduction, Classification of Pressure Vessels, Stresses in a Thin Cylindrical Shell due to an Internal Pressure, Circumferential or Hoop Stress, Longitudinal Stress, Thin Spherical Shells Subjected to an Internal, Thick Cylindrical Shell Subjected to an Internal Pressure, Compound Cylindrical Shells, Stresses in Compound Cylindrical Shells, Cylinder Heads and Cover Plates, Auto-frettage.		
Unit V	**Design of Machine Tool Gearbox**	**(08 Hrs.)**
Introduction to machine tool gear boxes, design and its applications, basic considerations in design of drives, determination of variable speed range, graphical representation of speed and structure diagram, ray diagram, selection of optimum ray diagram, deviation diagram, difference between numbers of teeth of successive gears in a change gear box.		
Unit VI	**Optimum Design**	**(08 Hrs.)**
Objectives of optimum design, adequate and optimum design, Johnson's Method of optimum design, primary design equations, subsidiary design equations and limit equations Frequency Distribution-Histogram and frequency polygon, normal distribution-units of central tendency and dispersion – standard deviation- population combinations , statistical analysis of tolerances, mechanical reliability and factor of safety.		

Term Work

Part A (Any 4)

1. To determine the natural frequency of damped vibration of single degree freedom system and to find it's damping coefficient.
2. To obtain frequency response curves of single degree freedom system of vibration for different amount of damping
3. Free vibration of simply supported beam
4. Free Vibration of a Two-DOF System
5. Forced vibration of SDOF system
6. To determine natural frequency of vibration of beam using vibration analyzer.
7. Noise measurement and analysis using vibration Analyzer

Part B

1. One design project: The design project shall consist of two imperial size sheets (Preferably drawn with 3D/2D CAD software)-one involving assembly drawing with a part list and overall dimensions and the other sheet involving drawings of individual components, manufacturing tolerances, surface finish symbols and geometric tolerances must be specified so as to make it working drawing. A design report giving all necessary calculations of the design of components and assembly should be submitted. Projects shall be in the form of design of mechanical systems like multispeed gear box.

Project Based Learning

Following is the list of topics for project based learning (Not Limited to) based on the syllabus contents:

1. Case study on : Free Undamped Single Degree of Freedom Vibration System
2. Case study on : Forced Single Degree of Freedom Vibratory System
3. Case study on : Free Undamped and Damped Vibration System
4. Case study on : Measurement of natural frequency of vibration of beam using FFT vibration analyzer
5. Case study on : Noise measurement using FFT vibration Analyzer.

Text Books/ Reference Books

1. Mechanical Vibrations - G. K. Grover Nem Chand & BrosJames Gere, Mechanics of
2. Mechanical Vibrations 4th edition- S. S. Rao - Pearson Education
3. Vibration Analysis - P. Srineevasan - Tata McGraw Hill
4. Bhandari V.B.— Design of Machine Elements, Tata McGraw Hill Pub. Co. Ltd
5. S. K. Basu and D. K. Pal,—Design of Machine Tools Oxford and IBH Pub Co
6. Design Data—,P.S.G.College of Technology, Coimbatore
7. Singiresu S. Rao, Engineering Optimization: Theory and Practice, ,John Wiley & Sons
8. I.S. 2825: Code for unfired pressure vessels

Unit Tests

Unit Test-I	Unit-I,II, III
Unit Test-II	Unit-IV, V, VI

VOCATIONAL COURSE-IV
(REFRIGERATION AND AIR CONDITIONING SYSTEM MAINTENANCE)
(Course No. C315)

Designation of Course	**Vocational Course-IV (Refrigeration and Air Conditioning System Maintenance)**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisites:-	The students should have knowledge of 1. Fundamentals of Thermodynamics Principles and applications. 2. Fundamentals of Heat transfer and RAC
Course Objectives	1. To provide the knowledge of materials used, piping systems, maintenance and installation of RAC systems 2. Analyze the fault in Refrigeration and A/C systems
Course Outcomes:-	The students should be able to– 1. Understand various materials used in RAC systems 2. Understand RAC piping systems 3. Understand Specialist tools and accessories 4. Analyze mechanical and electrical faults in RAC systems 5. Understand RAC installation techniques 6. Analyze Cooling & heating load calculations

Course Contents

Unit I	**Refrigeration & Air-conditioning Material**	**(04 Hrs.)**
Introduction, desired properties of ideal insulating material, factors effecting the thermal conductivity, types of insulating material., reflective insulating blinds, lap rock – a thermal acoustic and fire insulation, natural insulator, new transparent heat insulator, heat transfer through insulation used for A.C, thickness of insulation, few insulated systems, low temperature insulations, importance of relative humidity for the selection of the insulations, air distribution for reducing heat lose.		
Unit II	**RAC Piping Systems**	**(04 Hrs.)**
Codes, Standards and Specifications: Piping codes, ASME codes and standards, ASTM Specifications ASME Boiler, Pressure vessel codes, ASME B31-Code for pressure piping, mechanical strength, testing of piping system and valves, fabrications, Piping Components: Pipe-seamless, welded pipes, pipe sizes, dimensional specifications, material, specifications, pipe ends, pipe fittings, pipe support		
Unit III	**RAC Maintenance Specialist Tools and Accessories**	**(04 Hrs.)**
Flexible charging line, bending springs, pipe tube cutter, fin combs, soldering and brazing equipment's, Vacuum pump, charging cylinders, electric test lamps, jumper lead, welding goggles, Pipe installation work, pumping down the system, purging the system, starting the plant, Using a system analyzer, transferring and handling liquid refrigerant		
Unit IV	**Mechanical and Electrical Fault Finding**	**(04 Hrs.)**
Compressor motor fails to start, compressor motors tries to start but does not run, compressor motor starts but does not reach running speed, thermostat failure type, pressure cut-out failure, wiring and		

collection faults, Fault analysis by temperature and pressure, methods of confirming the fault, finding the fault when the compressor is not running, abnormal noise problem, domestic system faults		
Unit V	**RAC Installation Techniques**	**(04 Hrs.)**
Introduction: Installation operation, adding oil, testing for leak detection, Evacuation and dehydration, removing air, charging of the system, through suction valve, through discharge, Installation of Room Air-Conditioner: Selection of proper location, providing proper slope and provision for to drain water, Installation of split air conditioner, providing arrangement for pipes and pipe, pipe insulations		
Unit VI	**Automobile Air Conditioning**	**(04 Hrs.)**
Design Automobile AC system: Load Calculations & Analysis- Design considerations for achieving desired inside/room conditions with respect to prevailing outside/environment conditions. Factors affecting/contributing towards the load on refrigeration & air conditioning systems, Cooling& heating load calculations, Load calculations for automobiles, Effect of air conditioning load on engine, AC Service & Control: Air Conditioning Service- Air conditioner maintenance & service - removing & replacing Components. Compressor service, Testing, Diagnosis & trouble shooting of air conditioning system, Refrigerant gas charging procedure &. Servicing of heater system, Air Conditioning Control - Common controls such as thermostats, humidistat, control dampers, pressure cut outs, relays.		

Term Work

Any ten experiments from the following:

1. Introduction of various insulating material, properties, fire hazard
2. Technique of glass wool filling method in conventional refrigerant
3. Leak detection in refrigeration system by different methods
4. Determination of cooling load for a specified situation
5. Study of piping codes, ASME codes and standards, ASTM Specifications
6. Checking the performance of air ducting system
7. To study hermetically sealed compressor, condensing units, performance, volumetric efficiency
8. To design the AC System for the automobile according to the use.
9. To diagnose the fault in Central Air conditioning System.
10. To diagnose the fault in Automobile AC System
11. Refrigeration systems and air conditioning system simulation analysis using METLAB, Java, ASPA, Suma soft, lab view.

Reference Books

1. Dossat Ray I, “Principal of Refrigeration”, Wiley Eastern Limited
2. Stocker W. F. and Jones J. W., “Refrigeration and Air Conditioning”, McGraw Hill
3. Air conditioning: procedures and installation by V. Paul Lang, CBS publishers &distributors, Delhi
4. Hand book of Air conditioning and refrigeration by Shan K Wang, McGraw-hill international edition, Singapore
5. Piping and Pipeline Calculations Manual by J. Phillip Ellenberger

Text Books

1. Arora C. P., “Refrigeration and Air Conditioning”, Tata McGraw Hill
2. Arora S. C., Domkundwar S., “Refrigeration and Air Conditioning”, Dhanpat Rai and Company
3. Khurmi R. S. and Gupta J. K., “Refrigeration and Air Conditioning”, S Chand Publication

INTRODUCTION TO DATA SCIENCE
(Course No. C316)

Designation of Course	**Introduction to Data Science**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial:- -- Hours/ Week	Internal Assessment	-- Marks	
Practical:- 04 Hours/ Week	Term Work	25 Marks	02
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**02**

Course Prerequisites:-	The students should have knowledge of 1. Linear Algebra, Probability, Statistics, Logical Reasoning
Course Objectives	To explore the fundamental concepts of data analytics. 1. To understand the various search methods and visualization techniques. 2. To apply various machine learning techniques for data analysis.
Course Outcomes:-	The students should be able to– 1. Understand the basics of data analytics using concepts of statistics and probability. 2. Understand the basics of data mining using concepts of statistics and probability 3. Apply various inferential statistical analysis techniques to describe data sets withdraw useful conclusions from acquired data set. 4. Explore the data analytics techniques using various tools. 5. Apply data science concept and methods to solve problems in real world context. 6. Apply an advanced techniques to conduct thorough and insightful analysis and interpret the results.

Course Content

Unit I	**Introduction to Data Science**	**(08 Hrs.)**
Predictive Analytics involves the use of mathematical methods and tools such as statistical analysis, and predictive models.		
Unit II	**Data mining**	**(08 Hrs.)**
Data mining is to identify anomalies in the process, which help in preventive maintenance. Estimate the demand for product, raw material etc. based on historical data and current scenario. Forecast possible outcomes based on data obtained from the process.		
Unit III	**Prescriptive Analytics**	**(08 Hrs.)**
Prescriptive Analytics is used identify ways in which an industrial process can be improved like action need to take to avoid the failure, plan the maintenance schedule, review your supplier, etc		
Unit IV	**Descriptive Analytics**	**(08 Hrs.)**
Descriptive Analytics, describe the problem by diagnosing the symptoms, analytics method to discover the trends and patterns based on historical data, charts, and graphs.		
Unit V	**Data visualization**	**(08 Hrs.)**
Data visualization tools, problems in the manufacturing process, descriptive analytics in the form of charts and graphs.		
Unit VI	**Diagnostic Analytics**	**(08 Hrs.)**
Root cause analysis, data discover, correlation, and down and drill.		

Term work

Any 8 experiments on following topics (not limited to this)

1. Data analysis of experiments in thermal engineering.
2. Data analysis of experiments in design engineering.
3. Data analysis of experiments in manufacturing processes.

Note: Students need to apply the computational algorithms using suitable software /programming language.

Text Book

1. Brunton, S. L., & Kutz, J. N. (2022). Data-driven science and engineering: Machine learning, dynamical systems, and control. Cambridge University Press.
2. Dunn, P. F., & Davis, M. P. (2017). Measurement and data analysis for engineering and science. CRC press.
3. Roy, S. S., Samui, P., Deo, R., & Ntalampiras, S. (Eds.). (2018). Big data in engineering applications (Vol. 44). Berlin/Heidelberg, Germany: Springer.
4. Middleton, J. A. (2021). Experimental Statistics and Data Analysis for Mechanical and Aerospace Engineers. Chapman and Hall/CRC.

References Books:

1. Zsolt Nagy, "Artificial Intelligence and Machine Learning Fundamentals", Packt Publishing, 2018, ISBN: 978-1-78980-165-1
2. Hastie, Trevor, Robert Tibshirani, Jerome H. Friedman, and Jerome H. Friedman. The elements of statistical learning: data mining, inference, and prediction. Vol. 2. New York: springer, 2009.
3. Zaki, Mohammed J., Wagner Meira Jr, and Wagner Meira. Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press, 2014.
4. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.

INDUSTRIAL AUTOMATION
(Course Code C401)

Designation of Course	Industrial Automation		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - --Hours/ Week	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	25 Marks	
	Total	**150 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1. Knowledge of Mathematics & Theory of Machines, Mechanical Engineering Systems 2. Knowledge of Properties of Fluid, Turbomachinery 3. Knowledge of Basic Electrical and Electronics
Course Objectives: -	1. Understand automation technologies and identify advantages, limitations and applications of the same. 2. Develop ability to recognize, articulate and solve industrial problems using automation technologies. 3. To provide students with knowledge of the applications of fluid power systems in process, construction, robotics and manufacturing industries and able to design and implement automated systems using pneumatics. 4. To make the students acquainted with the conceptual as well as practical knowledge of the PLC programming & latest technologies being used to achieve PLC Industrial Automation.
Course Outcomes: -	The students should be able to– 1. Understand & apply fundamentals of industrial automation. 2. Understand concepts of control system and apply it for automation. 3. Understand concepts related to fluid power system, Power units and its accessories. 4. Understand concepts related to Control of fluid power and Control valves. 5. Understand concepts related to Hydraulics and Pneumatics – Actuators and Circuits and its application. 6. Understand concepts of PLC and Develop ladder diagram for industrial applications.

Course Contents

Unit I	Introduction to Industrial Automation and Robotics	(06 Hrs.)
Introduction of Automation and Robotics, Historical Development, three laws of robotics by Isaac Asimov, Broad classes of industrial automation-Fixed, flexible and programmable and their comparative study, Automation Principles and Strategies, USA Principle, Ten Strategies for Automation and production systems, Automation Migration Strategy-Manual Production, Automated Production, Automated integrated production		
Unit II	**Automatic Control Systems and Control Actions**	**(06 Hrs.)**
Introduction to control systems: mechatronics system & its examples, mechatronics system components. Open loop and closed loop system, effects of feedback and basic characteristic of feedback control systems, classification of control systems. **Introduction to Controllers:** Control System Parameters, Controller Modes, Control Actions, Types of Controllers-ON-OFF Controller, Proportional Controller (P-Controller), Proportional + Integral Controller (P-I Controller), Proportional + Derivative Controller (P-D Controller),		

Proportional + Integral + Derivative Controller (P-I-D Controller), Effect of Proportional, Integral, and derivative control on the Time Response of the System **Control System Components:** Elements of a Data Acquisition and Control System, Overview of the Input/Output Process, Data Acquisition Case Studies. Variable Frequency Drive, Servomotor, switches, Relays and Contactors.		
Unit III	**Fundamentals of Industrial Fluid Power Systems**	**(06 Hrs.)**
Fluid Power System: Components of fluid power system, advantages and limitations. Difference between electrical, pneumatic and fluid power systems. Seals, sealing materials. Types of pipes, hoses, material. Fluid conditioning through filters, strainers, sources of contamination and contamination control. **Power units and accessories**: Types of power units, reservoir assembly, sizing of reservoirs, constructional details, pressure switches, temperature switches. Accumulators: Types, selection procedure, applications of accumulators. ISO symbols for hydraulic and pneumatic Components		
Unit IV	**Fluid Power Control**	**(06 Hrs.)**
Necessity of fluid control through pressure control, directional control and flow control valves. Control valves: i) Principle of pressure control valves, direct operated and pilot operated pressure relief valves, pressure reducing valve, sequence valve. ii) Principle of flow control valves, pressure compensated and non-compensated flow control valves. iii) Principle of directional control valves, types of directional control valves, two-way, three-way, four-way valves, check valve and shuttle valve. Open centre, close centre, tandem centre valves. Actuating devices- manually operated, mechanically operated, solenoid operated, pilot operated, lever operated.		
Unit V	**Hydraulic & Pneumatic Circuits**	**(06 Hrs.)**
Linear and rotary actuators: Types, construction and characteristics. Cylinder mountings, cushioning of cylinders. **Hydraulic & Pneumatic circuits:** Simple reciprocating, regenerative, speed control (meter in, meter out and bleed off), sequencing, synchronization, traverse and feed, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, unloading circuit, motor breaking circuit etc. Types of filters, pressure regulators, lubricators, mufflers, dryers, direction control valves, pneumatic actuators, shuttle valve, two pressure valve, quick exhaust valve and time delay valves. Speed regulating methods, pneumatic circuits, reciprocating, cascading time delay etc. Application of pneumatics in low-cost automation and in industrial automation. Development of Electro-hydraulic Circuits and Electro-pneumatic Circuits.		
Unit VI	**Programmable Logic Controller**	**(06 Hrs.)**
Introduction to PLCs, Basic Structure of a PLC, Principles of Operation, PLC Programming Languages, Ladder diagram, Latching and internal relays, Timers and Counters, Selection of a PLCs for Control System, Application of PLCs for Automatic Control System. Concept of SCADA and its Applications,		

Term Work

(Term work shall consists of minimum 8 experiments from following)

1. Study of P, P+I, P+D, P+I+D control actions using any trainer kit / simulation software.
2. To study working of servomotor and its applications in industrial automation.
3. To study working of variable frequency drive and its applications in industrial automation.
4. Study of flow control valves (Meter in, Meter out Circuits).
5. Study of directional control valves.
6. Study of pressure control valves.
7. Study of ISO/JIC Symbols for hydraulic and pneumatic systems.
8. Following experiments to be done on hydraulic trainer a) Regenerative circuit b) Speed control circuit c) Sequencing circuit d) Traverse and feed circuit etc.
9. Following experiments to be done on pneumatic trainer a) Automatic reciprocating circuit b) Speed control circuit c) Pneumatic circuit involving Shuttle valve/ Quick exhaust valve / Two pressure valve.
10. Design of simple hydraulic/pneumatic systems used in practice such as hydraulic clamp, jacks, dumper, forklift etc by using fluid simulation software’s such as LVSIM®-HYD & PNEU, AUTOMATION STUDIO.

11. Study of PLC, SCADA and development of ladder logic for various industrial applications.
12. Industrial visit to study Hydraulic / Pneumatic based Automation systems.
13. Study of industrial pick and place robot and integrated automation.

Project Based Learning

Following are list for project-based learning (Not limited to)

1. . To prepare a demonstration model of PID Controller with any application.
2. To prepare a demonstration model of control system applications.
3. To prepare a demonstration model of applications of Fluid power systems.
4. To prepare a demonstration model of applications of electro-hydraulic and electro-pneumatic systems.
5. To prepare a demonstration model of pick and place robot with any application.
6. To prepare a demonstration model of any industrial automation system with PLC programming.

Textbooks

1. Automation, Production Systems and Computer Integrated Manufacturing M.P.Groover, Pearson Education.5th edition, 2009.
2. Majumdar S.R, Pneumatics Systems Principles and Maintenance ,Tata McGraw Hill.
3. R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi.
4. Majumdar S.R, Oil Hydraulic system- Principle and maintenance ,Tata McGraw Hill.
5. Esposito Anthony, Fluid Power with application, Prentice Hall.
6. Stewart H. L, Hydraulics and Pneumatics , Taraporewala Publication.
7. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, "Industrial Robotics: Technology, Programming and Applications", McGraw Hill Book Company.
8. Pipenger J.J, Industrial Hydraulics, McGraw Hill .

Reference Books

1. Automation, Production Systems and Computer Integrated Manufacturing M.P.Groover, Pearson Education.5th edition, 2009.
2. R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi.
3. Stuart A Boyer: SCADA supervisory control and data acquisition, International Society of Automation, 2010

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

ELECTIVE-I: SIX SIGMA, LEAN & AGILE MANUFACTURING

(Course Code C402.1)

Designation of Course	**Six sigma, Lean & Agile Manufacturing**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - --Hours/ Week	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites: -	Student should have knowledge of 1. Students should have Basic knowledge of Industrial Engineering. 2. Students should have Basic knowledge of Statistics
Course Objectives: -	Student should be able to 1. Use of six sigma technique to reduce variation 2. Use of Lean manufacturing for process improvement 3. Use of Agile manufacturing
Course Outcomes: -	Learner will be able to… 1.Understand and work with the Lean manufacturing process 2. Understand and work with the Agile Production System 3. Management in the Agile Organization. 4. Understand basic statistical processes. 5. Understand and calculate the six sigma levels 6. Understand and work with the DMAIC process

Course Contents

Unit 1	**Lean Manufacturing**	**06 Hrs.**
Origin and objectives of lean manufacturing, 3M concept, study of Ford and Toyota Production system, Just in Time (JIT) manufacturing, lean building blocks. Value Creation and Waste elimination, seven types of waste, pull production, different models of pull production, Kanban system, design of Kanban quantities, Kaizen, tools for continuous improvement. The value stream-benefits, mapping process. Current state maps-mapping icons, mapping steps. VSM exercise. Takt time calculations standardize work- standard work sequence, timing and working progress Quality at source-Automation/Jidoka, Visual management system, Mistake Proofing/Poka-Yoke.5s technique-Elements and waste elimination through 5s. advantages and benefits, 5s audit, Visual control aids for improvements, Flexible work force.		
Unit 2	**Agile Production system and Practices**	**06 Hrs.**
Agile production system-the task allied organization-production planning and control, quality assurance, purchasing maintenance, overview of production support, business operations, engineering, finance and accounting. Agile Practices-Agile practice for product development, manufacturing Agile practice, understanding the value of investment in people.		
Unit 3	**Management in the Agile Organization**	**06 Hrs.**
Old management styles, role of management in agile organization-vision champion, team leader, coach, business analyzer, supporting the new culture-performance appraisal system, selection system, reward and recognition system, organizational measurement, organizational learning processes.		
Unit 4	**Statistics and probability distribution**	**06 Hrs.**
Basic statistics, probability distributions, normal distribution, central limit theorem, measurement system analysis – precision, accuracy, bias, linearity, gage repeatability & reproducibility. Process capability analysis.		

Multi-Variate analysis, sampling techniques, Hypothesis testing, testing with normal data, One Way ANOVA, nonparametric tests for non-normal data. Chi-square tests		
Unit 5	**Introduction to Six Sigma**	**06 Hrs.**
Six Sigma Defined, Calculating the Sigma Level – Toolset, Six Sigma Framework, DMAIC – The Six Sigma Improvement Process, Introduction to Measure, Introduction to Define, Process Thinking, Spaghetti Charts, Value Stream Mapping Toolset, Pareto Chart Toolset, Project Selection Toolset, Project Charter Toolset		
Unit 6	**Six Sigma in manufacturing**	**06 Hrs.**
Introduction to Measure, Measurements, Discrete vs. Continuous Measurements, Measurement Subjects, Measurement as a Process, The Analysis of Measurement Systems, Statistical Process Control – Introduction and Background, Introduction to Control Charts , Control Chart Limits, More On Control Limits, Cause & Effect Diagram Toolset, Introduction to Hypothesis Testing, The Process on Trial, The Hypothesis – Accept or Reject, Types of Error, Hypothesis Testing , Confidence Intervals, Design of Experiments, Design for Six Sigma (DFSS), Benchmarking , Brainstorming		

Term Work:

1. Case study on Just in Time system
2. Case study on Toyota production system
3. Case study on Kanban and Kaizen production system
4. Case study on Management in the Agile Organization
5. To find the Process capability.
6. Application of Chi-square tests
7. Case study on Sigma level calculations.
8. Case study on design of Experiment.

Project Based Learning

1. Chart preparation showing different methods of waste elimination.
2. Chart preparation for showing the various elements of JIT system.
3. Study of a system based on value stream mapping.
4. Demonstration of elimination of waste using 5S system.
5. Demonstration of Cause and effect diagram for a system.
6. Demonstration of control charts for a system.
7. Study of system using Six sigma for reduction in variation.
8. Formulation of Hypothesis, testing and analysis.

Textbooks:

1. Jain R. K., “Engineering Metrology”, Khanna Publishers
2. Hume K. J., “Engineering Metrology”, Macdonald, 1950
3. Sharp K. W. B., “Practical Engineering Metrology”, Pitman Publication, 1970.

Reference Book:

1. Productions and Operations Management - Chasel Aquilino - Dreamtech latest edition.
2. Toyota Production System -An integrated approach to Just in Time - Yasuhiro Monden – Engineering and Management Press -Institute of Industrial Engineers Norcross Georgia-1983.
3. The Machine that changed the World. The Story of Lean Production - James P Womack – Daniel T Jones - and Daniel Roos -Harper Perennial - edition published 1991.

4. Lean Thinking - James Womack – ISBN 0743249275 – 2003.
5. Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity - Richard Stumberger - ASQC Press 1991.
6. Quality Function Development - James Bossert - ASQC Press 1991.

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

ELECTIVE-I: WASTE TO ENERGY CONVERSION
(Course Code C402.2)

Designation of Course	**Waste to Energy Conversion**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - -- Hours/ Week	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisites:-	The students should have knowledge of - 1. Mechanical Engineering System. 2. Thermodynamic principals 3. Thermodynamic Applications 4. Power Plant Technology
Course Objectives:-	1. To enable students to understand of the concept of Waste to Energy. 2. To learn about the best available technologies for Waste to Energy Conversion
Course Outcomes:-	On completion of the course, students will be able to– 1. **Understand** fundamentals of waste and waste Processing. 2. **Understand** Environmental and social impacts of waste to energy conversion plants 3. **Understand** fundamentals Pyrolysis and Combustion technology and **analyze** their performance 4. **Understand** Gasification technologies and **analysis** their performance. 5. **Understand** fundamentals of Anaerobic Digestion. 6. **Understand** Air quality equipment and systems for waste to energy conversion plants

Course Contents

Unit I	**Introduction to Waste and Waste Processing**	**(06Hrs.)**
Solid waste sources, types, composition, properties, global warming; Municipal solid waste: Physical, chemical and biological properties, waste collection and, transfer stations, waste minimization and recycling of municipal waste, segregation of waste, size reduction, managing waste, status of technologies for generation of energy from waste treatment and disposal aerobic composting, incineration, furnace type and design, medical waste / pharmaceutical waste treatment technologies incineration, environmental impacts, measures to mitigate environmental effects due to incineration.		
Unit II	**Environmental and social impacts of waste to energy conversion plants**	**(06 Hrs.)**
Contributions of WTE conversion to waste reduction and energy generation, Air quality and residue management considerations of WTE conversion, Greenhouse gas profile of WTE, Compatibility of WTE with recycling, Health and safety aspects of WTE, Integrated planning for WTE plants, Future trends.		

Unit III	Pyrolysis and Combustion technology	(06 Hrs.)
Pyrolysis - Introduction, Pyrolysis, Pyrolysis reactors, Investigations on pyrolysis of MSW, Plusses and minusses of the process, Utilization of the process products, Commercial scale pyrolysis plants. Combustion technology - Introduction, Benefits & issues, Chemistry of combustion, Efficiency of combustion, Process stabilization & combustion control, MSW incinerator systems, Grate technology, Fluidized bed combustion technology, Refuse-derived fuel combustion.		
Unit IV	**Gasification technologies**	**(06 Hrs.)**
Gasification, Conventional gasification, Chemical reactions in gasification, Key factors for gasification of waste, Gasifier configurations, Fixed bed gasifiers, Fluidized bed gasifiers, Slagging gasification, Plasma gasification, Plasma arc gasifier, Plasma technology for treatment of incinerator residues & hazardous waste, Issues with plasma arc gasification, Gasification plants in operation, Energy recovery from plastics, Recycling of plastic waste, Technologies for energy recovery from plastic waste, Demonstration-level liquid fuels production from plastic Pyrolysis, Production of gaseous fuel, Commercial systems, Fuel properties of pyrolytic oils.		
Unit V	**Anaerobic Digestion**	**(06 Hrs.)**
Anaerobic food web, Bioreactor configurations, Experiences in different countries, Fundamentals behind anaerobic digestion, Thermophilic anaerobic digestion, Power-to-gas concept to store electric power in the natural gas grid, Electrolysis; Biomethanation at thermophilic conditions, Microbial electrochemical systems, Bioreactor configurations.		
Unit VI	**Air quality equipment and systems for waste to energy conversion plants**	**(06 Hrs.)**
Air quality considerations and regulations for municipal, waste combustors, Acid gas scrubbing in municipal waste combustors, Particulate control devices utilized at waste combustion, facilities, Control of nitrogen oxide emissions and hazardous, air pollutants from waste combustors, Air pollution control cost–benefit analysis, Air quality technology innovations for municipal, waste combustors		

Term Work

1. Market survey on municipal Waste and Waste Processing.
2. Study of Pyrolysis technology.
3. Study of Combustion technology.
4. Study of Gasification technologies.
5. Study of Anaerobic Digestion.
6. Visit to Biogas Power Plant.
7. Visit to Pyrolysis reactors or Gasifier.
8. Case study on Environmental and social impacts of waste to energy conversion plants.
9. Case study on Air quality equipment and systems for waste to energy conversion plants.

Project Based Learning

Following is the list of Topics for project based learning (Not Limited to) based on the syllabus Contents:

1. To prepare a chart Waste and Waste Processing
2. To prepare a chart on Environmental and social impacts of waste to energy conversion plants
3. To prepare a chart on Pyrolysis Process.
4. To prepare a chart on Combustion technology for waste energy conversion.
5. To prepare a chart on Gasification technologies.

6. To prepare a chart on Anaerobic Digester.
7. To prepare demonstration model of Pyrolysis Process
8. To prepare demonstration model of Fixed bed gasifiers
9. To prepare demonstration model of Fluidized bed gasifiers
10. To prepare demonstration model of Plasma arc gasifier
11. To prepare demonstration model of Anaerobic Digestion
12. Case study on Pyrolysis technology
13. Case study on Combustion technology
14. Case study on Gasification technologies
15. Case study on Anaerobic Digestion

Text Books:

1. Nicholas P Cheremisinoff, ―Handbook of Solid Waste Management and Waste Minimization Technologies‖, An Imprint of Elsevier, New Delhi, 2003.
2. P AarneVesilind, William A Worrell and Debra R Reinhart, ―Solid Waste Engineering‖, 2nd edition 2002.
3. M Dutta , B P Parida, B K Guha and T R Surkrishnan, ―Industrial Solid Waste Management and Landfilling practice‖, Reprint Edition New Delhi, 1999.
4. M. L. Davis and D. A. Cornwell, ―Introduction to environmental engineering‖, International Edition, 2008.
5. C. S. Rao, ―Environmental Pollution Control Engineering, Wiley Eastern Ltd. New Delhi, 1995.
6. S. K. Agarwal, ―Industrial Environment Assessment and Strategy, APH Publishing Corporation, New Delhi, 1996.

Reference Books:

1. Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", Elsevier Store.
2. Young G.C., "Municipal Solid Waste to Energy Conversion processes", John Wiley and Sons.
3. Harker, J.H. and Backhusrt, J.R., "Fuel and Energy", Academic Press Inc.
4. EL-Halwagi, M.M., "Biogas Technology- Transfer and Diffusion", Elsevier Applied Science.
5. Hall, D.O. and Overeed, R.P.," Biomass - Renewable Energy", John Willy and Sons.
6. Mondal, P. and Dalai, A.K. eds., 2017. Sustainable Utilization of Natural Resources. CRC Press.
7. C Parker and T Roberts (Ed), ―Energy from Waste, An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
8. KL Shah, ―Basics of Solid and Hazardous Waste Management Technology, Prentice Hall, Reprint Edition, 2000.
9. M Datta, ―Waste Disposal in Engineered Landfills‖, Narosa Publishing House, 1997.
10. G Rich et.al, Hazardous, ―Waste Management Technology, Podvan Publishers, 1987.

Unit Test –

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

ELECTIVE-I: JIG FIXTURE AND DIE DESIGN
(Course Code C402.3)

Designation of Course	**JIG FIXTURE AND DIE DESIGN**		
Teaching Scheme:	End Semester Examination		**Credits Allotted**
Theory: - 03 Hours/ Week	Internal Assessment	60 Marks	03
Tutorial: - --Hours/ Week	Term Work	40 Marks	
Practical: - 02 Hours/ Week	Oral/Practical	25 Mark	01
	Total	125 Marks	04

Course Prerequisites: -	The student should have. 1. Basic knowledge of conventional and non-conventional manufacturing processes. 2. Knowledge of casting processes. 3. Knowledge plastic processes methods
Course Objectives: -	1. To design jigs. 2. To design fixtures. 3. To design dies for manufacturing system.
Course Outcomes: -	The students should be able to– 1. To understand the concept of jigs and fixture and its principles. 2. To design jigs with use of standard components. 3. To design fixture with use of standard components. 4. To select plastic processes methods. 5. To understand the concept of injection moulding and able to design the injection molding die. 6. To design dies for the pressure die casting.

Course Contents

Unit I	**Fundamentals of Jigs and Fixtures**	**(6 Hrs.)**
Significance and purpose of jigs and fixtures and their functions in manufacturing processes. Classifications of Jigs and Fixtures. Design features of main elements of Jigs and Fixtures such as locating, clamping and guiding elements and their integrations. Indexing, locking and auxiliary elements. Bodies and bases or frames of Jigs and fixtures. Economics of Jigs and fixtures, Pneumatics & Hydraulics for Jig & Fixtures.		
Unit II	**Design of Jigs**	**(6 Hrs.)**
General guidelines & procedures for design of Jigs. Design & selection of standard elements, Analysis of clamping force required & their magnitude, Design of drilling jigs.		
Unit III	**Design of Fixtures**	**(6 Hrs.)**
General guidelines & procedures for design of fixtures. Design & selection of standard elements, Analysis of clamping force required & their magnitude, concept of modular fixtures & tool presetting fixtures. Design of milling, turning fixture and fixture for assembly. Economic analysis.		
Unit IV	**Plastics Processing**	**(6 Hrs.)**
Materials used for plastic processing, Compression, transfer, injection & blow moulding processes - its working, construction, types & advantages and limitations.		
Unit V	**Design of Injection Molds**	**(6 Hrs.)**
Specifications and elements of injection molding machine, Injection molding feed system: runner and gates, ejection methods, ejection force calculation, parting surface selection, cooling systems, Defects & remedies.		

Unit VI	Design of Die Castings Dies	(6 Hrs.)
Die casting machines-Hot & cold chamber, metals for die casting, die locking methods, interlocks & safety devices, specific details of die constructions, casting, ejection, cores, slides, loose die pieces, types of cores, directional solidification, types of feeders, die venting, water cooling, classification of dies- single, combination, multi impression. General details of die design, Gating system, inserted impressions, die casting defects and remedies, die lubrication & rules for die lubrication.		

Term Work: (Any Eight)

1. Design & working drawing of simple blanking die.
2. Design & working drawing of progressive die.
3. Design & working drawing of compound die.
4. Design & working drawing of combination die.
5. Design & working drawing of a deep drawing die.
6. Injection molding process.
7. Injection Mold Design
8. Blow Molding process.
9. Hot & cold chamber die casting.
10. Design gating system in die casting.
11. A report on factory visit, comprising of product range, processes, plant layout, AuxilIary equipment, process parameters etc.

Project Based Learning:

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. Fabrication of simple blanking die.
2. Automatic blanking Machine
3. Fabrication of progressive die.
4. Fabrication of compound die.
5. Automatic Pneumatic Punching Machine
6. Tool and die design for Progressive tools.
7. Tool and die design for trimming tools.
8. Pneumatic drill jig
9. Fabrication of combination die.
10. Fabrication of a deep drawing die.
11. Tool and die design for Blanking.
12. Fabrication of Sandwich Jig.
13. Fabrication of universal Fixture
14. Indexing drill jig by using bevel Gear
15. Fabrication of Injection mold.
16. Fabrication of Blow Mold.
17. Automatic Multi spindle drilling machine

Textbooks:

1. P. N. Rao, “Manufacturing Technology”, Tata McGraw Hill
2. M. H. A. Kempster, “Introduction to Jigs and Fixtures Design”
3. P. H. Joshi, “Press Tools”, A.H. Wheeler
4. P. C. Sharma, “Production Engineering”, S. Chand

Reference Books:

1. Donaldson, Lecain & Goold, “Tool Design”, Tata McGrw Hill PRODUCTION
2. Doebler H. H., “Die Casting”, McGraw Hill
3. “Tool Engineering Handbook”, A. S. T. M. E.
4. Wilson, “Fundamentals of Tool Design”, A. S. T. M. E.
5. Richard Kibbe, John E. Neely, Meyer, White, “Machine Tool Practices”

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

ELECTIVE-I: ARTIFICIAL INTELLIGENCE
(Course Code C402.4)

Designation of Course	**Artificial Intelligence**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 3 hrs/Week	End Semester Examination	60	03
Practical: - 2 Hrs /Week	Internal Assessment	40	
	Term Work	25	01
	Total	125	04

Course Prerequisite: -	1. Engineering mathematics-III, Statistics and Numerical Methods, Sensors Technology
Course Objective: -	To provide Knowledge about 1. To understand the artificial intelligence algorithms to robotics problems. 2. To understand the performance of AI algorithms 3. To compute the complex problems in flexible automation
Course Outcomes: -	On completion of the course, students will be able to 1. Use different machine learning techniques. 2. Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and learning. 4. Demonstrate awareness and a fundamental understanding of AI techniques in intelligent agents, artificial neural networks. 5. Demonstrate proficiency in developing applications in AI and Machine Learning. 6. Demonstrate an ability to share in discussions of AI, its current scope and limitations, and societal implications.

Course Content

Unit I	**Introduction to artificial intelligence techniques**	**(06 Hrs)**
Evolutionary computation, Goals of AI in manufacturing, tools for AI such as Search algorithm, Mathematical optimization, programming in AI environment, developing artificial intelligence system, natural language processing.		
Unit II	**Introduction to fuzzy logic**	**(06 Hrs)**
Basic concepts in fuzzy set theory, operations of fuzzy sets, fuzzy relational fuzzy logic principles, fuzzy inference, fuzzy rule-based systems, Fuzzy logic controllers, fuzzy decision making, various industrial applications of fuzzy logic control.		
Unit III	**Introduction to artificial neural networks**	**(06 Hrs)**
Fundamentals of neural networks, neural network architectures, Neural Learning, Supervised Learning, Unsupervised Learning, taxonomy of neural network architectures, standard back propagation algorithms.		
Unit IV	**Handling uncertainty**	**(06 Hrs)**
Probabilistic methods for uncertain reasoning such as Bayesian network, Hidden Markov model, Kalman filter, Decision theory and Utility theory, statistical learning methods, support vector machines, expert systems.		

Unit V	Intelligent systems	(06 Hrs)
Robotic vision systems, image processing techniques, application to object recognition and inspection, automatic speech recognition, Path Planning Robot Control in Dynamic Environments, Accurate Motion Control of Fast Mobile Robots.		
Unit VI	**Industrial application of AI and expert systems**	**(06 Hrs)**
Recent advances: Fundamentals of genetic algorithms, hybrid systems, meta heuristic techniques like simulated annealing, tabu search, ant colony optimization, artificial immune systems, applications in design and manufacturing.		

List of Practical /Term work: -

Term work shall consist of programs listed below based on syllabus

1. Fuzzy logic sets.
2. Fuzzy logic relation.
3. A* algorithm.
4. AO* algorithm.
5. Searching algorithms.
6. Min/MAX search procedure for game Playing.
7. Variants of Min/ Max search procedure.
8. Implementation of mini-Project using the concepts studied in the AI course.

Project based learning:-

Following is the list of topic for project based learning (Not Limited to) based on the syllabus contents:

Create a demo model/ chart/ Working Block diagram for any application of the following topics using any programing language:

1. Search algorithm
2. Fuzzy set theory
3. Fuzzy decision making
4. Neural Learning
5. Supervised Learning,
6. Unsupervised Learning
7. Robotic vision systems
8. Path Planning Robot Control
9. Genetic algorithms

Text Book:-

1. Luger " Artificial Intelligence", Edition 5, Pearson, 2008
2. Bhattacharya S., Artificial Intelligence, Laxmi Publications, Ltd., 2008, ISBN: 9788131804896
3. Chopra Rajiv, Artificial Intelligence, S. Chand Publishing, 2012, ISBN9788121939485
4. Pawar P. J., Evolutionary Computations for Manufacturing, Studium Press, 2019, ISBN: 978- 93-85046-52-0
5. Jain N, Artificial Intelligence: making a system intelligent, 2018, ISBN: 9788126579945

Reference Book:-

1. Russell, Stuart and Norvig, Peter, Artificial Intelligence: A Modern Approach" Prentice Hall, 2003.

2. Aleksander, Igor and Burnett, Piers, Thinking Machines Oxford, 1987.

3. Bench-Capon, T. J. M., Knowledge Representation: An approach to artificial intelligence Academic Press, 1990.

4. Genesereth, Michael R. and Nilsson, Nils J, Logical Foundations of Artificial Intelligence Morgan Kaufmann,1987.

2. Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems (3rd Edition)

3. Vinod Chandra S.S., Anand Hareendran S, " Artificial Intelligence And Machine Learning"

4. Luger " Artificial Intelligence", Edition 5, Pearson, 2008

5. Jacek M. Zurada, Introduction to Artificial Neural Systems, PWS Publishing Company, 1995.

6. Simon Haykin, Neural Networks: A Comprehensive Foundation, Macmillan College Publishing Company, 1994.

Unit Test:

Unit Test 1	Unit I, II, III
Unit Test 2	Unit IV, V, VI

ELECTIVE-I: PRINCIPLES OF AIRCRAFT & SUBMARINE DESIGN
(Course No.C402.5)

Designation of Course	**Principles of Aircraft & Submarine Design**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial:- --Hours/ Week	Internal Assessment	40 Marks	
Practical:- 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1. Theory of Machine 2. Machine Design and Analysis-I and II
Course Objectives:-	1. To make the student understand the choice of the selection of design parameters, Fixing the geometry and to investigate the performance and stability characteristics of airplanes. 2. To make the student understand the basic concepts of submarine design, various systems in submarine, dynamics and control of submarine.
Course Outcomes: -	The students should be able to– 1. Initiate the preliminary design of an aircraft starting from data collection to satisfy mission specifications. 2. Understand the estimation of geometric and design parameters of an airplane. 3. Understand the design of a system, component, or process to meet requirements for aircraft systems. 4. Understand the concepts of submarine design and development process. 5. Understand the various system used in the submarine. 6. Understand the dynamics and control system of submarine.

Course Contents

Unit I	**Introduction to Aircraft Design**	**(06 Hrs.)**
State of art in airplane design, Purpose and scope of airplane design, Classification of airplanes based on purpose and configuration. Factors affecting configuration, Merits of different plane layouts. Stages in Airplane design. Designing for manufacturability, Maintenance, Operational costs, Interactive designs.		
Unit II	**Preliminary Design Procedure**	**(06 Hrs.)**
Data collection and 3-view drawings, their purpose, weight estimation, Weight equation method – Development & procedures for evaluation of component weights. Weight fractions for various segments of mission. Choice of wind loading and thrust. Loading.		
Unit III	**Design of Wing, Fuselage and Emphanage**	**(06 Hrs.)**
Selection of aero foil. Selection of Wing parameters, selection of sweep, Effect of Aspect ratio, Wing Design and Airworthiness requirements, V-n diagram, loads, Structural features. Elements of fuselage design, Loads on fuselage, Fuselage Design. Fuselage and tail sizing. Determination of tail surface areas, Tail design, Structural features, check for nose wheel lift off.		
Unit IV	**Introduction to Submarine Design**	**(06 Hrs.)**
Introduction, Design Objectives, Design Progression, Basic principles of submarine design in a complex modern multi-platform system. Operational requirements for submarines, Architecture and technologies can deliver the capability. Submarine design and development process and all its phases, the platform and combat systems, pressure hull design considerations, Balancing of a submarine design (e.g., weight and buoyancy relations, overall submarine performance,).		

Unit V	Submarine Systems	(06 Hrs.)
Introduction, Hydraulic system, High Pressure Air systems, water systems, System for hydrostatic Control, Environmental control system, Provision for escape, Electrical System.		
Unit VI	**Dynamics and Control**	**(06 Hrs.)**
Introduction, Some Basic Concept, Operational Requirement, Equation of motion of a submarine, Hydrodynamic derivatives, Stability, and control in the horizontal and vertical plane, Steering and depth control system, Impact on design.		

Term Work

Any four case studies from the following:

1. Aircraft Conceptual Design Practices & Case Studies
2. Study of brake systems of various aircraft.
3. Study of pneumatic systems of various aircraft.
4. Study of hydraulic systems of various aircraft.
5. Case study on: Submarine Design in a Changing World.
6. The Submarine as a Case Study in Transformation: Implications for Future Investment
7. Understanding Structure Design of a Submarine.

Project Based Learning

Any One from the following:

1. One design project on various components of aircraft.
2. One design project on various component of submarine.
3. CAD detailed drawing of any one component of aircraft.
4. CAD detailed drawing of any one component of submarine.
5. Detailed drawing of a submarine system using any CAD software.

Textbooks

1. Raymer, D.P. Aircraft conceptual Design, AIAA series, 5th edition, 2012.
2. Torenbeck, E. Synthesis of Subsonic Airplane Design, Delft University Press, U.K. 1986.

Reference Books

1. Kuechemann, D, The Aerodynamic Design of Aircraft, American Institute of Aeronautics publishers, 2012
2. Harrington, R. L. (1992). Marine Engineering (Revised, Subsequent ed.). Revised, Penyunt.) Jersey City, United States: *The Society of Naval Architects and Marine Engineers.*
3. Burcher, R., & Rydill, L. J. (1995). Concepts in submarine design (Vol. 2). Cambridge university press.

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

PRODUCTION PLANNING AND CONTROL

(Course Code C403)

Designation of Course	Production Planning and Control		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 04 Hours/ Week	End Semester Examination	60 Marks	04
Tutorial: - --Hours/ Week	Internal Assessment	40 Marks	
Practical: - -- Hours/ Week	Term Work	-- Marks	--
	Total	**100 Marks**	**04**

Course Prerequisites:-	The student should have 1. Basic knowledge of Industrial Engineering & Management. 2. Basic knowledge of statistics. 3. Basic knowledge of resources of production Man, Machine Material.
Course Objectives: -	The student should 1. To acquire the knowledge of scope, objective and application of Production Planning and Control manufacturing Industries. 2. To acquire knowledge of forecasting, material planning and purchasing. 3. To acquire the knowledge of Inventory control and recent trends in PPC.
Course Outcomes:-	The students should be able to– 1. Understand the importance of PPC in industry. 2. Understand the different techniques of forecasting and apply them in sales forecasting. 3. Understand different ideas and concept to improve PPC in industry. 4. Understand different techniques for material requirement planning. 5. Understand different techniques used for PPC in industry. 6. Understand Recent trends in PPC.

Course Contents

Unit I	Introduction	(8 Hrs.)
Definition, Objectives of PPC, Functions of PPC, PPC Department Organization, Coordination of PPC with other Departments. Types of Manufacturing systems-intermittent system and continuous system. Product development and design-Factor determining the design of a product, Essentials of good design, Product Life Cycle, Steps in new product design and development, Effect of competition on design, Product Analysis, Tools for product development.		
Unit II	**Forecasting and Capacity planning**	**(8 Hrs.)**
Forecasting- Introduction, Needs of Sales forecasting, Forecasting Methods, Statistical methods for making a forecast-Moving average method, Exponential smoothing, Regression analysis. Capacity planning-concept of capacity, measurement of capacity measures of capacity, factor influencing effective capacity, capacity planning procedure. Aggregate planning.		
Unit III	**Planning Materials and Purchasing**	**(8 Hrs.)**
Scope and requirement of MRP, MRP I and MRP II, Master Production Schedule, Bill of Materials, Capacity Requirement Planning. Purchasing - Documentation, Make or Buy decisions, Vendor Development.		

Unit IV	Techniques And Production Control	(8 Hrs.)
Process planning, route sheet, factor influencing process planning. Line Balancing-Heuristic Method, Rank Position Weightage Method. Scheduling-procedure of scheduling, scheduling devices, Gantt Chart, loading devices, Machine Loading Chart, Scheduling and loading techniques, Sequencing of operations - Johnson's rule, Loading, Dispatching, Follow- up, Evaluation, PERT, CPM		
Unit V	**Inventory Control and Store control**	**(8 Hrs.)**
Inventory- Definition, characteristics, objectives, Limitations and Types of Inventories. Cost associated with Inventory, EOQ- basic model and production model. Quality standards of inventory control, Selective Inventory Management, ABC analysis, Replenishment Systems. Stores Management: Function of store keeping, Types of stores, Store layout and storage systems, Stores Documentations, Stores Control and Control of Wastage and surplus.		
Unit VI	**Recent Trends in PPC**	**(8 Hrs.)**
Introduction to computer integrated production planning systems, Applications of computer in production planning and control, Enterprise Resource Planning (ERP), Automation of repetitive process, Customer Relationship Management (CRM), Advanced Planning and Scheduling (APS), MRP software, JIT- elements of Just in Time Systems, Kanban System, Kaizen Strategy.		

Project Based Learning:

Following is the list of topics for project-based learning (Not Limited to) based on the syllabus contents:

1. Basic production control problem in automobile industry and best ways of solving them.
2. Impact of inventory management on productivity in an organization.
3. Impact of production planning and control in a manufacturing organization.
4. The effect of stock control profit maximization in manufacturing company.
5. The effect of material management technique on production planning processes.
6. The impact of production planning and control on productivity in the manufacturing industry.
7. Impact of quality control as an effective tool in product standardization.
8. An appraisal of material management concept as a strategy for achieving higher productivity.
9. The impact of production planning and control on operational cost of the manufacturing industry.
10. Minimizing defective product through effective production planning and control.
11. Effect of manpower planning on organization performance.
12. The impact of quality control technique on the profitability in manufacturing organizations.
13. An assessment of the impact of marketing segmentation on production planning in an organization.
14. An optimal inventory control of raw materials and network analysis of production planning.
15. Minimizing defective products through effective production planning and control in defence.

Textbooks:

1. “Production Systems - Planning Analysis and Control”, J. L. Riggs, “, Jhon Wiley& Sons.
2. “Industrial Engineering and Production and Operations Management” Sanjay.S.Patil, Nandakumar K. Hukeri, Electrotech Publication.
3. "Production and Operation Management”, S N Charry " Tata McGraw Hill
4. " Production Planning And Inventory Control" Mager and Boodman
5. "Production Planning and Control, A. K. Bewoor”, Satya Publication

6. “Production Planning and Cost Control Jain and Arrawal”, Khanna Publisher

Reference Books

1. "Operations Management - Design, Planning & Control for Manufacturing and Services”, J.B. Dilworth ", McGraw Hill
2. “Production Management” Martin Star,
3. “Process Engineering” Erry Johnson
4. “Industrial Engineering and Production Management Mart and Telsang” S. Chand and Co. Ltd.
5. “Elements of PPC, Samuel Elion”, Universal Book Company

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

POWER PLANT TECHNOLOGY
(Course Code C404)

Designation of Course	**Power Plant Technology**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: 03 Hours/ Week	End Semester Examination	60 Marks	04
Practical: - 02 Hours/ Week	Internal Assessment	40 Marks	
Tutorial : 1 Hours/ Week	Term Work	25 Marks	01
	Total	**125 Marks**	**05**

Course Prerequisites:-	The student should have 1. Mechanical Engineering System. 2. Thermodynamic principals 3. Thermodynamic Applications
Course Objectives:-	To explain the concepts of different types of Power Plants To study and analyze different types of Steam Condenser, Cooling Towers, Steam Nozzle and Steam Turbine.
Course Outcomes:-	On completion of the course, students will be able to– 1. **Understand** fundamentals of Power Plants 2. **Understand** Thermal Power Plant and Nuclear Power Plant and **analysis** their performance. 3. **Understand** fundamentals of Thermal power plant and **analysis** their performance. 4. **Understand** construction and working of Steam Condenser and Cooling Towers and **analysis** their performance. 5. **Understand** construction and working of Steam Nozzle and Steam Turbine Plants and **analysis** their performance. 6. **Understand** study fundamentals of Power Plant Economics.

Course Content

Unit No. -I	**Introduction to Power Plants :**	**(8 Hrs)**
Introduction of steam, hydel, diesel, nuclear and gas turbine power plants, combined power cycles, comparison and selection, Power and energy, sources of energy, Indian Energy scenario, Conventional & Non-Conventional sources of energy and their availability in India, Power Plants in India, Location of power plant. Issues in Power plants. Resources and development of power in India, NTPC, NHPC and their role in Power development in India. Plant Safety and Maintenance: Operation and Maintenance procedures of power plants, Operator training, Safety during selection of power plant equipment –safety in commissioning of thermal power plant equipments, hydrostatic and air leakage test, acid and alkali cleaning, safety in auxiliary plants. Cooling water system, Safety in maintenance of power plants.		
Unit No.-II	**Thermal Power Plant and Nuclear Power Plant:**	**(8 Hrs)**
Thermal Power Plant - Role of thermal power plant in current power generation scenario, Selection site for thermal power plant, General lay out of a thermal power plant, Fuels used in thermal power plant- Fuel handling layout and its methods, stages in coal handling storage, Fuel burning-Stoker firing, Pulverized fuel burning- Pulverization of coal, Ash handling system- Gravity system, pneumatic or vacuum system. Ash disposal management and its utilization, Feed water treatment-Mechanical, thermal methods. Introduction, Nuclear power-Radio activity-Radioactive charge-types of reactions, Working of a nuclear power plant, Thermal fission Reactors- PWR, BWR and gas cooled reactors, Advantages and Disadvantages of Nuclear power plant.		

Unit No. -III	Thermodynamic Analysis:	(8 Hrs)
Review of thermodynamic cycles related to power plants - Rankine cycle, Rankine cycle with reheat, Reheat factor, regeneration rankine cycle, Principal of regeneration, types of feed water heaters, Numerical based on different combinations.		
Unit No.-IV	**Steam Condenser and Cooling Towers:**	**(8 Hrs)**
Necessity of steam condenser, elements of steam condensing plant, classification, cooling water requirements, condenser efficiency, vacuum efficiency (Numerical Treatment),cooling towers, Types of cooling towers, air leakage and its effects on condenser performance, air pumps (Numerical Treatment for Air Pump capacity)		
Unit No. -V	**Steam Nozzle and Steam Turbine:**	**(8 Hrs)**
General forms of nozzles Flow through steam nozzles, Velocity of steam leaving nozzle, mass of steam discharged, Critical Pressure ratio, Areas of throat and exit for maximum discharge, length of nozzle, efficiency of nozzle, effect of friction in nozzle. Working principle of steam turbine, classification, Simple impulse turbine, Compounding of Impulse turbine, Reaction turbine, Velocity diagram, Blade efficiency, Stage efficiency, Net efficiency, Comparison between Impulse and Reaction turbines, Losses in steam turbine, and Governing of steam turbine.		
Unit No.-VI	**Power Plant Economics**	**(8 Hrs)**
Power Plant Economics - Cost of electric energy, fixed and operating costs, energy rates, types tariffs, economics of load sharing, Load Curves, Load duration Curves, types of load and their characteristics, performance and operational characteristics of power plants, comparison of various power plants, Energy, Economic and Environmental issues of Power plants.		

Term work:

1. Study of National & International Grid, Indian Electricity Grid Code
2. Study of combined cycle gas based and coal based Power plant.
3. To perform analysis of a thermal power plant.
4. To perform analysis of gas turbine/ diesel power system.
5. Study of Power plant Instrumentation.
6. Study of Heat Exchangers used in Power Plant
7. To study different types of hybrid power plants.
8. Visit to a thermal power plant / Hydro Electric Power Plants
9. Case Study on Plant Safety and Maintenance

Project Based Learning

Following is the list of Topics for project based learning (Not Limited to) based on the syllabus Contents:

1. To prepare a chart on National & International Grid, Indian Electricity Grid Code
2. To prepare a chart on Thermal Power Plant
3. To prepare a chart on Hydro Electric Power Plants
4. To prepare a chart on Steam Condenser and Cooling Towers
5. To prepare a chart on Steam Nozzle and Steam Turbine
6. To prepare a chart on Energy Storage Technologies
7. To prepare demonstration model of Thermal Power Plant
8. To prepare demonstration model of Hydro Electric Power Plants
9. To prepare demonstration model of Steam Condenser
10. To prepare demonstration model of Cooling Towers
11. To prepare demonstration model of Steam Nozzle
12. To prepare demonstration model of Steam Turbine

13. Case study on Thermal Power Plant
14. Case study on Hydro Electric Power Plants
15. Case study on Steam Nozzle and Steam Turbine

Text Books:

1. Modern Power Station Practice, Vol.6, Instrumentation, Controls and Testing, Pergamon Press, Oxford, 1971.
2. John V Grimaldi and Rollin H Simonds, Safety Management
3. M. M. El Wakil, Power Plant Technology –Mc Graw Hill. Int. Edition.
4. Domkundwar and Arora, Power Plant Engineering, Dhanpatrai and Sons.

Reference Books

1. Grainger John J, and Stevenson Jr. W.D. Power System Analysis, McGraw Hill 1994
2. L. K. Kirchmeyer, Economic Operation of Power Systems, John Wiley and Sons, 1993.
3. C. A. Gross, Power System Analysis, John Wiley and Sons, Inc.1986.
4. John Weisman & L.E. Eckart, Modern Power Engineering, Prentice Hall, 1985
5. A course on Power Plant Engineering Ramlingam SCITECH Publication
6. S. P. Sukhatme, Solar Energy, Tata McGraw Hill, 3rd Edition 1996.
7. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 2011
8. P. K. Nag, Power plant Engineering, TMH, 3rd Edition 2002

Unit Test –

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

MEASUREMENT AND METROLOGY TECHNIQUES
(Course Code C405)

Designation of Course	**Measurement and Metrology Techniques**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral	25 Marks	
	Total	**50 Marks**	**01**

Course Prerequisites: -	Student should have knowledge of 1. Students should have Basic knowledge of Mechanical terms Force, Pressure, Temperature, and Electronics terms like as Voltage, Resistance and Current. 2. Students should have Basic knowledge of Measuring Units, Mathematics, and Various Measurement terms.
Course Objectives: -	Student should be able to *1.* Use various precision measuring instruments *viz.* Vernier caliper, micrometer *etc.* 2. Acquire knowledge of different sensors and transducers 3. Acquire knowledge of tolerances, gauges and measurement of surface finish
Course Outcomes: -	Learner will be able to… 1. Understand static and dynamic characteristics of measurement systems. 2. Know different devices used for linear and angular measurement. 3. Measure temperature, pressure, strain and fluid flow using different sensors for various applications. 4. Using of concepts like limits, fits and tolerances for designing the limit gauges. 5. Use displacement, velocity, position, force, torque, level sensors for specific applications. 6. Measure various screw thread or gear tooth parameters using specific equipment.

Course Contents

Term Work: (Any 8 experiments need perform during practical's)

1. Study & Calibration of Thermocouples (J & K-Type)/RTD(PT-100)
   Thermocouples & Laws of thermocouples
2. Study & Calibration of Pressure Measurement, & Vacuum Measurement
   Diaphragm Pressure Gauge, Bourdon Tube, Bellows, McLeod Gauge
3. Measurement of Load/Force using Load Cells
4. Displacement & Angle measurement using LVDT & Encoder Sensor
5. Study of Different Switches & Relays
6. Measurement of the surface roughness.
   Surface texture, Meaning of RMS and CLA values, grades of roughness.
7. Measurement of angle by sine bar/sine center.
   Sine bar, Sine center, uses of sine bar, angle gauge, slip gauges.
8. Measurement of optical surface using Interferometer.

Introduction, flatness testing by interferometry, NPL flatness interferometer.

10. Measurements of screw tread parameters using Floating Carriage Micrometer.

External screw threads terminologies, floating carriage instruments, pitch and flank Measurement.

11. Measurement of gear tooth thickness using gear tooth Vernier caliper and span micrometer

Spur gear parameters, gear tooth thickness measurement, gear tooth Vernier caliper.

12. Study and experiment on profile projector/Tool makers microscope

13. Industrial visit to Automation Company and Inspection & Quality control division of any Industry with detail report.

Text Books:

1. Ramchandran K. P., Vijyaraghavan G. K., Balasundaram M. S., "Mechatronics: Integrated Mechanical Electronic Systems", John Wiley & Sons, 2008.
2. Bolton W., "Mechatronics - A Multidisciplinary approach", 4thEdition, Prentice Hall,2009.
3. Kumar D. S., "Mechanical Measurement & Control", Metropolitan Book Co. Pvt. Ltd. New Delhi,2007
4. Singh M. D. and Joshi J. G., "Mechatronics", 3rd Edition, Prentice Hall, New Delhi,2009.
5. Beckwith T. G., Marangoni R. D., Lienhard J. H., "Mechanical Engineering Measurements", Pearson Prentice Hall, 2007
6. Jain R. K., "Engineering Metrology", Khanna Publishers
7. Hume K. J., "Engineering Metrology", Macdonald, 1950
8. Sharp K. W. B., "Practical Engineering Metrology", Pitman Publication, 1970.

Reference Book:

1. Doebelin Ernesto, "Measurement Systems", McGraw Hill International Publication Co. New York, 4th Edition,1990.
2. Sawhney A. K. and Sawhney P., "Mechanical Measurement and Control", Dhanpat Rai and Company Pvt. Ltd., New Delhi, 12th Edition, 2010.
4. Figliola R. S., Beasley D. E., "Theory and design for mechanical measurements", Wiley India Edition.
5. Alciatore & Histand, "Introduction to Mechatronics and Measurement System", 4th Edition, Mc-Graw Hill publication, 2011.
6. Bishop (Editor), "Mechatronics – An Introduction", CRC Press, 2006.

Unit Test -

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

MACHINE LEARNING
(Course Code C406)

Designation of Course	Machine Learning		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 00 hrs/Week	Term Work	25	01
	Oral	25	
Practical: - 02 Hrs /Week	**Total**	**50**	

Course Prerequisite: -	1. Engineering mathematics-III, Statistics and Numerical Methods, Introduction to Data Science.
Course Objective: -	To provide Knowledge about 1. To understand the difference of supervised and unsupervised learning. 2. Apply the knowledge of linear regression for different applications. 3. To understand the knowledge of deep learning.
Course Outcomes:-	On completion of the course, students will be able to 1. Understand the different machine learning techniques. 2. Apply the knowledge of probability for uncertain methods. 3. Understand the concept of various processes in machine learning. 4. Apply the knowledge of linear regression process. 5. Apply the knowledge of Multiple linear regression process. 6. Apply the knowledge of clustering method.

Course Content

List of Practical /Term work: - (Any 6 of the following list)

1. Study and practice of Linear regression system.
   - ML Techniques overview, Validation Techniques.
2. Study and practice of logistics regression system
   - Regression basics: Relationship between attributes using Covariance.
3. Study and practice or regularization technics.
   - ML: Supervised learning, Unsupervised learning, Reinforcement learning
4. Study and practice of KNN systems.
   - K-Nearest Neighbor algorithm
5. Study and practice of decision tree.
   - Wilson editing and triangulations or Decision Trees
6. Study and practice of random forest.
   - Classification & Regression of random forest.
7. Study and practice of K-mean clustering.
   - K-Medoids, k-Mode and density-based clustering.
8. Study and practice of Natural Language Programing.
9. Study and practice of deep learning process.
   - Introduce popular architectures, models, and the use of it in various settings.
10. Implementation of mini-Project or case study using the concepts studied in the ML course.

Text Book

1. Bhattacharya S., Artificial Intelligence, Laxmi Publications, Ltd., 2008, ISBN: 9788131804896
2. Chopra Rajiv, Artificial Intelligence, S. Chand Publishing, 2012, ISBN9788121939485
3. Pawar P. J., Evolutionary Computations for Manufacturing, Studium Press, 2019, ISBN: 978-93-85046-52-0
4. Jain N, Artificial Intelligence: making a system intelligent, 2018, ISBN: 978812657994

References Books:

1. Zsolt Nagy, “Artificial Intelligence and Machine Learning Fundamentals”, Packt Publishing, 2018, ISBN: 978-1-78980-165-1
2. Hastie, Trevor, Robert Tibshirani, Jerome H. Friedman, and Jerome H. Friedman. The elements of statistical learning: data mining, inference, and prediction. Vol. 2. New York: springer, 2009.
3. Zaki, Mohammed J., Wagner Meira Jr, and Wagner Meira. Data mining and analysis: fundamental concepts and algorithms. Cambridge University Press, 2014.
4. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021

PROJECT STAGE -I

(Course Code C407)

Designation of Course	Project Stage -I		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 02 Hours/ Week	End Semester Examination	-- Marks	--
Tutorial: - --Hours/ Week	Internal Assessment	-- Marks	
Practical: - -- Hours/ Week	Term Work	50 Marks	03
	Oral/Practical	50 Marks	
	Total	**100 Marks**	**03**

Course Prerequisites: -	The students should have knowledge of 1. Knowledge of Mathematics & Science 2. Knowledge of basic concepts in heat transfer. 3. Basic information of thermodynamics. 4. Basic knowledge of design 5. Knowledge of basic concepts in mechanical engineering.
Course Objectives: -	1. To identify problem for a specific need of an organization 2. To review literature on specific research topic 3. To make feasible, sustainable design 4. To work sincerely as a member of a team 5. To communicate ideas to supervisors as well as subordinates 6. To develop new equipment or make modifications in existing one
Course Outcomes: -	The students should be able to–

Course Contents

Details of Project Stage -I

1. The formation of a project team with members having similar interest.
2. Discuss the ideas within the team members and choosing a faculty member interested in similar activity with the consent of the HOD. The projects can be on new equipment development, on industry sponsored problems or on research-oriented subjects.
3. Discuss the project with the faculty with the idea that projects selected are suitable for design and fabrication with the available resources.
4. First stage presentation with
    - Project Aim
    - Feasible design and alternatives considered.
    - Estimation of approximate cost of the project
    - Activities bar chart
    - Internal Lab resources required.
    - External resources required and their availability.
5. Second presentation with
    - Collection of reference material and
    - Design of the equipment with working drawings
    - Stage of work completed through activities bar chart.
6. Third presentation of complete work with suggested modifications.

INTERNSHIP
(Course Code C408)

Designation of Course	**Internship**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial: - --Hours/ Week	Internal Assessment	-- Marks	
Practical: - -- Hours/ Week	Term Work	25 Marks	03
	Oral/Practical	25 Marks	
	Total	**50 Marks**	**03**

Course Prerequisites: -	The students should have knowledge of 1. All courses up to B. Tech Semester VI.
Course Objectives: -	1. To expose technical student to the industrial environment. 2. To provide possible opportunities to learn, understand, and sharpen the real time technical, managerial skills required at the job. 3. To familiarize with various materials, processes, products and their applications along with relevant aspects of quality control. 4. To acquaint the social, economic, and administrative considerations that influence the working environment of industrial organization.
Course Outcomes: -	The students should be able to– 1. Understand the latest changes in technological world and apply fundamental principles of science and engineering. 2. Create ability to identify, formulate and model problems and apply it to find engineering solutions based on a system approach. 3. Understand importance of sustainability and cost-effectiveness in design and development of engineering solution. 4. Create ability to be multi skilled engineer with a good technical knowledge, management, leadership, entrepreneurship skills. 5. Create awareness of social, cultural, global, and environmental responsibility as an engineer. 6. Create ability to communicate efficiently.

Course Contents

Introduction:
Internships are educational and career development opportunities, providing practical experience in a field or discipline. Internships are far more important as the employers are looking for employees who are properly skilled and having awareness about industry environment, practices, and culture. Internship is structured, short-term, supervised training often focused on tasks or projects with defined time scales. Core objective is to expose technical students to the industrial environment, which cannot be simulated/experienced in the classroom and hence creating competent professionals in the industry and to understand the social, economic and administrative considerations that influence the working environment of industrial organizations. Engineering internships are intended to provide students with an opportunity to apply theoretical knowledge from academics to the realities of the field work/training.
Duration:
Internship to be completed after semester 6 and before commencement of semester 7 of at least 8 weeks (60 Days); and it is to be assessed and evaluated in semester 7.
Internship work Identification:
Student may choose either to work on innovation or entrepreneurial activities resulting in start-up or undergo internship with industry/NGO’s/Government organizations/Micro/Small/Medium enterprises to make themselves ready for the industry.

Contacting various companies for Internship and Internship work identification process should be initiated in the 6^{th} semester in coordination with training and placement cell/ industry institute cell/ internship cell. This will help students to start their internship work on time. Also, it will allow students to work in vacation period after their 6^{th} semester examination. Student can take internship work in the form of Online/onsite work from any of the following but not limited to:

- Working for consultancy/ research project,
- Participation at Events (Technical / Business)/in innovation related completions like Hackathon,
- Contribution in Incubation/ Innovation/ Entrepreneurship Cell/ Institutional Innovation Council/ startups cells of institute
- Development of new product/ Business Plan/ registration of start-up,
- Participation in IPR workshop/Leadership Talks/ Idea/ Design/ Innovation/ Business Completion/ Technical Expos,
- Industry / Government Organization Internship, Internship through Internshala,
- In-house product development, intercollegiate, inter department research internship under research lab/group,
- micro/small/medium enterprise/online internship.

[1] https://www.aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

Internship Diary/ Internship Workbook:

Students must maintain Internship Diary/ Internship Workbook. The main purpose of maintaining diary/workbook is to cultivate the habit of documenting. The students should record in the daily training diary the day-to-day account of the observations, impressions, information gathered, and suggestions given, if any. The training diary/workbook should be signed after every day by the supervisor/ in-charge of the section where the student has been working. Internship Diary/workbook and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training.

Internship Diary/workbook may be evaluated based on the following criteria:

• Proper and timely documented entries • Adequacy & quality of information recorded. • Data recorded. • Thought process and recording techniques used. • Organization of the information

Internship Work Evaluation:

The evaluation of these activities will be done by Cell In-charge/faculty mentor or Industry Supervisor based on Overall compilation of internship activities, evidence needed to assign the points and the duration for certain activities. Assessment and Evaluation is to be done in consultation with internship supervisor (Internal and External – a supervisor from place of internship.

Recommended evaluation parameters-Post Internship Internal Evaluation -25 Marks + Internship Diary/Workbook and Internship Report - 25 Marks

Evaluation through Seminar Presentation/Viva-Voce at the Institute

The student will give a seminar based on his training report, before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

• Depth of knowledge and skills Communication & Presentation Skills • Teamwork • Creativity • Planning & Organizational skills • Adaptability • Analytical Skills • Attitude & Behavior at work • Societal Understanding • Ethics • Regularity and punctuality • Attendance record • Logbook • Student’s Feedback from External Internship Supervisor.

After completion of Internship, the student should prepare a comprehensive report to indicate what he/she has observed and learnt in the training period. The student may contact Industrial Supervisor/

Faculty Mentor for assigning special topics and problems and should prepare the final report on the student's presence physically, if the student is found absent without prior intimation to the department/institute/concern authority, entire training can be cancelled. The report shall be presented covering following recommended fields but not limited to, • Title/Cover Page • Internship completion certificate • Internship Place Details- Company background-organization and activities/Scope and object of the study / personal observations • Index/Table of Contents • Introduction • Title/Problem statement/objectives • Motivation/Scope and rationale of the study • Methodological details • Results / Analysis /inferences and conclusion • Suggestions / Recommendations for improvement to industry, if any • Attendance Record • Acknowledgement • List of reference (Library books, magazines and other sources)
Feedback from internship supervisor (External and Internal)
Post internship, faculty coordinator should collect feedback about student with following recommended parameters: Technical knowledge, Discipline, Punctuality, Commitment, Willingness to do the work, Communication skill, individual work, Teamwork, Leadership, etc.

RENEWABLE ENERGY TECHNOLOGIES

(Course Code C409)

Designation of Course	**Renewable Energy Technologies**		
Teaching Scheme :	**Examination Scheme**		**Credits Allotted**
Theory: 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - -- Hours/ Week	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisites:-	The students should have knowledge of 1. Mechanical Engineering System. 2. Thermodynamic principals 3. Thermodynamic Applications 4. Power Plant Technology
Course Objectives:-	1. To explain the concepts of Non-renewable energy systems 2. To outline utilization of renewable energy sources for both domestic and industrial applications 3. To analyze the environmental and cost economics of renewable energy sources in comparison with fossil fuels.
Course Outcomes:-	On completion of the course, students will be able to– 1. **Understand** Fundamentals of Solar Energy. 2. **Understand** construction working of solar power system and **analysis** their performance. 3. **Understand** Wind Energy Technology and **analysis** their performance. 4. **Understand** fundamentals of Biogas and Biomass Energy and **analysis** their performance. 5. **Understand** different Renewable Technologies and **analysis** their performance. 6. **Understand** construction and working Energy Storage Technologies

Course Contents

Unit I	**Fundamentals of Solar Energy:**	**(06Hrs.)**
Principle of conversion of solar radiation into heat, Applications of solar energy, Collectors used for solar thermal conversion: Flat plate collectors and Concentrating collectors, Collection efficiency, Solar Thermal Power Plant, Solar Pond, Solar cookers, Solar hot water systems, Solar dryers, Solar Distillation, Solar greenhouses.		
Unit II	**Solar Energy Technology :**	**(06 Hrs.)**
Conversion of Solar energy into Electricity - Photovoltaic Effect, Solar photovoltaic cell and its working principle, Different types of Solar cells, Series and parallel connections, Photovoltaic applications: Battery chargers, domestic lighting, street lighting and water pumping		

Unit III	Wind Energy Technology:	(06 Hrs.)
Power from wind, site selection, characteristics of the wind, wind energy conversion systems and their classification, construction and working of typical wind mill, design considerations for wind mills, small wind turbines, performance, blade element theory, social and environmental considerations, present status.		
Unit IV	**Bio-Energy Technology:**	**(06 Hrs.)**
Importance of biogas technology, Different Types of Biogas Plants. Aerobic and anaerobic bioconversion processes, various substrates used to produce Biogas, Individual and community biogas operated engines and their use. Removal of CO_2 and H_2O, Application of Biogas in domestic, industry and vehicles. Bio-hydrogen production. Isolation of methane from Biogas and packing and its utilization. Biomass Energy: Introduction, Photosynthesis Process, Biofuels; Biomass Resources, Biomass conversion technologies -fixed dome, Urban waste to energy conversion, Biomass gasification.		
Unit V	**Other Renewable Technologies:**	**(06 Hrs.)**
Ocean Thermal Energy Conversion: Introduction, Working principle, Resource and site requirements, Location of OTEC system, Electricity generation methods from OTEC, open cycle and closed cycle OTEC systems, Advantages and disadvantages, Applications of OTEC. Tidal Energy - Introduction, Origin and nature of tidal energy, Basic principle of tidal power generation, Components of tidal power plants, Tidal energy technology, Tidal range power, Basic modes of operation of tidal systems. Advantages and limitations Introduction to Hydroelectric power plant, Introduction- types - system components of Small Hydro Power Systems, discharge curve and estimation of power potential - Turbines for SHP.		
Unit VI	**Energy Storage Technologies :**	**(06 Hrs.)**
Pumped Hydroelectric Storage, Compressed Air Energy Storage, Battery Technologies - Traditional and Advanced, Flow Batteries, Flywheels, Fuel cell: Principle of working- various types – construction and applications. Energy Storage System- Hybrid Energy Systems. Superconducting Magnetic Energy Storage, Super-capacitors/Ultra-capacitors, Energy Storage Technology Comparisons, Functional Comparison, Cost Comparison, latest Energy Storage Technologies		

Term Work

1. Study of national and global renewable energy scenario.
2. To perform analysis of solar power system.
3. Case Studies on solar power system.
4. To perform analysis of Wind power system.
5. Determination of characteristics of a wind generator.
6. Performance evaluation of vertical and horizontal axes wind turbine rotors.
7. Measurement of I-V characteristics of solar cell.
8. Study the effect of input light intensity on the performance of solar cell.
9. Study of Energy Storage Technologies

10. Study of Biogas/ Biomass Plant
11. Study of Tidal Power/ Ocean power plant
12. Visit to Wind Power/ Solar Power Plant.
13. Visit to Biogas Plant

Project Based Learning

Following is the list of Topics for project based learning (Not Limited to) based on the syllabus Contents:

1. To prepare demonstration model of Solar Power System
2. To prepare demonstration model of Small Hydro Power Systems
3. To prepare demonstration model of Wind power system
4. To prepare demonstration model of Biomass Energy system
5. To prepare demonstration model of Biogas system
6. To prepare demonstration model of Fuel cell system
7. To prepare demonstration model of Energy Storage Technologies
8. Case study on Small Hydro Power Systems
9. Case study on Solar Power System
10. Case study on Wind power system
11. Case study on Biomass Energy
12. Case study on Biogas system
13. Case study on Fuel cell system
14. Case study on Ocean Thermal Energy
15. Case study on Tidal Energy

Text Books:

1. Felix A. Farret, M. Godoy Simoes, Integration of Alternative Sources of Energy, John Wileyand Sons, 2006.
2. Solanki: Renewable Energy Technologies: Practical Guide for Beginners, PHI Learning Pvt. Ltd., 2008.

Reference Books:

1. Solar Energy Principles, Thermal Collection & Storage, S. P. Sukhatme: Tata McGraw Hill Pub., New Delhi.
2. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009.
3. Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016.
4. Solar Cells: From Materials to Device Technology edited by S. K. Sharma, Khuram Ali, Springer (2020)
5. D. Mukherjee: Fundamentals of Renewable Energy Systems, New Age International publishers, 2007.
6. Remus Teodorescu, Marco Liserre, Pedro Rodriguez: Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, 2011.
7. Gilbert M. Masters: Renewable and Efficient Electric Power Systems, John Wiley and Sons, 2004.
8. Non-Conventional Energy Sources, G. D. Rai, NewDelhi.

9. Renewable Energy, power for a sustainable future, Godfrey Boyle,2004,
10. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub.,2009.
11. Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007.
12. Rational Design of Solar Cells for Efficient Solar Energy Conversion edited by Alagarsa my Pandikumar, Ramasamy Ramaraj, Wiley (2018).
13. Energy fables, Edited by edited by Jenny Rinkinen, Elizabeth Shove, Jacopo Torriti, Routledge a T&F group, (2019).

Unit Test –

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Elective-II: INDUSTRIAL PRODUCT DESIGN
(Course Code C410.1)

Designation of Course	**Industrial Product Design**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03 Hours/ Week	End Semester Examination	60 Marks	03
Practical : 02 Hours/ Week	Internal Evaluation	40 Marks	
	Term Work:	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites:-	Student should have Basic Knowledge of 1. Machine Drawing I & II 2. Industrial Engineering & Management, Manufacturing Process, Advanced Manufacturing Processes 3. CAD software viz. CATIA/ ProE/ SolidWorks/ Uni-Graphics
Course Objectives:-	To study 1. Various aspects of product design and development different product design methods. 2. Concept generation and product specification. 3. Industrial Design and Prototyping. 4. Aesthetic, Environment and Ergonomic considerations to develop an industrial product.
Course Outcomes:-	Students should be able to 1. Understand fundamental concept of industrial product design 2. Understand and apply different product design methods 3. Understand the concept generation and develop the product specifications 4. Evaluate legal economic issues and select a prototyping method for industrial product 5. Evaluate the approaches of Aesthetic, Ergonomics and safety in industrial product 6. Understand design for manufacturing, assembly and environment and apply for industrial product

Course Contents

Unit 1	**Introduction to Product Design and Development**	**(6 Hrs)**
Overview of industrial design, Successful product, development of quality aspect of product design; Challenges of product development, Market survey. Identify customer needs and product planning processes. Product architecture: Implication of architecture, establishing the architecture, related system level design issue.		
Unit 2	**Product Design Methods**	**(6 Hrs)**
Creative and rational, clarifying objectives - the objective tree method, establishing functions- the function analysis method, setting requirements–the performance specification method, determining characteristics–the QFD method, generating alternatives – morphological chart method, evaluating alternatives – the weighted objective method, improving details – the value engineering method and design strategies.		

Unit 3	**Product Specifications and Concept Generation**	**(6 Hrs)**
Concept generation, five step concept generation method, concept selection, concept screening, concept testing, Product specification, steps to establish the target specifications.		
Unit 4	**Industrial Design and Prototyping**	**(6 Hrs)**
Its need, impact and quality, industrial design process and its management, legal issues in product design, IPR, design resources, economics and management of product development projects. Prototyping: Basics and principles of prototyping, Rapid prototyping technologies, planning for prototypes		
Unit 5	**Aesthetics, Ergonomics and Industrial Safety**	**(6 Hrs)**
Introduction-General approach to the man-machine relationship-workstation design working position and posture. An approach to industrial design - elements of design structure for industrial design in engineering applications in manufacturing systems. Environmental Application of ergonomics in industry for safety, health and environment control. Safety and ISO 14000 Systems		
Unit 6	**Design for Manufacture, Assembly and Environment**	**(6 Hrs)**
Estimating manufacturing cost, reducing component, assembly and support costs, design for assembly, design for disassembly, design for environment, design for graphics and packaging, effective prototyping-principle and planning. Product data management. Innovation and creativity in product design. Product costing, value engineering, aesthetic concepts.		

Project Based Learning:
1. Quality function deployment
2. Aesthetics and ergonomics
3. Design for manufacturing and assembly
4. Design for environment
5. Rapid prototyping

Term Work: Use of different CAD software *viz.* CATIA/ ProE/ SolidWorks/ Uni-Graphics while doing following case studies:

1. A case study on market study to identify costumer needs
2. A case study on use of morphological analysis
3. A case study on Quality Function Development (QFD)
4. A case study of one aesthetic considerations in product design
5. Failure Modes and Effects Analysis (FMEA) in product design
6. A case study on Design for Manufacturing
7. A case study on Product Lifecycle Management (PLM)
8. A case study of one ergonomic considerations in product design
9. A case study of one industrial safety considerations in product design

Text Books:

1. Product Design and Development: Karl T. Ulrich, Steven G. Eppinger; Irwin McGraw Hill
2. Product design and Manufacture: A.C. Chitale and R.C. Gupta; PHI Chitale & Gupta, “Product Development”, Tata McGraw Hill
3. New Product Development: Tim Jones, Butterworth, Heinemann, Oxford, 1997.
4. Product Design for Manufacture and Assembly: Geoffrey Boothroyd, Peter Dewhurst and Winston Knight.

Reference Books

1. Product Design: Otto and Wood; Pearson education.

2. Industrial Design for Engineers: Mayall W.H, London, Hiffee books Ltd, 1988
3. Introduction to ergonomics – R.C. Bridger, McGraw Hill Pub.
4. Product Design – Kevin Otto, Kristin Wood Pierson Education

Unit Tests

Unit Test-I	Unit-I,II,III
Unit Test-II	Unit-IV,V,VI

Elective-II: Engineering Economics
(Course Code C410.2)

Designation of Course	**Name of the subject**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - --Hours/ Week	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of Basic of Mathematics
Course Objectives: -	Students will be able to understand the economics behind running a successful engineering project
Course Outcomes: -	Student should be able to 1. Understand the basic concepts of economics any apply them for selection and planning 2. Understand time value of money and calculate the value of money at any given time in a project 3. Understand Basic Methodologies of Engineering Economic Analysis and use them to for selection of project 4. Use various methods to compare two different projects to check their viability 5. Use replacement analysis for panning and changing of resources in a project 6. Plan for Depreciation and Corporate Income Taxes

Course Contents

Unit 1	**Introduction to Economics**	**(06 Hrs.)**
Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.		
Unit 2	**Interest and Time Value of Money**	**(06 Hrs.)**
Introduction to Time Value of Money; Simple Interest; Compound Interest; Nominal Interest rate; Effective Interest rate; Continuous Compounding; Economic Equivalence; Development of Interest Formulas; The Five Types of Cash flows; Single Cash flow Formulas; Uneven Payment Series; Equal Payment Series; Linear Gradient Series; Geometric Gradient Series.		
Unit 3	**Basic Methodologies of Engineering Economic Analysis**	**(06 Hrs.)**
Minimum Attractive (Acceptable) Rate of Return (MARR); Payback Period Method; Equivalent Worth Methods: Present Worth Method, Future Worth Method, Annual Worth Method; Rate of Return Methods: Internal Rate of Return Method; External/Modified Rate of Return Method; Public		

Sector Economic Analysis (Benefit Cost Ratio Method); Introduction to Lifecycle Costing; Introduction to Financial and Economic Analysis		
Unit 4	**Comparative Analysis of Alternatives**	**(06 Hrs.)**
Comparing Mutually Exclusive Alternatives having Same useful life by 1. Payback Period Method and Equivalent Worth Method 2.Rate of Return Methods and Benefit Cost Ratio Method Comparing Mutually Exclusive Alternatives having different useful lives by 1. Repeatability Assumption 2.Co-terminated Assumption 3. Capitalized Worth Method Comparing Mutually Exclusive, Contingent and Independent Projects in Combination.		
Unit 5	**Replacement Analysis**	**(06 Hrs.)**
Fundamentals of Replacement Analysis: Basic Concepts and Terminology; Approaches for Comparing Defender and Challenger; Economic Service Life of Challenger and Defender Replacement Analysis When Required Service Life is Long: Required Assumptions and Decision Framework; Replacement Analysis under the Infinite Planning Horizon; Replacement Analysis under the Finite Planning Horizon		
Unit 6	**Depreciation and Corporate Income Taxes**	**(06 Hrs.)**
Concept and Terminology of Depreciation; Basic Methods of Depreciation: Straight line method, Declining Balance Method, Sinking Fund Method, Sum of the Year Digit Method, Modified Accelerated Cost Recovery System (MACRS); Introduction to Corporate Income Tax; After Tax Cash flow Estimate; General Procedure for Making After Tax Economic Analysis.		

Term Work

1. Completing a break even analysis of a company
2. Calculation of time value of money
3. Calculating the feasibility of a project by economic analysis
4. Comparing Mutually Exclusive Alternatives having Same useful life by Payback Period Method and Equivalent Worth Method
5. Comparing Mutually Exclusive Alternatives having Same useful life by Payback Rate of Return Methods and Benefit Cost Ratio Method
6. Comparing Mutually Exclusive Alternatives having different useful lives
7. Replacement analysis of a machine
8. Calculation of depreciation of a machine
9. Calculation of corporate taxes.

Project Based Learning

1. Case study on break even analysis of a company
2. Case study on Calculation of time value of money
3. Case study on feasibility of a project by economic analysis
4. Case study on Comparing Mutually Exclusive Alternatives having Same useful life by Payback Period Method and Equivalent Worth Method
5. Case study on Comparing Mutually Exclusive Alternatives having Same useful life by Payback Rate of Return Methods and Benefit Cost Ratio Method
6. Case study on Comparing Mutually Exclusive Alternatives having different useful lives

7. Case study on Replacement analysis of a machine
8. Case study on Calculation of depreciation of a machine
9. Case study on Calculation of corporate taxes.

Textbooks

1. R. Paneerselvem, Engineering Economics, Prentice Hall India.

Reference Books

1. Chan S. Park, Contemporary Engineering Economics, Prentice Hall, Inc.
2. E. Paul De Garmo, William G. Sullivan and James A. Bonta delli, Engineering Economy, MCMilan Publishing Company.
3. James L. Riggs, David D. Bedworth and Sabah U. Randhawa, Engineering Economics, TataMCGraw Hill Education Private Limited.

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

Elective-II: PROJECT MANAGEMENT & ETHICS
(Course Code C410.3)

Designation of Course	**Project Management & Ethics**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - --Hours/ Week	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1. Mathematics & Statistics 2. Industrial engineering & management 3. Soft skills and professional skills
Course Objectives: -	1. To create awareness about the concepts of project management and its components 2. To apply the techniques specified by project management body of knowledge for effective project management. 3. To create awareness of social and professional responsibility among stakeholders
Course Outcomes: -	The students should be able to– 1. Understand concepts of project management and apply it to various phases in project life cycle 2. Understand economic models, evaluate project profitability and analyze risk management 3. Understand different cost estimating & forecasting methods to apply in project budgeting 4. Understand the methods of project planning, scheduling and apply it to reduce project duration 5. Understand the project execution, monitoring, control process and evaluate the performance of the project 6. Understand professional ethics of project management and apply it for organizational benefits

Course Contents

Unit I	**INTRODUCTION TO PROJECT MANAGEMENT**	**(06 Hrs.)**
Project, Project Management, Management by projects, Project Management Associations, Benefits of Project Management, Project management Process, Role of Project Manager, Project Lifecycle		
Unit II	**PROJECT MANAGEMENT TECHNIQUES AND RISK MANAGEMENT**	**(06 Hrs.)**
Feasibility Studies, Numerical Models (Payback Period, Return on Investment, Net Present Value, Internal rate of Return), Scoring Models, Break Even Analysis, Project Risk Management: Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks.		
Unit III	**PROJECT COST ESTIMATING**	**(06 Hrs.)**
Estimating terminology, Project Costs, Estimating Methods (Jobbing, Factoring, Inflation, Economies of Sales, Unit Rates, Day Work), Analogous Estimating, Parametric Estimating, Bottom-Up Estimating, Three-Point Estimates, Monte Carlo Simulation, Project Budgeting, Resource Allocation, Cost Forecasts.		
Unit IV	**PROJECT PLANNING AND SCHEDULING**	**(06 Hrs.)**

Project Planning: Introduction, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS), Scheduling: Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System.		
Unit V	**PROJECT MONITORING AND CONTROL**	**(06 Hrs.)**
Project Execution and Control: Introduction, Project Execution, Project Control Process, Purpose of Project Execution and Control, Project Management Information System: Introduction, Project Management Information System (PMIS), Planning of PMIS, Design of PMIS, Project Performance Measurement and Evaluation: Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects		
Unit VI	**PROFESSIONAL RESPONSIBILITY (ETHICS)**	**(06 Hrs.)**
Ensuring Integrity and Professionalism, Project Management Knowledge Base, Enhancing Individual Competence, Balancing Stakeholder Interests, Interactions with Team Members and Stakeholders, Templates, Tools and Techniques		

Term Work

1. Identify the Key Components of a Project
2. Create a Project with MS Project
3. Represent Project Resources in MS Project
4. Perform Resource Leveling in MS Project
5. Plan and manage procurement
6. Plan and manage schedule
7. Develop, execute, and validate a strategy for stakeholder engagement
8. Determine risk management options
9. Displaying Calendar Information in a Gantt Chart

Project Based Learning

1. Case study involving various aspects of project
2. Case study involving various techniques used for project selection.
3. Case study of project cost estimation
4. Case study based on project scheduling
5. Industrial case study of project ethics
6. Case study on project risk management

Textbooks

1. Erik Larson, Clifford Gray; "Project Management: The Managerial Process"; McGraw Hill Education; Sixth edition (1 July 2014)
2. Panneerselvam R; "Project Management"; Prentice Hall India Learning Private Limited; 1 Edition (2009)
3. Samuel J. Mantel, Jack R. Meredith; "Project Management: A Managerial Approach"; Wiley; Eighth edition (6 August 2012)
4. Gupta R; "Project Management"; Prentice Hall India Learning Private Limited; Second edition (2014)

Reference Books

1. Project Management Institute; "A Guide to the Project Management Body of Knowledge (PMBOK Guide)"; 5th Revised edition (1 January 2013)
2. Harold Kerzner; "Project Management: A Systems Approach to Planning, Scheduling and Controlling Paperback"; Wiley; tenth edition (20 November 2012)

Unit Tests

Unit Test-I	Unit- I,II, III
Unit Test-II	Unit- IV, V, VI

Elective-II: VIRTUAL REALITY
(Course Code C410.4)

Designation of Course	**Virtual Reality**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03Hours/ Week	End Semester Examination	60 Marks	03
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
	Term Work	25 Marks	01
	Total	**125 Marks**	**04**

Course Prerequisites: -	Companion Course, if any: Virtual Reality Lab
Course Objectives:-	This course is designed to give historical and modern overviews and perspectives on virtual reality. It describes the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems.
Course Outcomes: -	The students should be able to– 1. Describe how VR systems work and list the applications of VR. 2. Understand the design and implementation of the hardware that enables VR systems to be built. 3. Understand the Geometry of Virtual Worlds &The Physiology of Human Vision. 4. Understand the system of human vision and its implication on perception and rendering. 5. Explain the concepts of motion and tracking in VR systems. 6. Describe the importance of interaction and audio in VR systems.

Course Contents

Unit I	Introduction to Virtual Reality	**(06Hrs.)**
Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output-Visual, Aural & Haptic Displays, Applications of Virtual Reality.		
Unit II	Representing the Virtual World	**(06 Hrs.)**
Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR		
Unit III	The Geometry of Virtual Worlds &The Physiology of Human Vision	**(06 Hrs.)**
Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.		
Unit IV	Visual Perception & Rendering	**(06 Hrs.)**
Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates		
Unit V	Motion & Tracking	**(06 Hrs.)**
Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies		
Unit VI	Interaction & Audio	**(06 Hrs.)**
Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio		

-The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering.

Term Work

1. Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2. Study and demonstration of depth perception.
3. Study and demonstration of skeleton tracking for various application
4. Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
5. Develop a scene in Unity that includes a cube and apply transformations on the 3 game objects.
6. Develop a scene in Unity that includes a plane and apply transformations on the 3 game objects
7. Develop a scene in Unity that includes a sphere and apply transformations on the 3 game objects
8. Develop a scene in Unity that includes a video source
9. Develop a scene in Unity that audio source.

Project Based Learning

Exemplar/ Case Studies

1. Study the use of Virtual Reality at NASA
2. GHOST (General Haptics Open Software Toolkit) software development toolkit.
3. Sweeping coverage of eye movements
4. Automatic stitching of panoramas in Virtual Reality
5. A virtual Study Use Case- NICE, An Educational Experience
6. Side effects of using VR systems/ VR sickness.

Text Books

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003

Unit Tests

Unit Test-I	Unit-I,II, III
Unit Test-II	Unit-IV, V, VI

Elective-II: ADDITIVE MANUFACTURING & RAPID PROTOTYPING

(Course Code C410.5)

Designation of Course	**EL II: Additive Manufacturing & Rapid Prototyping**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - 03 Hours/ Week	End Semester Examination	60 Marks	03
Tutorial: - --Hours/ Week	Internal Assessment	40 Marks	
Practical: - 02 Hours/ Week	Term Work	25 Marks	01
	Oral/Practical	-- Marks	
	Total	**125 Marks**	**04**

Course Prerequisites: -	The students should have knowledge of 1) Solid Modelling, Auto CAD 2) Manufacturing Technology I & II 3) Design & Analysis of Machine Components
Course Objectives: -	1) To understand the fundamental concepts of Additive Manufacturing (i.e., Rapid Prototyping) and 3-D printing, its advantages, and limitations. 2) To classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc. 3) To have a holistic view of various applications of these technologies in relevant fields such as mechanical, Bio-medical, Aerospace, electronics etc.
Course Outcomes: -	The students should be able to– 1. Understand the importance of additive manufacturing process and AM process chain 2. Understand and apply Liquid-based and Solid Based additive manufacturing processes. 3. Understand and apply powder based additive manufacturing processes. 4. Understand and apply various Metal Additive Manufacturing process for different products 5. Apply various AM data formatting and data processing techniques for different products 6. Select suitable material for AM process and explore different applications of AM parts from various fields like Automobile, Aerospace, Bio-medical etc.

Course Contents

Unit I	**Introduction to Rapid Prototyping**	**(06 Hrs.)**
Introduction: Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing		
Unit II	**Liquid-based and Solid Based Rapid Prototyping**	**(06 Hrs.)**
Liquid-based Rapid Prototyping Systems: Stereo lithography Apparatus (SLA), Solid ground curing (SGC). Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. **Solid-based Rapid Prototyping Systems:** Laminated Object Manufacturing (LOM), Fused Deposition Modeling (FDM), Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.		
Unit III	**Powder Based Rapid Prototyping**	**(06 Hrs.)**

Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Materials, Indirect and direct SLS, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, post processing, post curing, surface deviation and accuracy, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes, Post processing of AM parts **Laser Engineered Net Shaping (LENS):** Processes, materials, products, advantages, limitations, and applications– Case Studies.		
Unit IV	**Design for Additive Manufacturing**	**(06 Hrs.)**
Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc. **Guidelines for process selection**: Introduction, selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control		
Unit V	**AM Data Formatting and Data Processing**	**(06 Hrs.)**
Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor. AM Data Processing: Part Orientation and Support Structure Generation, Model Slicing and Contour Data Organization, Direct and Adaptive Slicing, Hatching Strategies and Tool Path Generation.		
Unit VI	**AM Materials and Applications**	**(06 Hrs.)**
3D Printing Materials: properties, characteristics, and application of all types (ABS, PLA, PVA, HDPE, PET, PETG etc.) Types of Composites Materials, properties, characteristics, and application of all types. (N6, N12, ABS Carban Fiber, etc.) RP Applications: Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.		

Term Work

1. Study of 3D Printing Machines
2. Study of different AM Software's
3. Study of AM Data Formatting and Data Processing
4. Study and demonstration of Plastic 3D Printing using FDM based Rapid Prototyping (Plastic & Composites)
5. Study and demonstration of Plastic 3D Printing using SLS based Rapid Prototyping (Plastic & Composites)
6. Study and demonstration of Plastic 3D Printing using Liquid based/solid based/powder based Rapid Prototyping (Plastic & Composites)
7. Study and demonstration of Plastic 3D using FDM based Rapid Prototyping Printing (Metals)
8. Assignment on 3D Printing Applications.
9. Select appropriate 3D printing material and justify it for following application: -
   a. Prototyping
   b. medical appliances
   c. Construction.
10. Selection of 3d printing machine specification for following materials: -

a. Polymers
b. Composites
c. Metals

11. To measure surface quality and mechanical properties of AM product
12. Study of CAM packages for AM

Project Based Learning

Students have to prepare and submit a demonstration models based on above syllabus (Not limited to)

1. To prepare a demonstration model/chart of AM Processes chain
2. To prepare a demonstration model of liquid-based AM technologies
3. To prepare a demonstration model of solid based AM technologies
4. To prepare a demonstration model of powder-based AM technologies
5. To prepare a 3D printed model for various applications (Bio-medical, aerospace etc.)
6. To prepare a document on data formatting and data process by selecting one application

Textbooks

1. Ali K. Kamrani, Emand Abouel Nasr, “Rapid Prototyping: Theory and Practice”, Springer,2006.
2. Anupam Saxena, Birendra Sahay, “Computer Aided Engineering Design”, Springer, 2005.
3. Patri K. Venuvinod and Weiyin Ma, “Rapid Prototyping: Laser-based and OtherTechnologies”, Springer, 2004.
4. Chua Chee Kai, Leong Kah Fai, “3D Printing and Additive Manufacturing: Principles &Applications”, 4th Edition, World Scientific, 2015.
5. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley& Sons, 2006.
6. Khanna Editorial, “3D Printing and Design”, Khanna Publishing House, Delhi.

Reference Books

1. Chua Chee Kai, Leong Kah Fai, “Rapid Prototyping: Principles and Applications”, Worldscientific, 2003.
2. Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: RapidPrototyping to Direct Digital Manufacturing”, Springer, 2010
3. D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of RapidPrototyping and Rapid Tooling, Springer 2001.
4. David F. Rogers, J. A. Adams, “Mathematical Elements for Computer Graphics”, TMH,2008.
5. Kevin N. Otto, Kristin L. Wood, “Product Design”, Pearson Education, 2004.

Unit Tests

Unit Test-I	Unit- I, II, III
Unit Test-II	Unit- IV, V, VI

Energy Audit & Management

(Course Code C411)

Designation of Course	**Energy Audit & Management**		
Teaching Scheme	**Examination Scheme**		**Credits Allotted**
Theory: - 4 hrs./Week	End Semester Examination	60 marks	04
	Internal assessment	40 marks	
	Total	100 marks	04

Course Prerequisite	The student should have knowledge of - 1. Basic Physics 2. Basic Electrical Engineering 3. Basic Thermal Engineering 4. Mathematics
Course Objective	1. Understand basic energy conversion, conservation, and management principles. 2. Identify sources of energy loss and target savings. 3. Understand design of waste heat recovery systems, efficient power cycle, and power generation systems. 4. To enable students in carrying out life cycle cost analysis and budgeting.
Course Outcomes	1. Analyze about energy scenario nationwide and worldwide 2. To know the procedure for the balance of energy and material in different processes 3. To conduct an economic analysis of energy conservation measures 4. To understand a system of electrical energy management 5. To understand a system of thermal energy management 6. Conduct energy audits and formulate & implement energy conservation strategies.

Course Content

UNIT I	**Energy Scenario**	**8 Hrs.**
Energy needs of a growing economy, Long-term energy scenario, Energy pricing, Energy sector reforms, Energy and Environment: Air pollution, Climate change, Energy Security, Energy conservation and its importance, Energy strategy for the future, Energy conservation Act-2001 and its features.		
UNIT II	**Energy Audit**	**8 Hrs.**
Energy Audit: Types and Methodology; Scope of Energy Audit, Energy Audit Reporting Format; Understanding Energy Costs; Benchmarking and Energy Performance; Matching Energy Usage to Requirement; Maximizing System Efficiency Fuel and Energy Substitution; Energy Audit Instruments; Duties and responsibilities of energy auditors. Energy Management of Building and Energy audit of Building- Energy management matrix monitoring and targeting Case Studies		
UNIT III	**Economic Analysis of Energy Conservation Measures**	**8 Hrs.**

Economics: Fundamentals: Cash flows, Inflation Rates, Time Points and Periods, Discount Rates, Cost of Capital, Present value, Taxes, Uncertainty and Risk Economic Measures: Net Present Value, Total Life-Cycle Cost, Revenue Requirements, Internal Rate of Return, Modified Internal Rate of Return, Simple Payback Period, Discounted Payback Period, Benefit-to-Cost Ratios, Savings-to-Investment Ratios, Profitability index estimation		
UNIT IV	**Electrical energy management**	**8 Hrs.**
Electricity tariff, Load management and maximum demand control, Power factor improvement, Distribution, and transformer losses. Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, energy efficient motors, Light source, Choice of lighting, Luminance requirements, and Energy conservation avenues. Case Studies		
UNIT V	**Thermal energy management**	**8 Hrs.**
Energy conservation in boilers, steam turbines and industrial heating systems; Application of FBC; Cogeneration and waste heat recovery; Thermal insulation; Heat exchangers and heat pumps; Building Energy Management. Case Studies on Thermal Energy Management. Case Studies.		
UNIT VI	**Material and Energy Balance**	**8 Hrs.**
Basic Principles, Sankey diagrams, Material balances for different processes, Energy balances, heat balances, Methods for preparing process flow chart, Procedures to carry out the material and energy balance in different processes.		

Project based learning:

1. Conduct preliminary energy audit and prepare report on electrical plant.
2. Conduct preliminary energy audit and prepare report on thermal plant.
3. Prepare energy audit report on small scale industry with payback period.
4. Conduct energy audit on residential house/own house with payback period.
5. Prepare economical audit sheet of any small scale industry.
6. Prepare social instructions charts for energy saving tricks.
7. Write one research paper on audit carried out in small scale industry.
8. Prepare standard energy efficient model for residential house.

Text Books:

1. Electric Energy Utilization and Conservation by S C Tripathy, Tata McGraw hill publishing company Ltd. New Delhi.
2. Energy management by Paul o’ Callaghan, Mc–Graw Hill Book company–1st edition, 1998.
3. Energy management handbook by W. C. Turner, John Wiley, and sons.
4. Energy management and conservation –k v Sharma and Venkata shariah-I K International Publishing House Pvt ltd, 2011.

Reference Books:

1. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, “Guide to Energy Management”, Seventh Edition, The Fairmont Press Inc., 2012.
2. Albert Thomann, “Handbook of Energy Audits”, Sixth Edition, The Fairmount Press, 2003.
3. G. G. Rajang, “Optimizing Energy Efficiencies in Industry”, Tata McGraw Hill, 2001
4. Wayne C. Turner, “Energy Management Hand Book”, The Fairmount Press, Inc., 2001.
5. Charles M. Gottschalk, “Industrial Energy Conservation”, John Wiley and Sons, 1996.
6. Craig B. Smith, “Energy Management Principles”, Pergamon Press, 2015.
7. IEEE Recommended “Practice for Energy Management in Industrial and Commercial Facilities”, IEEE std 739 – 1995. (Bronze book).
8. Hamis, “Energy Auditing and Conservation; Methods, Measurements, Management and Case Study”, Hemisphere Publishers, Washington, 1980.
9. C.W. Gelling’s and J.H. Chamberlin, “Demand-Side Management Planning”, Fairmount Press, 1993.

10. Wayne C Turner, “Energy Management Handbook”, The Fairmount Press, 2006.
11. Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I to IV.

Unit Tests: -

Unit Test-I	Unit- I, II and III
Unit Test-II	Unit- IV, V and VI

Reliability and Machine Condition Monitoring
(Course Code C412)

Designation of Course	Reliability and Machine Condition Monitoring		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory:- 03Hours/ Week	End Semester Examination	60 Marks	03
Practical:- 02 Hours/ Week	Internal Assessment	40 Marks	
Tutorial;- o1 Hours/Week	Term Work	25 Marks	01
	Oral	25 Marks	01
	Total	**150 Marks**	**05**

Course Prerequisites: -	Student should have knowledge of Engineering Mathematics, Probability, Statistics and Mechanical Vibration
Course Objectives:-	1. Understanding of basic principles of reliability for ensuring sustainable product design. 2. Application to system requirements, design, manufacturing and testing, with real world examples 3. Understand in detail Asset Management, Maintenance, Quality and Productiveness
Course Outcomes: -	Student should be able to 1. Understand different measures of reliability 2. Know different probability methods used in reliability engineering 3. Calculate MTTF, MTBF, failure rate and hazard rate. 4. To acquire knowledge of methods for evaluation of reliability of different systems. 5. Understand the concepts of maintainability and availability in reliability engineering 6. Understand the reliability design procedure 7. Know different methods to test reliability of the system.

Course Contents

Unit I	**Fundamental Concepts of Reliability and Reliability Measures**	**(06Hrs.)**
Brief history, concepts, terms and definitions, applications, the life cycle of a system, concept of failure, typical engineering failures and their causes **Reliability Measures:** Reliability function–R(t), cumulative distribution function (CDF)– F(t), probability density function (PDF) – f(t), hazard rate function-λ(t), Mean time to failure (MTTF) and Mean time between failures (MTBF), typical forms of hazard rate function, bathtub curve		
Unit II	**Probability Concepts and Failure Data Analysis**	**(06 Hrs.)**
Theory of probability, rules of probability, Introduction to independence, mutually exclusive, conditional probability random variables, discrete and continuous probability distributions. Binomial, normal Comparison of probability distributions - , lognormal, Weibull, exponential, Standard deviation, variance, mean, mode and Central Limit Theorem. **Failure Data Analysis** Data collection and empirical methods, estimation of performance measures for ungrouped complete data, grouped complete data, analysis of censored data, fitting probability distributions graphically (Exponential and Weibull) and estimation of distribution parameters		
Unit III	**Reliability Evaluation of Systems**	**(06 Hrs.)**
Reliability Improvement Redundancy, element redundancy, unit redundancy, standby redundancy - types of stand by redundancy, parallel components single redundancy, multiple redundancies, cut and tie set approach for reliability evaluation. Star and delta method, matrix method (Numerical).		

Introduction to Reliability allocation or apportionment, reliability apportionment techniques- equal apportionment, AGREE, ARINC, Minimum effort method (Numerical)		
Unit IV	**Design for Reliability and Maintainability**	**(06 Hrs.)**
Reliability design process and design methods, reliability allocation, failure modes, effects and criticality analysis (FMECA), fault tree and success tree methods, symbols used, maintainability design process, quantifiable measures of maintainability, repair versus replacement		
Unit V	**Data Acquisition, Signal Processing, Applications and Representation:**	**(06 Hrs.)**
Introduction, Collection of vibration signal – vibration transducers, characteristics and mountings, Conversion of vibrations to electrical signal. The fast Fourier transform (FFT) analysis, Time waveform analysis, Phase signal analysis, Spectral signal processes.		
Unit VI	**Machinery Fault Diagnosis Using Vibration Analysis and Oil and Particle Analysis Oil Fundamentals**	**(06 Hrs.)**
Commonly witnessed machinery faults diagnosed by vibration analysis, correcting faults that cause vibration; Balancing, Alignment, Resonance vibration control with dynamic absorbers. Condition-based maintenance and oil analysis, Setting up an oil analysis program, Oil analysis – sampling methods, Oil analysis – lubricant properties, Oil analysis – contaminants in lubricants, Particle analysis techniques, Alarm limits for various machines.		

Term Work

Term work shall consists of

1. Data acquisition using a velocity pickup.Data acquisition using an accelerometer.
2. Data acquisition of sound signals.
3. Spectral analysis of velocity, acceleration noise signals.
4. Experiment demonstrating balancing of rotating shaft shaft.

Project Based Learning

Exemplar/ Case Studies

1. Data acquisition using a velocity pickup.
2. Data acquisition using an accelerometer.
3. Data acquisition of sound signals.
4. Spectral analysis of velocity, acceleration noise signals.
5. Experiment demonstrating balancing of rotating shaft shaft.

Text Books

1. Ebling C. E., 2004, “An Introduction to Reliability and Maintainability Engineering”, Tata McGraw Hill Education Private Limited, New Delhi.
2. Srinath L. S., 1991, “Reliability Engineering”, East West Press, New Delhi.
3. Birolini A., 2010, “Reliability Engineering: Theory and Practice”, Springer.
4. Parkhi R. M., “Market Leadership by Quality and Reliability”, Vidyanand Publications 2012.
5. Roy B. and Allan R. N., 1992, “Reliability evaluation of engineering systems: concepts and techniques”, Springer.
6. Thomson, W. T., "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 1990
7. Gupta K., "Introductory Course on Theory and Practice of Mechanical Vibrations", New Age International Ltd., 1984
8. J. S. Rao., “Vibratory Condition Monitoring of Machines”, Narosa publishing house, New Delhi

Reference Books

1. Patrick D. T. Newton O’Conner, D., Bromley R., 2002, “Practical Reliability Engineering”, John Wiley and Sons.
2. Rao S. S., 1992, “Reliability Based Design. McGraw-Hill
3. Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, 2006, “Maintenance, Replacement and

Reliability: Theory and Applications”, CRC/Taylor and Francis.
4. Nachlas Joel A., 2005, “Reliability Engineering: Probabilistic Models and Maintenance Methods” Taylor and Francis.
5. Cyril M. Harris, Allan G. Piersol, “Shock and Vibration Handbook”, McGraw-Hill Publishing Co.
6. C. Scheffer, Paresh Girdhar, “Practical Machinery Vibration Analysis and Predictive Maintenance”, Newnes an imprint of Elsevie

Unit Tests

Unit Test-I	Unit-I,II, III
Unit Test-II	Unit-IV, V, VI

PROJECT STAGE -II
(Course Code C413)

Designation of Course	**Project Stage -II**		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
Theory: - -- Hours/ Week	End Semester Examination	-- Marks	--
Tutorial: - --Hours/ Week	Internal Assessment	-- Marks	
Practical: - 04 Hours/ Week	Term Work	100 Marks	06
	Oral/Practical	100 Marks	
	Total	**200 Marks**	**06**

Course Prerequisites: -	The students should have knowledge of 1. Knowledge of basic concepts in heat transfer. 2. Basic information of thermodynamics 3. Basic knowledge of fluid mechanics. 4. Knowledge of basic concepts in mechanical engineering 5. Basic knowledge of design
Course Objectives: -	1. To fabricate the designed equipment 2. To conduct laboratory and field testing of the new equipment 3. To analyze performance of the equipment with different performance parameters 4. To make changes in design if necessary, based on the performance analysis 5. To prepare project report and deliver presentation. 6. To work sincerely as a member of team
Course Outcomes: -	The students should be able to– 1. Understand the latest changes in technological world and apply fundamental principles of science and engineering. 2. Create ability to identify, formulate and model problems 3. Understand importance of sustainability and cost-effectiveness in design and development of engineering solution. 4. Create ability to be multi skilled engineer with a good technical knowledge, management, leadership, entrepreneurship skills. 5. Create awareness of social, 6. Create ability to communicate efficiently.

Course Contents

Details of Project Stage -II

1. The project taken in the First semester will be continued as far as possible. In case after the training, the students wish to change their project, the same may be allowed after discussion with the faculty. The new project should be based on the training taken and should utilize the training experience.

   In Semester II concentration will be on

   - Hardware fabrication
   - Testing of equipment
   - Preparing a project report

2. The work will be evaluated through three presentations with aim of watching the progress and suggesting modifications for completing the project.

Operations Research Practices
(Course Code C414)

Designation of Course	Operations Research Practices		
Teaching Scheme:	**Examination Scheme:**		**Credits Allotted**
	End Semester Examination	-	---
Practical: - 02 hours/Week	Internal Assessment	-	
	Term Work	25 Marks	1
	Practical	-	-
	Total	25 Marks	1

Course Prerequisites: -	Good knowledge of mathematics.
Course Objective: -	The students will be able to understand various models in operations research used in industries to solve problems
Course Outcomes	As a part of this course, students will: 1. Understand graphical method of solving Linear ProgrammingProblems. 2. Understand simplex method of solving Linear ProgrammingProblems. 3. Understand transportation and assignment problems. 4. Use CPM and PERT for modelling. 5. Apply queuing theory to optimize queues. 6. Use Inventory Control System to optimize inventory costs.

Course Contents

Unit 1	**LPP: Graphical Method**	**(04 Hrs.)**
Linear programming – Examples from industrial cases, formulation & definitions, Matrix form. Implicit assumptions of LPP. Graphical Method of solving the LPP.		
Unit 2	**LPP: Simplex Method**	**(04 Hrs.)**
Simplex Algorithm – slack, surplus & artificial variables, computational details, big-M method, 2 phasemethod. identification and resolution of special cases through simplex iterations.		
Unit 3	**LPP: Special Cases**	**(04 Hrs.)**
Transportation Problems - Examples, Definitions – decision variables, supply & demand constraints, formulation, Balanced & unbalanced situations, Solution methods – NWCR, minimum cost and VAM, test for optimality (MODI method), degeneracy and its resolution. **Assignment Problems** - Examples, Definitions – decision variables, constraints, formulation, Balanced & unbalanced situations, Solution method – Hungarian, test for optimality (MODI method), degeneracy& its resolution.		
Unit 4	**Project Modelling**	**(04 Hrs.)**
Project definition, Project scheduling techniques – Gantt chart, PERT & CPM, Determination of critical paths, Estimation of Project time and its variance in PERT using statistical principles,		
Unit 5	**Inventory Model**	**(04 Hrs.)**
Concept of inventory costs, Basics of inventory policy (order, lead time, types), Fixed order-quantity models – EOQ, POQ & Quantity discount models. EOQ models for discrete units,		
Unit 6	**Queuing Theory**	**(04 Hrs.)**

Definitions – queue (waiting line), waiting costs, characteristics (arrival, queue, service discipline) of queuing system, queue types (channel vs. phase). Kendall's notation, Little's law, steady state behavior. Models with examples - M/M/1 and its performance measures.

Term work

Term work shall consist of any eight practicals described in syllabus and listed below.

1. Solution of linear programming problem using graphical method
2. Solution of linear programming problem with simplex method.
3. Problem solving using Big M method.
4. Problem solving using two phase method.
5. Solution of transportation problem.
6. Solution of assignment problem.
7. Identification of project duration using CPM
8. Finding probabilities of project completions using PERT
9. Performance measures for M/M/1 queuing model.
10. Determination of various inventory cost using inventory model.

Textbooks:

1. Operations Research: An Introduction. H.A. Taha.

Reference Books:

1. Linear Programming. K.G. Murthy.
2. Linear Programming. G. Hadley.
3. Principles of OR with Application to Managerial Decisions. H.M. Wagner.
4. Introduction to Operations Research. F.S. Hiller and G.J. Lieberman.
5. Elements of Queuing Theory. Thomas L. Saaty.
6. Operations Research and Management Science, Handbook: Edited by A. Ravi Ravindran.
7. Management Guide to PERT/CPM. Wiest& Levy.
8. Modern Inventory Management. J.W. Prichard and R.H. Eagle.

Robot Movement System
(Course Code C415)

Designation of Course	Robot Movement System		
Teaching Scheme:	**Examination Scheme**		**Credits Allotted**
Theory: -	End Semester Examination	--	01
Practical: 02 Hours/Week	Internal Assessment	--	
	Term Work	25 Marks	
	Total	**25 Marks**	**01**

Course Prerequisites: -	The students should have knowledge of 1.Mechanism and Mechanics 2.Basic Electrical Engineering. 3.Engineering Mathematics
Course Objectives: -	To provide knowledge about 1.Robot Movement system components 2.Robot Motion control techniques 3.Mechanics of robot manipulator
Course Outcomes: -	The students should be able to 1. To Identify robot movement system 2. To Understand robot drive system 3. To Understand robot end effector 4. To Select robot sensor as per application 5. To Understand robot motion control technique 6.To Evaluate Kinematics Model of Robot

Course Contents

Unit-I	**Introduction to Robot Movement System**	**04 Hrs.**
Introduction to robot movement system, Components of robot movement system, working of robot motion system, Robot configurations, Work volume and work envelope, Robot Joints and symbols, Robot Coordinates, Robot Reference Frames, Resolution, accuracy and precision of Robot, Work cell control, Robot locomotive system and its types.		
Unit-II	**Robot Drive Systems**	**04 Hrs.**
Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors, BLDC-Salient Features, Applications and Comparison of all these Drives, Micro actuators, selection of drive, Power transmission systems for robot, Motion conversion, Determination of HP of motor, Types of Gearboxes: - Planetary, Harmonic, Cycloidal gearbox and gear Ratio, variable speed arrangements.		
Unit-III	**End Effectors**	**04 Hrs.**
Grippers, Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Advance Grippers- Adaptive grippers, Soft Robotics Grippers, Tactile Sensor Grippers; Various process tools as end effectors; Robot end effectors interface, Active and passive compliance, Selection and Design Considerations.		
Unit-IV	**Robot Sensor**	**04 Hrs.**
Position sensors – Piezo Electric Sensor, LVDT, Resolvers. Proximity Sensor – Optical, Inductive and capacitive ,Encoders: Absolute and Incremental: - Optical, Magnetic, Capacitive, pneumatic Position Sensors Range Sensors: Range Finders, Laser Range Meters, Touch Sensors, Force and torque sensors. Safety Sensor: Light Curtain, Laser Area Scanner, Safety Switches; Machine vision		

Unit-V	Robot motion control technique	04 Hrs.
Introduction to robot motion control, Point to Point (PTP) control, Continuous path control (CP), controlled path, Stop to stop control, Trajectory planning, Joint and cartesian space trajectory.		
Unit-VI	**Mechanics of Robot Manipulator Movement**	**04 Hrs.**
Co-ordinate and vector transformation using matrices, Rotation matrix, Homogenous Transformations-H Parameter, Forward and Inverse kinematics of 2 and 3 Link robot manipulator		

Term Work:

Term work shall consist record of minimum 8 experiments from the following.

1.Study of different type of robot locomotive mechanism.
2.Study of different robot drive for Pick and place application
3.Demonstration of different type of robot gripper .
4. Study of robotics sensor used in AI based object sorting system
5.Demonstration of robot motion control system for object sorting system by robotic arm
6. Study and create robot joint trajectory by using any robotic simulation software
7. Analysis of Forward kinematics of 2 link manipulator
8. Analysis of Inverse kinematics of 2 link manipulator
9.Operation and troubleshooting of robot motion control system

Text Books :

1. M.P. Groover , "Automation, Production Systems & Computer Integrated Manufacturing", PHI, 3rd Edition, 2012.
2. M.P. Groover, M.Naegel, "Industrial Robotics, Technology, Programming & Applications", TMH,2nd Edition, 2012.

References Books :

1. J.G. Keramas, "Robotics Technology Fundamentals", Thompson Learning, 2nd Edition, 2002.
2. J.J.Craig "Introduction to Robotics Mechanics & Control", Pearson Education, 3rd Edition,2004.
3. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book co, 1987.
4. S.R. Deb, " Robotics Technology and Flexible Automation", TMH, 2nd Edition, 2010.
5. Mike Wilson, "Implementation of Robotic Systems"

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY), PUNE

Faculty of Engineering & Technology
B. Tech. - Mechanical
Old Syllabus

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY) Pune.

College of Engineering, Pune- 411043
The Structure of the Curriculum: 2014 Course
Choice Based Credit System (CBCS)

COURSE STRUCTURE AND SYLLABUS

(Choice Based Credit System - 2014 Course)

B. TECH. MECHANICAL: SEMESTER- I & II

Programme: B. Tech. Mechanical

Vision of the Bharati Vidyapeeth (Deemed to be University) College of Engineering is:

To be a World Class Institute for Social Transformation through Dynamic Education

Missions of the Bharati Vidyapeeth (Deemed to be University) College of Engineering are:

- To provide quality technical education with advanced equipment, qualified faculty members, infrastructure to meet needs of profession & society.
- To provide an environment conducive to innovation, creativity, research and entrepreneurial leadership.
- To practice and promote professional ethics, transparency and accountability for social community, economic & environmental conditions.

Goals of the Bharati Vidyapeeth (Deemed to be) University College of Engineering are:

- Recruiting experienced faculty.
- Organizing faculty development programs.
- Identifying socio-economically relevant areas & emerging technologies.
- Constant review &up gradation of curricula.
- Up gradation of laboratories, library & communication facilities.
- Collaboration with industry and research & development organizations.
- Sharing of knowledge, infra-structure and resources.
- Training, extension, testing and consultancy services.
- Promoting interdisciplinary research.

Vision of the Mechanical Engineering Department is:

To develop, high quality Mechanical Engineers through dynamic education to meet social and global challenges.

Mission Statements of the Mechanical Engineering Department are:

- To provide extensive theoretical and practical knowledge to the students with well-equipped laboratories and ICT tools through motivated faculty members.
- To inculcate aptitude for research, innovation and entrepreneurial qualities in students.

- To acquaint students with ethical, social and professional responsibilities to adapt to the demands of working environment.

Program Educational Objectives (PEOs) of the B. Tech. Mechanical are:

Graduates will be able,

- To fulfill need of industry and society with theoretical and practical knowledge.
- To engage in research, innovation, lifelong learning and continued professional development.
- To fulfill professional ethics and social responsibilities.

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Statements of Programme Specific Outcomes (PSOs)

PSO1: Apply the knowledge of thermal, design, manufacturing engineering and computational sciences to solve Mechanical Engineering problems.

PSO2: Apply Mechanical Engineering principles for research, innovation and develop entrepreneurial skills.

PSO3: Apply concepts of mechanical engineering to asses' societal, environmental, health and safety issues with professional ethics.

B. TECH. MECHANICAL: SEMESTER- I (2014 Course)

S.N.	Course	Teaching Scheme (Contact Hrs./ week)			Examination Scheme (Marks)						Total Credits		
		L	P/D	T	End Sem. Exam	Continuous Assessment: Unit Test	Attendance	Assignments	TW	Total	TH	TW	Total
C101	Engineering Mathematics – I	3	-	1	60	20	10	10	-	100	3	1	4
C102	Fundamentals of Civil Engineering	3	2	-	60	20	10	10	25	125	3	1	4
C103	Engineering Graphics *	4	2	-	60	20	10	10	25	125	4	1	5
C104	Engineering Physics	4	2	-	60	20	10	10	25	125	4	1	5
C105	Fundamentals of Electrical Engineering	3	2	-	60	20	10	10	25	125	3	1	4
C106	Professional skill Development – I	2	-	-	50		-	-	-	50	2	-	2
C107	Workshop Technology	-	2	-	-	-	-		50	50	-	1	1
	Total	19	10	1	350	100	50	50	150	700	19	6	25

L: Lectures, P/D: Practical/ drawing, T: Tutorial, TH: Theory, TW: Term work

* End Semester examination of duration 4 Hours.

B. TECH. (MECHANICAL) SEM.-II (2014 COURSE)

S. N	Course	Teaching Scheme (Contact Hrs./week)			Examination Scheme (Marks)						Total Credits		
		L	P/D	T	End Sem. Exam	Continuous Assessment: Unit Test	Attendance	Assignments	TW	Total	TH	TW	Total
C108	Engineering Mathematics – II	3	-	1	60	20	10	10	-	100	3	1	4
C109	Fundamentals of Mechanical Engineering	3	2	-	60	20	10	10	25	125	3	1	4
C110	Engineering Mechanics	4	2	-	60	20	10	10	25	125	4	1	5
C111	Engineering Chemistry	4	2	-	60	20	10	10	25	125	4	1	5
C112	Mechanical Engineering Drawing*	2	4	-	60	20	10	10	25	125	2	2	4
C113	Professional skill Development-II	2	-	-	50	-	-	-	-	50	2	-	2
C114	Production Practice- I	-	2	-	-	-	-	-	50	50	-	1	1
	Total	18	12	1	350	100	50	50	150	700	18	7	25

L: Lectures, P/D: Practical/ drawing, T: Tutorial, TH: Theory, TW: Term work

* End Semester examination of duration 4 Hours.

Total Credits Sem. I - 25

Total Credits Sem. II -25

Grand Total -50

Rules for Conducting Tests

Mode of the test

- In each semester for each subject three tests shall be conducted. The schedule for the same will be declared at the commencement of academic year in the academic calendar.
- Each test shall carry 20 marks.
- University examination pattern has given weightage of 20 marks for the tests.
- To calculate these marks following procedure is followed:
  - i) Out of the three tests conducted during the semester, the marks of only two tests in which the candidate has shown his/her best performance shall be considered, to decide the provisional marks in each subject.
  - ii) Average marks obtained in two tests in which students have performed well, shall be considered as provisional marks obtained by the student in the tests.
  - iii) If the candidate appears only for two tests conducted during the semester, he/she will not be given benefit of the best performance in the tests.
  - iv) If the candidate appears only for one test conducted during the semester, to calculate the marks obtained in the tests it will be considered that the candidate has got 0 (zero) marks in other tests.
  - v) The provisional marks obtained by the candidate in class tests should reflect as proportional to theory marks. In cases of disparity of more than 15% it will be scaled down accordingly; these marks will be final marks obtained by the student. No scaling up is permitted.
  - vi) If the candidate is absent for theory examination or fails in theory examination his final marks for tests of that subject will not be declared. After the candidate clears the theory, the provisional marks will be finalized as above.
- Paper pattern for tests
  - i) All questions will be compulsory with weightage as following

    Question 1 - 7 marks

    Question 2 - 7 marks

    Question 3 - 6 Marks
  - ii) There will not be any sub-questions.
- For granting the term it is mandatory to appear for all three tests conducted in each semester.
- Roll nos. allotted to students shall be the examination nos. for the tests.

Engineering Mathematics-I
(Course No.C101)

Teaching Scheme	Examination Scheme		Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks		Theory : 03
Tutorial : 01 Hours/ Week	Tutorial : 01 Hours/ Week		Tutorial : 01
	Unit Test 20 Marks		
	Assignments10 Marks		
	Internal Evaluation 10 Marks		
	Term Work / Oral	-- Marks	
	Total 100 Marks		4

Course Pre-requisites:

Student should have Basic Knowledge of Algebra

Course Objectives:

1. Effectively solve the system of equations
2. Use the concept of infinite series
3. Obtain maxima and minima of multivariable function

Course Outcomes: Students Should be able to:

1. Understand the consistency of any type of system of equations. imaginary points using argand diagram.
2. Understand the concepts DeMoiver's theorem and Apply to find the roots of equations.
3. Understand Leibnitz's rule and Apply to find n th derivative.
4. Remember the concepts Test convergence and divergence of infinite series.
5. Understand the concepts to Compute total derivative
6. Understand the concept of Maxima and Minima and apply it to for the functions having two variable.

Programme: B. Tech. Mechanical

Unit I **08 Hours**

Matrices

Rank, Normal form, System of Linear Equations, Linear Dependence and Independence, Linear and Orthogonal Transformations. Eigen values, Eigen Vectors, Cayley – Hamilton Theorem. Application to problems in Engineering.

Unit II **08 Hours**

Complex Numbers And Applications

Definition, Cartesian, Polar and Exponential Forms, Argand's Diagram, De'Moivre's theorem and its application to find roots of algebraic equations., Hyperbolic Functions, Logarithm of Complex Numbers, Separation into Real and Imaginary parts, Application to problems in Engineering.

Unit III **08 Hours**

Differential Calculus and Expansion Of Functions

Successive Differentiation, nth Derivatives of Standard Functions, Leibnitz's Theorem.

Taylor's Series and Maclaurin's Series.

Unit IV **08 Hours**

Differential Calculus and Infinite Series

Indeterminate Forms, L' Hospital's Rule, Evaluation of Limits. Infinite Sequences, Infinite Series, Alternating Series, Tests for Convergence, Absolute and Conditional Convergence, Power series, Range of Convergence.

Unit V **08 Hours**

Partial Differentiation And Applications

Partial Derivatives, Euler's Theorem on Homogeneous Functions, Implicit functions, Total Derivatives, Change of Independent Variables. Errors and Approximations.

Unit VI **08 Hours**

Jacobian and Maxima And Minima

Jacobians and their applications, Chain Rule, Functional Dependence.

Maxima and Minima of Functions of two variables, Lagrange's method of undetermined multipliers.

Assignment:

Problems and/or theory questions on following topics:

1. Linear algebra: matrices
2. Partial differentiation and indeterminate forms
3. Vector differential calculus
4. Vector integral calculus and applications
5. Partial Differentiation
6. Jacobian and Maxima And Minima

Textbooks:

1. Applied Mathematics (Volumes I and II) by P. N. Wartikar & J. N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune, 7th edition (1988).
2. Higher Engineering Mathematics by B. S. Grewal, Khanna Publication, Delhi, 42th edition (2012).
3. Higher Engineering Mathematics by B.V. Ramana, Tata McGraw-Hill (2008).
4. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley Eastern Ltd, 8thedition (1999).
5. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil, Thomson Learning, 6th edition (2007).
6. Advanced Engineering Mathematics, 2e, by M. D. Greenberg, Pearson Education, 2nd edition (2002).

Syllabus for Unit Test:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Fundamentals of Civil Engineering
(Course No.C102)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours/ Week	End Semester Examination 60 Marks	Theory : 3
Practical:- 02 Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 25 Marks	Practical : 1
	Total 125 Marks	4

Course Pre-requisites:

1. Concepts of Units and conversion of units
2. Basic knowledge of Chemistry Basic knowledge of physics
3. Basic knowledge of Geography, concepts of lattitude and longitude

Course Objectives:

1. To study scope and application of Civil Engineering
2. To study different surveying techniques and its classification
3. To study building planning by considering foundations, earthquake, and bye laws
4. To study infrastructure utilization and water resource management

Course Outcomes: Students should be able to

1. Understand different building materials and components of a building / structure.
2. Understand the principles, classification of surveying and apply actual techniques of surveying
3. Understand and apply building planning concepts for eco-friendly structures and intelligent buildings.
4. Evaluate knowledge of different foundations and earthquake resistant design
5. Understand methods of irrigation and water supply systems.
6. Understand different methods of transportation.

Unit I **06 Hours**

Civil Engineering Scope And Applications.

Civil Engineering scope, importance and applications to other disciplines of Engineering; Civil Engineering construction process and role of Civil engineer; Government authorities related to Civil Engineering; Types of structures based on loading , material and configuration; Building components and their functions; Civil Engineering materials: concrete, construction steel, bricks, flooring material and tiles, paints, plywood , glass and aluminum.

Unit II **06 Hours**

Surveying

Objectives, Principles and Classification of Surveying; Linear, angular, Vertical and area Measurements and related instruments.

Unit III **06 Hours**

Building Planning And Bye Laws

Site selection for residential building; Principles of building planning; Building bye laws- necessity, Floor Space Index, Heights , open space requirements, set back distance , ventilation and lighting, concept of carpet and built up area, minimum areas and sizes for residential buildings ; Concept of Eco friendly structures and Intelligent buildings.

Unit IV **06 Hours**

Foundations and Earthquakes

Function of foundation, concept of bearing capacity and its estimation, types of foundation and its suitability, causes of failure of foundation. Earthquakes causes, effects and guidelines for earthquake resistant design, earthquake zones.

Unit V **06 Hours**

Irrigation And Water Supply

Rainfall measurement and its use in design of dams; Types of dams, canals, methods of irrigation and their merits and demerits; hydropower structures ;Water supply, drinking water requirements and its quality, water and sewage treatment flow chart.

Unit VI **06 Hours**

Infrastructure

Roads- types of roads and their suitability, cross section of roads, meaning of terms ; width of roads, super elevation, camber, gradient ,sight distance, materials used for construction of roads. Railways- Types of gauges, section of railway track, components of railway track, advantages. Bridges: Components - Foundation, Piers, Bearings, Deck. Airways- Components -Runway, Taxiway and Hangers.

List of Assignments

Numerical and/or theory questions on following topics:

1. Resultant and equilibrium of forces
2. Civil Engineering Scope And Applications.
3. Surveying
4. Building Planning And Bye Laws
5. Foundations and Earthquakes
6. Irrigation And Water Supply & Infrastructure

Term Work Experiments

Any ten experiments from the following:

1. Study and use of prismatic compass and measurement of bearings.
2. Study and use of Dumpy level and reduction of levels by collimation plane method.
3. Area measurement by Digital Planimeter.
4. Drawing plan and elevation of a residential bungalow.
5. Study of features of topographical maps.
6. Assignment on collection of information on Civil Engineering materials.
7. Assignment on types of foundations.
8. Assignment problem on irrigation and hydropower structures.
9. Assignment on study of flow chart of water and sewage treatment.
10. Assignments on types of transportation systems.

Text Books/ Reference Books

1. " Surveying- Vol I " - S.K. Duggal , Tata McGraw Hill Publication.
2. "Built Environment" – Shah , Kale, Patki, , Tata McGraw Hill Publication
3. "Building Construction" – Dr. B.C. Punmia , Laxmi Publication
4. "Irrigation and water Power Engineering "- Dr. P.N. Modi, Standard Publishers ,New Delhi
5. "Text book of Transportation Engineering "- Arora, Charotar Publishers.
6. Water supply and sanitary engineering-Rangawala, Charotar Publishers.
7. Basic Civil engineering"- M.S. Palanichamy- Tata McGraw Hill Publication

Syllabus for Unit Tests:

Unit Test-I Unit-I,II, III

Unit Test-II Unit-IV, V, VI

Engineering Graphics
(Course No.C103)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04Hours/ Week	End Semester Examination 60 Marks	Theory: 04
Practical:- 02 Hours/Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical : 01
	Total 150 Marks	05

Course Pre-requisites:

Fundamentals of Mathematics

Course Objectives:

1. To highlight the importance of graphics in engineering
2. To develop skills in reading and interpretation of engineering drawing
3. To develop the graphical skills for communication of concepts & idea through technical drawings

Course Outcomes: Students Should be able to:

1. Understand different types of lines, curves and dimension technique with practical application.
2. Understand the concept of Orthographic projections and apply it to draw detail views by using 1st angle projection method.
3. Understand the concept of isometric projection and apply it to construct 3D view of a component.
4. Understand the concept of projections of Point and Line and apply to draw its projection by using 1st angle projection method and to locate its traces.
5. Understand the concept of projections of different types of planes apply to draw its projection by using 1st angle projection method.
6. Understand the concept of projections of different types of solids and its sections apply to draw its projection by using 1st angle projection method.

Unit I **08 Hours**

Lines and Dimensioning in Engineering Drawing and Engineering Curves

Different types of lines used in drawing practice, Dimensioning – linear, angular, aligned system, unidirectional system, parallel dimensioning, chain dimensioning, location dimension and size dimension. Ellipse by Directrix-Focus method, Arcs of Circle method, Concentric circle method and Oblong method. Involute of a circle, Cycloid, Archimedean Spiral, Helix on cone, Loci of points- Slider Crank mechanisms.

Unit II **08 Hours**

Orthographic Projection

Basic principles of orthographic projection (First and Third angle method). Orthographic projection of objects by first angle projection method only. Procedure for preparing scaled drawing, sectional views and types of cutting planes and their representation, hatching of sections.

Unit III **08 Hours**

Isometric Projections

Isometric view, Isometric scale to draw Isometric projection, Non-Isometric lines, and construction of Isometric view from given orthographic views and to construct Isometric view of a Pyramid, Cone, and Sphere.

Unit IV **08 Hours**

Projections of Points and Lines

Projections of points, projections of lines, lines inclined to one reference plane, Lines inclined to both reference planes. (Lines in First Quadrant Only) Traces of lines,

Unit V **08 Hours**

Projections of planes

Projections of Planes, Angle between two planes, Distance of a point from a given plane, Inclination of the plane with HP, VP

Unit VI **08 Hours**

Projection of Solids and Section of Solids

Projection of prism, pyramid, cone and cylinder by rotation method. Types of section planes, projections of solids cut by different sections of prism, pyramid, cone and cylinder.

Term Work:

Term work shall consist of five half-imperial size or A2 size (594 mm x 420 mm) sheets. Assignment 05 Problems on each unit in A3 size Drawing Book

Sheets

1. Types of lines, Dimensioning practice, Free hand lettering, 1nd and 3rd angle methods symbol.
2. Curves and loci of points.
3. Projections of Points and Lines and planes.
4. Orthographic Projections.
5. Isometric views.
6. Projection of Solids.

Assignment:

Minimum five problems on each unit in A3 size Drawing Book

Textbooks:

1. “Elementary Engineering Drawing”, N.D. Bhatt, Charotar Publishing house, Anand India.
2. “Text Book on Engineering Drawing”, K.L.Narayana & P.Kannaiah, Scitech Publications, Chennai.
3. “Fundamentals of Engineering Drawing”, Warren J. Luzzader, Prentice Hall of India, New Delhi.
4. “Engineering Drawing and Graphics”, Venugopal K., New Age International publishers.
5. M. B. Shah and B. C. Rana, "Engineering Drawing", 1st Ed, Pearson Education, 2005.
6. P. S. Gill, "Engineering Drawing (Geometrical Drawing)", 10 Edition, S. K. Kataria and Sons, 2005.
7. P. J. Shah, "Engineering Drawing", C. Jamnadas and Co., 1 Edition, 1988.

Syllabus for Unit Tests:

Unit Test-I Unit-I,II, III

Unit Test-II Unit-IV, V, VI

Engineering Physics
(Course No.C104)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours/ Week	End Semester Examination 60 Marks	Theory : 04
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 25 Marks	Practical : 01
	Total 125 Marks	5

Course Pre-requisites:

Basics knowledge of Higher secondary physics.

Course Objectives:

To provide the knowledge of

1. Modern physics, nuclear physics, solid state physics and super-conductor
2. Fundamental concepts of thermodynamic and nano technology
3. Fundamental concepts of wave optics and lasers
4. Fundamental concepts of acoustics and quantum mechanics

Course Outcomes: Students should be able to

1. Understand fundamental concepts of modern physics, nuclear physics and analyze practical problems.
2. Understand the concepts of solid state physics, superconducters and analyze practical problems on solid state physics.
3. Understand the concepts of thermodynamic, nano technology and analyze problems on thermodynamics.
4. Understand the concepts of interference and diffraction of light; analyze practical problems.
5. Understand the concept of light polarization, lasers and its application.
6. Understand the concepts of quantum mechanics, architecural acoustics and analyze practical problems.

Programme: B. Tech. Mechanical

Unit I **Modern Physics and Nuclear Physics** **8 Hours**

Motion of a charged particle in electric and magnetic fields, Electrostatic and Magnetostatic focussing, Wavelength and resolution, Specimen limitation, Depth of field and focus, Electron microscope, Positive rays, Separation of isotopes by Bainbridge mass spectrograph. Nuclear fission, Liquid drop model of nucleus, Nuclear fission in natural uranium, Fission energy, Critical mass and size, Reproduction factor, Chain reaction and four factor formula, Nuclear fuel and power reactor, Nuclear fusion and thermonuclear reactions, Merits and demerits of nuclear energy, Particle accelerators, Cyclotron, Betatron.

Unit II **08 Hours**

Solid State Physics and Superconductivity

Band theory of solids, Free electron theory, Fermi-Dirac probability function and position of Fermi level in intrinsic semi-conductors (with derivation) and in extrinsic semi-conductors, Band structure of p-n junction diode under forward and reverse biasing, Conductivity in conductor and semi-conductor, Hall effect and Hall coefficient, Photovoltaic effect, Solar cell and its characteristics. Introduction, Properties of a super conductor, Meissner's effect, Critical field, Types of superconductors, BCS theory, High temperature superconductors, Application of superconductors.

Unit III **08 Hours**

Thermodynamics And Nanoscience

Zeroth law of thermodynamics, first law of thermodynamics, determination of j by Joule's method, Applications of first law, heat engines, Carnot's cycle and Carnot's engine, second law of thermodynamics, entropy, change in entropy in reversible and irreversible processes, third law of thermodynamics. Introductions of nanoparticals, properties of nanoparticals (Optical, electrical, Magnetic, structural, mechanical), synthesis of nanoparticals(Physical and chemical), synthesis of colloids, growth of nanoparticals, synthesis of nanoparticals by colloidal rout, applications.

Unit IV **08 Hours**

Optics – I, Interference, Diffraction

Interference of waves, Visibility of fringes, interference due to thin film of uniform and non-uniform thickness, Newton's rings, Engineering applications of interference (optical flatness, interference filter, non-reflecting coatings, multi-layer ARC. Classes of diffraction, Diffraction at a single slit (Geometrical method), Conditions for maximum and minimum, Diffraction at a circular aperture (Result only), Plane diffraction grating, Conditions for principal maxima and minima, Rayleigh's criterion for resolution, Resolving power of grating and telescope.

Unit V **08 Hours**

Optics – Ii, Polarization , Lasers

Introduction, Double refraction and Huygens's theory, Positive and negative crystals, Nicol prism, Dichroism, Polaroids, Elliptical and circular polarisation, Quarter and half wave plates, Production of polarised light, Analysis of polarised light, half shade polarimeter, LCD. Spontaneous and stimulated emission, Population inversion, Ruby laser, Helium-Neon laser, Semiconductor laser, Properties of lasers, Applications of lasers (Engineering/ industry, medicine, communication, Computers), Holography.

Unit VI **08 Hours**

Architectural Acoustics , Quantum Mechanics

Elementary acoustics, Limits of audibility, Reverberation and reverberation time, Sabine's formula, Intensity level, Sound intensity level, Sound absorption, Sound absorption coefficient, different types of noise and their remedies, Sound absorption materials, basic requirement for acoustically good hall, factors affecting the architectural acoustics and their remedies. Electron diffraction, Davisson and Germer's experiment, Wave nature of matter, De-Broglie waves, Wavelength of matter waves, Physical significance of wave function, Schrodinger's time dependant and time independent wave equation, Application of Schrodinger's time independent wave equation to the problems of Particle in a rigid box and non rigid box.

Term Work:

Experiments: Any ten experiments from the following:

1. Determination of band gap of semi-conductor.
2. Solar cell characteristics.
3. e/m by Thomson's method.
4. Uses of CRO for measurement of phase difference and Lissajos figures.
5. Hall effect and Hall coefficient.
6. Conductivity by four probe method.
7. Diode characteristics (Zener diode, Photo diode, LED, Ge/Si diode).
8. Plank's constant by photodiode.
9. Wavelength by diffraction grating.
10. Newton's rings.
11. Ultrasonic interferometer.
12. Sound intensity level measurement.
13. Wavelength of laser by diffraction.
14. Determination of refractive index for O-ray and E-ray.
15. Brewester's law.

List of Assignments

Numerical and/or theory questions on following topics:

1. Physics and Nuclear Physics
2. Solid State Physics and Superconductivity
3. Thermodynamics And Nanoscience
4. Optics – I, Interference, Diffraction
5. Optics – Ii, Polarization , Lasers
6. Architectural Acoustics , Quantum Mechanics

Textbooks:

1. Physics for Engineers – Srinivasan M.R.
2. A text Book of Engineering Physics- M.N. Avadhanulu, P.G. Kshirsagar
3. Engineering Physics- K. Rajagopal
4. Electronics Principles – A.P.Molvino
5. Fundamentals of Optics – Jenkins and White
6. A Textbook of Sound – Wood
7. Engineering Physics – Sen, Gaur and Gupta

Syllabus for Unit Tests:

Unit Test-I Unit-I,II, III

Unit Test-II Unit-IV, V, VI

Fundamentals of Electrical Engineering
(Course No:C105)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
	Unit Test 20 Marks	
Practical: 2Hr/Week	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 25 Marks	Practical : 01
	Total 125 Marks	04

Course Prerequisites:-

1. Students should have the basic knowledge of Higher secondary Physics
2. Students should have the basic knowledge of Higher secondary mathematics

Course Objectives:

1. To introduce the basic concepts of electrical engineering and its applications.
2. To acquire skills of basic laws, network theorms of electrical engineering and electrostatics.
3. To get acquainted with Transformer, AC Circuits, Electrical Wiring & Illumination system.

Course Outcomes: Students should be able to:

1. Understand the fundamentals of electrical engineering and their application.
2. Understand basic laws , various Network Theorems and evaluate electrical network problems.
3. Understand the fundamentals of Electrostatics , their circuits and apply it to electrical devices.
4. Understand the concept of electromagnetism and apply it to single phase Transformer.

5. Understand different types of AC Circuits, their working and apply to electrical network problems .
6. Understand the different types of Wiring Systems and lamps.

Unit I **06 Hours**

Basic concepts

Concept of EMF, Potential Difference, current, resistance, Ohms law, resistance temperature coefficient, SI units of Work, power, energy. Conversion of energy from one form to another in electrical, mechanical and thermal systems.

Unit II **06 Hours**

Network Theorems:

Voltage source and current sources, ideal and practical, Kirchhoff's laws and applications to network solutions using mesh analysis, Simplifications of networks using series- parallel, Star/Delta transformation. Superposition theorem, The venin's theorem, Max Power Transfer theorem.

Unit III **06 Hours**

Electrostatics

Electrostatic field, electric field intensity, electric field strength, absolute permittivity, relative permittivity, capacitor composite, dielectric capacitors, capacitors in series& parallel, energy stored in capacitors, charging and discharging of capacitors, Batteries-Types, Construction& working.

Unit IV **06 Hours**

Magnetic Circuit & Transformer

Magnetic effect of electric current, cross and dot convention, right hand thumb rule, concept of flux, flux linkages, Flux Density, Magnetic field, magnetic field strength, magnetic field intensity, absolute permeability, relative permeability, B-H curve, hysteresis loop, series-parallel magnetic circuit, composite magnetic circuit, Comparison of electrical and magnetic circuit Faraday's law of electromagnetic induction, statically and dynamically induced emf, self inductance, mutual inductance, coefficient of coupling, Single phase transformer construction, principle of operation, EMF equation, voltage ratio, current ratio, kVA rating, losses in transformer, Determination of Efficiency & Regulation by direct load test.

Unit V **06 Hours**

AC Fundamentals & AC Circuits

AC waveform definitions , form factor, peak factor, study of R-L, R-C, RLC series circuit, R-L-C parallel circuit, phasor representation in polar & rectangular form, concept of impedance, admittance, active, reactive, apparent and complex power, power factor, 3-ph AC Circuits.

Unit VI **06 Hours**

Electrical Wiring and Illumination system

Basic layout of distribution system, Types of Wiring System & Wiring Accessories, Necessity of earthing, Types of earthing, Different types of lamps (Incandescent, Fluorescent, Sodium Vapour, Mercury Vapour, Metal Halide, CFL, LED), Study of Electricity bill.

Assignments:

The students will be given total twelve assignments (Two assignments on each Unit respectively).

1. DC Circuit Analysis
2. Network Theorems
3. AC Circuits and Switch Gear
4. Electrical Measurement
5. Single Phase Transformer
6. Three Phase Transformer
7. 3 Phase induction motor
8. Single phase motor
9. DC Generator
10. DC Motor
11. Power transmission and distribution
12. Safety Measures

Term Work:

The term work shall consist of record of minimum eight exercises / experiments

1. Determination of resistance temperature coefficient .
2. Verification of Superposition Theorem .
3. Verification of The venin’s Theorem .

4. Verification of Kirchhoff's Laws .
5. Verification of Maximum power transfer Theorem .
6. Time response of RC circuit.
7. Study of R-L-C series circuits for XL> XC , XL< XC & XL= XC .
8. Verification of current relations in three phase balanced star and delta connected loads.
9. Direct loading test on Single phase transformer .
10. a)Voltage and current ratios
11. b) Efficiency and regulations
12. Study of a Residential (L.T.) Bill.

Textbooks

1. B. L. Theraja- "A Textbook of Electrical Technology" Volume- I, S.Chand and Company Ltd., New Delhi.
2. V. K. Mehta, - "Basic Electrical Engineering", S. Chand and Company Ltd., New Delhi.
3. I.J. Nagrath and Kothari – "Theory and problems of Basic Electrical Engineering", Prentice Hall.
4. Edward Hughes – "Electrical Technology"- Seventh Edition, Pearson Education Publication .
5. H. Cotton – "Elements of Electrical Technology", C.B.S. Publications .
6. John Omalley Shawn – "Basic circuits analysis" Mc Graw Hill Publications.
7. Vincent Del Toro – "Principles of Electrical Engineering", PHI Publications.

Syllabus for Unit Test:

Unit Test-I Unit-I,II ,III

Unit Test-II Unit-IV,V,VI

Professional Skills Development-I
(Course No:C106)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 2 Hours/ Week	End Semester Examination 50 Marks	Theory: 02
Practical:- -- Hours/ Week	Unit Test -- Marks	
	Assignments -- Marks	
	Internal -- Marks	
	Evaluation	
	Term Work -- Marks	
	Total 50 Marks	02

Course Pre-requisites:

1. Basic communication in tenses (past, present, future).
2. Awareness of common words (adjectives used in daily verbal communication).
3. Basic idea of sentence formation and thereby paragraph building and writing.
4. Communication according to daily and varied contextual scenarios.
5. Basic communication model/channel (sender, receiver and feedback), Active and passive listening skills.
6. Basic social etiquettes and knowledge of group work and communication that will enhance their professional
7. growth.

Course Objectives:

The Professional Skills Development course aims to augment students overall communication and interpersonal skills by engaging them in group activities and thus aid in helping them to emerge as professionals. The English language topics for this semester focus on the development of basic fluency in English, usage of words and also introduce them to the concept and importance of interpersonal skills so as to effectively present their personalities.

Programme: B. Tech. Mechanical

Course Outcomes: After completion of course, students will able to:

1. Speak fluently in English without errors in tenses and hence present themselves as effective English communicators. They will be able to learn the 12 tenses and use them appropriately.
2. Differentiate between active and passive vocabulary and be able to use the 60 words discussed in class for their daily conversation and 40 words also given as assignments.
3. The ability to process their ideas and thoughts (verbal communication) into written communication in an effective, coherent and logical manner within a stipulated time and specific word limit of 100-150 words for paragraph writing.
4. Present them in a certain manner by using the 50-55 phrases discussed in class appropriately for group discussions,
5. personal interviews during the campus recruitment process/competitive exams.
6. Enhance their communication skills by acquainting with the 2 important aspects of communication and helping them to overcome the 10 most common barriers of communication. Learn the 7 different types of listening skills; differentiate effective listening skills and understand the importance of it through 5 activities held in class and
7. implement them in professional life.
8. Understand the importance of team work, team motivation and effective team communication for further
9. implementation in the corporate life. They should also be able to identify concretely between team and group dynamics.

Unit I **04 Hours**

Essential Grammar – I:

- Application of Tenses: Usage of past, present and future according to context.
- Activities/games for tenses

Unit II **04 Hours**

Vocabulary – I

- Vocabulary building
  - Adjectives- physical attributes, Intellectual qualities,
  - Words describing vacations.
- Application of the vocabularies.
- Activities: Story telling/ Poem building (Using those words)

Unit III **04 Hours**

Written Communication - I

- Paragraph writing:
  - Structure of paragraphs,
  - Mnemonics to build Paragraph,
  - Coherence and Unity of paragraphs.

Unit IV **04 Hours**

Situational Conversation – I

- Application of grammar according to context.
- Situation based conversation
- Activities: Conversation based on context(personal and professional)

Unit V **06 Hours**

Fundamental Communication Skills - I

- Importance of effective communication.
- Types of communication.
- Verbal, Non-verbal communication.
- Barriers of communication.
- Activities: Extempore
- Listening Skills
- Importance of listening skills.
- Types of listening skills.
- Difference between hearing and listening.
- Activities: Word ball Game. Chinese Whisper

Unit VI **06 Hours**

Interpersonal Skills – I :

- Introduction to Interpersonal skills.
- Group Dynamics.
- Introduction to Team work.
- Difference between a group and a team.
- Importance of group/team in an organization.
- Activities on team and group dynamics.

Textbooks:

1. APAART: Speak Well 1 (English language and communication)
2. APAART: Speak Well 2 (Soft Skills)

Reference Books:

1. English vocabulary in use – Alan Mc'carthy and O'dell
2. Business Communication – Dr. Saroj Hiremath

Workshop Technology
(Course No:C107)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- -- Hours/ Week	End Semester Examination -- Marks	
	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation -- Marks	
Practical:- 2 Hours/ Week	Term Work 50 Marks	Practical : 01
	Total 50 Marks	01

Course Pre-requisites:

1. Basic knowledge of materials and hand tools used in day to day life.
2. Basic knowledge of the Safety precautions.

Course Objectives:

1. To acquire skills for preparation of different carpentry and fitting models.
2. To acquaint the skills for preparation of sheet metal ,forging and joining processes.
3. To acquire skills for plastic moulding and plumbing operations.

Course Outcomes: Students should be able to ,

1. Understand various operations of carpentry and fitting and apply it to create the jobs as per the given specification.
2. Understand various sheet metal operations and create the shape.
3. Understand the different joining process and apply it to specific applications.
4. Understand the different forging processes and create the job using hand forging.
5. Understand the different moulding methods and create the job by plastic moulding.
6. Understand the bending and threading operations to create pipe joints.

Course Contents

Carpentry- Introduction to wood working, kinds of woods, hand tools & machines, Types joints, wood turning. Pattern making, types of patterns, contraction, draft & machining allowances

Fitting- Types of Fits, concepts of interchangeability, datum selection, location layout, marking, cutting, shearing, chipping, sizing of metals, drilling and tapping.

Sheet Metal Practice - Introduction to primary technology processes involving bending punching and drawing various sheet metal joints, development of joints.

Joining- Includes making temporary and permanent joints between similar and dissimilar material by processes of chemical bonding, mechanical fasteners and fusion technologies.

Forging -Hot working, cold working processes, forging materials, hand tools & appliances, Hand forging, Power Forging.

Moulding -Principles of moulding, methods, core & core boxes, preparation of foundry sand, casting, Plastic moulding.

Plumbing- (Demonstration Common for Electrical & Non electrical Group) Types of pipe joints, threading dies, Pipe fittings.

Term Work

Term work shall consist of any three jobs, demonstrations on rest of the trades and journal consisting of six assignments one on each of the above topics.

Engineering Mathematics-II
(Course No.C108)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Tutorials: 01Hr/Week	Unit Test 20 Marks	Tutorial : 01
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral -- Marks	
	Total 100 Marks	04

Course Pre-requisites:

1. Student must have basic knowledge of calculus.

Course Objectives: To study:

1. Methods to evaluate first order, first degree differential equations and its applications in engineering problems.
2. Distinct co-ordinate systems, fourier series and curve tracing.
3. Various techniques for integral calculus and its applications in engineering problems.

Course Outcomes: Students should be able to,

1. Understand and evaluate first order and first degree differential equations.
2. Understand the formulation of physical systems as first order, first degree differential equation and evaluate particular solution of it.
3. Understand the Fourier series and apply it to represent periodic function.
4. Understand methods of integral calculus and curve tracing.
5. Understand co-ordinate system and apply it to solve locus problems.
6. Understand concept of multiple integral and apply it to evaluate area, volume, centre of gravity and moment of inertia.

Unit I **08 Hours**

Differential Equations (DE)

Definition, Order and Degree of DE, Formation of DE. Solutions of Variable Separable DE, Exact DE, Linear DE and reducible to these types.

Unit II **08 Hours**

Applications Of Differential Equations

Applications of DE to Orthogonal Trajectories, Newton's Law of Cooling, Kirchhoff's Law of Electrical Circuits, Motion under Gravity, Rectilinear Motion, Simple Harmonic Motion, One–Dimensional Conduction of Heat, Chemical engineering problems.

Unit III **08 Hours**

Fourier Series And Integral Calculus

Definition, Dirichlet's conditions, Fourier Series and Half Range Fourier Series, Harmonic Analysis. Reduction formulae, Beta and Gamma functions.

Unit IV **08 Hours**

Integral Calculus And Curve Tracing

Differentiation Under the Integral Sign, Error functions. Tracing of Curves, Cartesian, Pola and Parametric Curves. Rectification of Curves.

Unit V **08 Hours**

Solid Geometry

Cartesian, Spherical Polar and Cylindrical Coordinate Systems. Sphere, Cone and Cylinder.

Unit VI **08 Hours**

Multiple Integrals And Their Applications

Double and Triple integrations, Applications to Area, Volume, Mean and Root Mean Square Values.

Assignments:

1. Differential Equations (DE)
2. Applications Of Differential Equations
3. Fourier Series And Integral Calculus

4. Integral Calculus And Curve Tracing
5. Solid Geometry
6. Multiple Integrals And Their Applications

Reference Books

1. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley Eastern Ltd, 8th edition(1999).
2. Higher Engineering Mathematics by B.V. Ramana, Tata McGraw-Hill (2008)
3. Applied Mathematics (Volumes I and II) by P. N. Wartikar& J. N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune, 7th edition (1988).
4. Higher Engineering Mathematics by B. S. Grewal, Khanna Publication, Delhi, 42th edition (2012).
5. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil, Thomson Learning, 6th edition (2007).
6. Advanced Engineering Mathematics, 2e, by M. D. Greenberg, Pearson Education, 2nd edition (2002).

Syllabus for Unit Tests:

Unit Test-I Unit-I,II ,III

Unit Test-II Unit-IV,V,VI

Fundamentals of Mechanical Engineering
(Course No.C109)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical:- 02 Hours/ Week	Unit Test 20 Marks	Practical : 01
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 25 Marks	
	Total 125 Marks	4

Course Pre-requisites:

1. Students should have the basic knowledge of Higher secondary of Physics
2. Students should have the basic knowledge of Higher secondary of Chemistry

Course Objectives:

1. To introduce the basic concepts of engineering thermodynamics and its applications
2. To introduce energy sources , power producing and absorbing devices.
3. To get acquainted with mechanisms, machine components and manufacturing processes

Course Outcomes: Student should be able to:

1. Understand the fundamentals of engineering thermodynamics and apply them to steady flow and non flow process.
2. Understand the basics of power producing and absorbing devices.
3. Understand fundamentals of energy sources, modes of heat transfer and apply laws of heat transfer to practical problems.
4. Understand the properties of fluids, engineering materials and evaluate the properties of fluids.
5. Understand the basics of different mechanisms and power transmission devices.
6. Understand the fundamentals of machine tools and manufacturing processes.

Unit I **06 Hours**

Thermodynamics

Heat, work and Internal Energy, Thermodynamic State, Process, Cycle, Thermodynamic System, First Law of Thermodynamics, Application of First Law to steady Flow and Non Flow processes, Limitations of First Law, PMM of first kind (Numerical Treatment), Second Law of Thermodynamics – Statements, Carnot Engine and Carnot Refrigerator, PMM of Second Kind (Elementary treatment only)

Unit II **06 Hours**

Introduction to I.C. Engines, turbines, refrigeration, compressors & pumps

Two stroke, Four Stroke Cycles, Construction and Working of C.I. and S.I. Engines, Hydraulic turbines, Steam turbines, gas turbines. (Theoretical study using schematic diagrams) Vapor compression and vapor absorption system, house hold refrigerator, window air conditioner. Reciprocating and rotary compressor, Reciprocating and centrifugal pump.(Theoretical study using schematic diagrams)

Unit III **06 Hours**

Energy Sources & Heat transfer

Renewable and nonrenewable, solar flat plate collector, Wind, Geothermal, Wave, Tidal, Hydro power, Bio-gas, Bio-Diesel, Nuclear power. (Theoretical study using schematic diagrams) Statement and explanation of Fourier's law of heat conduction, Newton's law of cooling, Stefan Boltzmann's law. Conducting and insulating materials and their properties, types of heat exchangers and their applications.

Unit IV **06 Hours**

Properties of fluids & Properties of Materials and their Applications:

Introduction, Units of measurements, mass density, specific weight, specific volume and relative density, viscosity, pressure, compressibility and elasticity, gas laws, vapor pressure, surface tension and capillarity, Regimes in fluid mechanics. Metals – Ferrous and Non-Ferrous, Nonmetallic materials, smart materials, Material selection criteria.

Unit V **06 Hours**

Mechanical devices & Mechanisms

Types of Belts and belt drives, Chain drive, Types of gears, Types of Couplings, types of friction clutch, Power transmission shafts, axles, keys, bush and ball bearings. Slider crank mechanism, Four bar chain mechanism, inversions of single slider crank chain mechanism, Geneva mechanism, Ratchet and Paul mechanism.

Unit VI **06 Hours**

Machine Tools, Introduction to manufacturing processes and Their Applications:

Lathe Machine – Centre Lathe, Drilling Machine – Study of Pillar drilling machine, Introduction to NC and CNC machines, Grinding machine, Power saw, Milling Machine. Casting, Sheet metal forming, Sheet metal cutting, Forging, Metal joining processes.

Assignment

1. Assignment on Thermodynamics
2. Assignment on Two stroke, Four Stroke Cycles, Construction and Working of C.I. and S.I. Engines
3. Assignment on Energy Sources & Heat transfer
4. Assignment on Properties of fluids & Properties of Materials
5. Assignment on Mechanical devices
6. Assignment on Machine Tools

Textbooks:

1. Thermodynamics an Engineering Approach, Yunus A. Cengel and Michael A. Boles, McGraw-Hill, Inc, 2005, 6th edition.
2. Applied Thermodynamics for Engineering Technologists, T. D. Eastop and A. McConkey, 5th Edition, Prentice Hall.
3. I.C. Engines Fundamentals, J. B. Heywood, McGraw Hill, 3rd Edition, MacMillian.
4. Internal Combustion Engine, V. Ganeshan, Tata McGraw-Hill, 3rd edition.
5. Strength of Materials, H. Ryder, Macmillians, London, 1969, 3rd edition.
6. Mechanics of Materials, Johston and Beer TMH, 5th edition.

7. Mechanisms and Machine Theory, Ambekar A.G., Prentice-Hall of India, 2007.
8. Theory of Machines, S.S. Rattan, Tata McGraw- Hill, 2nd edition.
9. A Textbook of production engineering" P.C. Sharma, S. Chand Publication, New Delhi, 2nd edition.
10. Fluid Mechanics & Fluid Power" D.S. Kumar, Katson Publishing Engineering House, Ludhiana. 8th edition

Syllabus for Unit Tests:

Unit Test-I Unit-I,II, III

Unit Test-II Unit- IV, V, VI

Engineering Mechanics
(Course No. C110)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04 Hours/ Week	End Semester Examination 60 Marks	Theaory: 04
Practical: 02 Hr/Week	Unit Test 20 Marks	Practical: 01
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 25 Marks	
	Total 125Marks	05

Course Pre-requisites:

1. Basic Physics
2. Basic Mathematics

Course Objectives:

1. To analyze the problems related to mechanical Engineering by using the fundamental laws and principles of Engineering mechanics and proceed to design of machine elements.
2. To develop the capacity to predict the effects of forces and motions for different machine components.

Course Outcomes: The student should be able to

1. Understand the equilibrium conditions for different types forces and evaluate the resultant forces of a system with the help of free-body diagram.
2. Analyze the truss for different loading conditions and evaluate frictional forces for different types of machine components.
3. Understand the concept of centroid and moment of inertia and apply it for different cross section.
4. Understand the concept of rectilinear motion and apply the law of motion to solve problem related to rectilinear motion.
5. Understand the concept of curvilinear motion and apply the law of motion to solve problem related to curvilinear motion.
6. Understand the concept of different principles of kinetics apply it to solve problems related kinetics.

Unit I **06 Hours**

Resultant and Equilibrium

Types and Resolution of forces, Moment and Couple, Free Body Diagram, Types of Supports, Classification and Resultant of a force system in a Plane - Analytical and Graphical approach. Equilibrant, Conditions of Equilibrium, Equilibrium of a force system in a Plane, Force and Couple system about a point.

Unit II **06 Hours**

Truss and Friction

Coefficient of Static Friction, Impending motion of Blocks, Ladders and Belts. Analysis of Perfect Trusses - Method of Joint, Method of Section and Graphical Method.

Unit III **06 Hours**

Centroid and Moment of Inertia

Centroid of line and plane areas, Moment of Inertia of plane areas, parallel and perpendicular axis theorem, radius of gyration, least moment of inertia.

Unit IV **06 Hours**

Kinematics of Rectilinear motion of a Particle

Equations of motion, Constant and variable acceleration, Motion Curves, Relative motion, Dependent motion.

Unit V **06 Hours**

Kinematics of Curvilinear motion of a Particle

Motion of a Projectile, Cartesian components, Normal and Tangential components of a curvilinear motion.

Unit VI **06 Hours**

Kinetics of a Particle

D'alembert's Principle, Work-Energy Principle and Impulse-Momentum Principle, Coefficient of Restitution, Direct Central Impact.

List of Assignments

Numerical and/or theory questions on following topics:

1. Resultant and equilibrium of forces
2. Centroid & Moment of Inertia
3. Friction
4. Trusses, frames and cables
5. Kinematics of particles
6. Kinematics of rigid body
7. Kinetics of particle
8. Structural materials and foundations

Term Work:

A) The term-work shall consist of minimum five experiments from list below.

1. Determination of reactions of Simple and Compound beam.
2. Study of equilibrium of concurrent force system in a plane.
3. Determination of coefficient of friction for Flat Belt.
4. Determination of coefficient of friction for Rope.
5. Study of Curvilinear motion.
6. Determination of Coefficient of Restitution.

B) The term-work shall also consist of minimum five graphical solutions of the problems on topics

Textbooks:

1. "Engineering Mechanics (Statics and Dynamics)", Hibbeler R.C., McMillan Publication.
2. Vector Mechanics for Engineers-Vol.-I and Vol.-II (Statics and Dynamics)", Beer F.P. and Johnston E.R., Tata McGraw Hill Publication.
3. "Engineering Mechanics", Bhavikatti S.S. and Rajashekarappa K.G., New Age International (P) Ltd.
4. "Engineering Mechanics (Statics and Dynamics)", Shames I.H., Prentice Hall of India (P) Ltd.
5. "Engineering Mechanics (Statics and Dynamics)", Singer F.L., Harper and Row Publication.

6. “Engineering Mechanics (Statics and Dynamics)”, Meriam J.L. and Kraige L.G., John Wiley and Sons Publication.
7. “Engineering Mechanics (Statics and Dynamics)”, Timoshenko S.P. and Young D.H., McGraw Hill Publication.
8. “Engineering Mechanics (Statics and Dynamics)”,Tayal A.K., Umesh Publication.
9. “Engineering Mechanics-I and II (Statics and Dynamics)”, Mokashi V.S., Tata McGraw Hill Publication.

Unit Tests-

Unit Test-I Unit-I,II ,III

Unit Test-II Unit-IV,V,VI

Engineering Chemistry
(Course No :C111)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 4 Hours/ Week	End Semester Examination 60Marks	Theaory:04
Practical - 2 Hours/ Week	Unit Test 20 Marks	Practical:01
	Assignments 10Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 25 Marks	
	Total 125Marks	05

Course Pre-requisites:

1. Types of titrations, Types of crystals, Hardness and its types.
2. Classification of fuels, Definition of calorific value, Optical Activity and chirality.
3. Definition of corrosion, Electrolysis, Primary and secondary cells.

Course Objectives:

1. To develop the interest among the students regarding chemistry and their applications in engineering.
2. To develop confidence among students about chemistry, how the knowledge of chemistry is applied in technological field.
3. To understand the concepts of chemistry to lay the groundwork for subsequent studies in the field such as Mechanical Engineering.

Course Outcomes: Student will be able to,

1. Understand and apply suitable water treatment techniques.
2. Understand and apply the concept of X-ray diffraction technique to study crystal structure.
3. Understand and apply the knowledge of determining the quality of fuel and quantify the oxygen required for combustion of fuel.
4. Understand different types of corrosion and suggest control measures in industries.
5. Understand and apply the concept of electrode potential and Nernst theory and relates it to electrochemical cells.
6. Understand and apply the principles of stereochemistry and study the skills for stereochemical assignment.

Programme: B. Tech. Mechanical

Unit I **06 Hours**

Water

Introduction, Hardness of water, Effect of hard water on boilers and heat exchangers: a) boiler corrosion b) caustic embrittlement c) scales and sludges d) priming and foaming Water softening methods for industrial purposes :a) Zeolite process b) Phosphate conditioning Numerical based on the zeolite process

Unit II **06 Hours**

Material Chemistry

Crystallography: Unit cell, Laws of crystallography, Weiss indices and Miller indices, Crystal defects (point and line defects), X-ray diffraction – Bragg's Law and numerical. Cement: Introduction of cement, Hydraulic/ Non-hydraulic cementing materials, classification of cement, chemistry of portland cement, chemical composition and compound constituents of portland cement, properties of cement and its applications.

Unit III **06 Hours**

Fuels

Introduction, classification of fuels, calorific value of fuels, NCV and GCV, Determination of calorific values using Bomb calorimeter and Boys' gas calorimeter. Theoretical calculation of calorific value of a fuel, Analysis of coal a) Proximate b) Ultimate analysis of coal, Numericals based on NCV, GCV.

Unit IV **06 Hours**

Corrosion And Its Prevention

Corrosion: - Definition, atmospheric corrosion-mechanism, Wet corrosion-mechanism, Electrochemical and galvanic series, Factors affecting corrosion-nature of metal, nature of environment. Methods of prevention of corrosion- Cathodic and Anodic protection, Metallic coatings, Electroplating, Hot dipping.

Unit V **06 Hours**

Electrochemistry

Introduction, Arrhenius Ionic theory, Kohlrausch's law of independent migration of ions Laws of electrolysis: Faradays Laws, Ostwald's dilution law, Acids and Bases, concept of pH and pOH, Buffer solutions, Solubility Product, Redox Reactions. Electrode Potential, electrochemical cell, concentration cell, reference Electrodes, Overvoltage, Conductometric Titrations, Fuel cells, Lead Acid Storage Cell and numericals based on the above articles.

Unit VI **06 Hours**

Stereochemistry

Introduction, chirality, optical activity, Enantiomers, Diastereomers, projection formula of tetrahedral carbon- Newman projection, Wedge projection, Fischer projection, Geometrical isomerism :- cis and trans isomerism, E and Z isomers Optical isomerism :- Mesoform, the number of optical isomers for chiral molecules, Conformations :- conformations of ethane, conformations of n-butane

Term Work:

Experiments : Any Ten experiments from the following:

1. Estimation of hardness of water by EDTA method.
2. Estimation of chlorine by Mohr's method.
3. Determination of percentage of Ca in given cement sample
4. Determination of coefficient of viscosity by Ostwald's viscometer
5. Study of Bomb calorimeter for determination of calorific value.
6. Determination of calorific value of gas fuel by using Boy's gas calorimeter.
7. Determination of dissolved oxygen in a water sample.
8. To determine the Molecular Weight of polymer
9. Estimation of Copper from brass sample solution by Iodometrically
10. Estimation of percentage of Iron in Plain Carbon Steel by Volumetric Method
11. To standardize NaOH solution and hence find out the strength of given hydrochloric Acid solution
12. To determine Surface Tension of given liquid by Stalagmometer
13. Study of corrosion of metals in medium of different pH.
14. To set up Daniel cell
15. To determine pH of soil
16. To determine Acidity of soil

Assignments:

1. Water softening methods
2. Material Chemistry
3. Fuels
4. Corrosion And Its Prevention
5. Electrochemistry
6. Stereochemistry

Reference Books:

1. Engineering Chemistry by Jain and Jain, Dhanpat Rai Company (P) Ltd, New Delhi
2. Chemistry of Engineering Materials, Agarwal C.V, Rata Publication Varanasi, 6th edition (1979)
3. Chemistry in Engineering and Technology, Volume W, Tata McGraw Hill Publishing Company Ltd, New Delhi (1988)
4. Applied Chemistry, O. P. Vidyankar, J. Publications, Madurai, (1955)
5. Engineering Chemistry, S. N. Chand and Co., Jalandhar, 31st Edition (1990)
7. Engineering Chemistry by Dara S. S. S Chand Publications
8. Fundamentals of Electrochemistry, V. S. Bagotsky (Ed) Wiley NY (2006)

Syllabus for Unit Test:

Unit Test-I Unit-I,II ,III

Unit Test-II Unit-IV,V,VI

Mechanical Engineering Drawing
(Course No. C112)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 2 Hours/ Week	End Semester Examination 60Marks	Theory:02
Practical - 4 Hours/ Week	Unit Test 20 Marks	Practical:02
	Assignments 10Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 25 Marks	
	Total 125Marks	4

Course Pre-requisites:

Students should have the basic knowledge of

1. Fundamentals of Mathematics
2. Fundamentals of Engineering Graphics

Course Objectives:

1. Effectively communicate drawing using software like AutoCAD
2. Use of AutoCAD commands for drawing 2D and 3D.
3. Use free hand sketching for machine components.

Course Outcomes: Student Should be able to,

1. Understand the concepts of freehand sketches and apply to draw free hand sketches of machine components.
2. Understand the concepts of dimensioning practices and apply to represent the dimensions for machine components
3. Understand commands of AutoCAD and apply appropriate commands for drawing.
4. Remember the concepts of orthographic projection and apply to draw it using AutoCAD command for drawing Orthographic projections.
5. Remember the concepts of isometric projection and apply to draw it using AutoCAD command for drawing 3D model.
6. Understand the concept of lateral development of surfaces and apply it to for development of surfaces of solids by using AutoCAD.

Unit I **06 Hours**

Freehand Sketching

Free hand sketching -- FV and TV of standard machine parts – Hexagonal headed nut and bolt, foundation bolts, shafts, keys, couplings, springs, screw thread forms, welded joints, riveted joints.

Unit II **06 Hours**

Dimensioning Practice

Terms and Notations, Leader, Extension Lines, Terminations and Origin indication, Functional dimension, Non-functional dimension, Datum dimension, Redundant and auxiliary dimension, Chain dimensioning, Running dimensioning, Co-ordinate dimensioning, Symmetrical or equidistant dimensioning, Methods of dimensioning Common features: Diameters, Radii, Hole sizes, chamfers, Screw threads, Chords, Arcs, Angles, Spheres, Cylinders, Squares. Conventional Representation of Machine Components As per SP-46 (1988)

Unit III **06 Hours**

Introduction to Computer Aided Drafting

Working Interface of AutoCAD, Drawing Limits, Creating 2-D Drawing in AutoCAD, AutoCAD commands, Editing commands in AutoCAD, Dimensioning in AutoCAD, Creating text in Auto CAD, Changing object properties Scale, Object Snap Mode, Display control in AutoCAD, Layer

Unit IV **06 Hours**

Orthographic Projections [By Using AutoCAD]

Reference planes, types of orthographic projections – First angle projections, Third angle projections, methods of obtaining orthographic views by First angle method, Sectional orthographic projections – full section, half section, offset section.

Unit V **06 Hours**

Isometric Projections [By Using AutoCAD]

Isometric view, Isometric scale to draw Isometric projection, Non-Isometric lines, and construction of Isometric view from given orthographic views and to construct Isometric view of a Pyramid, Cone, and Sphere.

Unit VI **06 Hours**

Development of Lateral Surfaces (DLS) of Solids. [By Using AutoCAD]

Applications of DLS, method of development, development of lateral surface of above solids, development of lateral surface of cut solids.

Term Work:

1. Sheet (Half Imperial 4sheets)
2. Dimensioning Practices no. of sheets -2
3. Free Hand sketch no. of sheets-2
4. Four AutoCAD Printout
5. Introduction to AutoCAD commands
6. Orthographic by using AutoCAD
7. Isometric Projections by using AutoCAD
8. Development of Lateral surface by using AutoCAD

Assignments:

Minimum Five Questions based on each unit in A2 size Sheets.

Text books

1. N.D. Bhatt, Elementary Engineering Drawing, Chartor Publishing house, Anand, India.
2. D. N. Johle, Engineering Drawing, Tata Mcgraw-hill Publishing Co. Ltd.
3. P.S. Gill, Engineering drawing S.K.Kataria and sons. Delhi-110006.
4. N.D. Bhatt, Machine Drawing, Chartor Publishing house, Anand, India.
5. Warren J. Luzzader, Fundamentals of Engineering Drawing, Prentice Hall of India, New Delhi.
6. Fredderock E. Giesecke, Alva Mitchell & others, Principles of Engineering Graphics,
7. Maxwell McMillan Publishing.

Syllabus for Unit Test:

Unit Test-I Unit-I,II ,III

Unit Test-II Unit IV, Unit-V, VI

Professional Skills Development-II
(Course No: C114)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 2 Hours/ Week	End Semester Examination 50 Marks	Theory: 02
Practical:- -- Hours/ Week	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation -- Marks	
	Term Work -- Marks	
	Total 50 Marks	02

Course Pre-requisites:

1. Basic knowledge of the parts of speech in English.
2. Vocabulary covered in the previous semester along with basic knowledge of verbs & adverbs.
3. Basic awareness of the need of speaking skills within social circle.
4. The elements of team dynamics done during the previous semester with proper application.
5. Basic awareness of the concepts of feedback, criticism.
6. The various common conflicts that may arise at varied situations.

Course Objectives:

The Professional Skills Development course aims to augment students overall communication and interpersonal skills by engaging them in group activities and thus aid in helping them to emerge as professionals. The soft skills topics for this semester are intended to develop student's expertise on public speaking skills and to deal positively with criticism and so as to effectively present their personalities.

Course Outcomes: After completion of course, students will able to:

1. Speak fluently in English without errors in the sentence construction and hence present themselves as effective English communicators. They will be able to learn 20-25 common errors made in parts of speech and also use 10 modal verbs efficiently during professional communication.

2. Differentiate between vocabulary used as adjectives, verbs and adverbs and be able to use the 60-70 words for their daily conversation.
3. Overcome the fear of speaking and will be aware of the 3 types of public speaking necessary according to the contemporary requirements. They would be able to deliver a public speech according to the need of the audience and also be aware of positive body language to be manifested during a speech.
4. Deal with the deeper parameters of working in teams like team motivation, multicultural team activity and team conflict resolution.
5. Analyze themselves relating to their hobbies and strengths and hence set realistic goals in terms of personal and professional growth. They will be able to identify at least 5-7 strengths and a couple of goals to be achieved that will enable their lives to be directed appropriately.
6. Apply 5-6 positive strategies to resolve conflicts arising during team work

Unit I **04 Hours**

Essential Grammar – II

- Auxiliaries
- Importance of auxiliary verb in formal communication.
- Group Activities
- Parts of Speech

Unit II **04 Hours**

Vocabulary- II

- Vocabulary related to Adjectives
- Vocabulary related to verbs and adverbs
- Adjectives, verbs, Adverbial vocabulary –Usage
- Application of the above taught vocabulary through activities

Unit III **04 Hours**

Fundamental Communication Skills – II

- Public speaking skills
- Effective public speaking skills

- Types of public speaking
- Overcoming stage fear
- Do's& Don't's of public speaking
- Importance of Body language in Public speaking
- Importance of the audience in Public speaking
- Activity – Extempore Speaking, Manuscript speech

Unit IV **04 Hours**

Interpersonal skills-II

- Team Work
- Team communication.
- Factors which ensure effective & smooth team communication
- Team conflict resolution-ways & methods
- Case studies/activities

Unit V **04 Hours**

- Perceptions, beliefs
- Analyzing achievements, goals, hobbies
- Handling criticism
- Developing positive attitudes

Unit VI **04 Hours**

Conflict Resolution

- Various conflicts that could be encountered in a work scenario.
- Causes of conflicts in work scenario.
- Ways and methods for conflict resolution.
- Do's and Don'ts for conflict resolution.

Text Books

1. APAART: Speak Well 1 (English language and communication)
2. APAART: Speak Well 2 (Soft Skills)

Reference Books

1. English vocabulary in use – Alan Mc'carthy and O'dell
2. Business Communication – Dr. Saroj Hiremath

PRODUCTION PRACTICE-I
(Course No: C114)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- -- Hours/ Week	End Semester Examination -- Marks	
Practical:- 2 Hours/ Week	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation -- Marks	
	Term Work 50 Marks	Practical: 01
	Total 50 Marks	1

Course Pre-requisites:

Students should have the basic knowledge of

1. Basic knowledge of Engineering Graphics
2. Basic knowledge of workshop technology

Course Objectives:

Student will be able to,

1. To acquire skills for plain and taper turning operations and its calculations
2. To acquaint the skills for preparation of grinding operations
3. To acquire skills for pattern making and sand moulding
4. To acquire skills for gas welding process
5. To demonstrate machine tools and mechanisms

Course Outcomes: Student should be able to,

1. Understand the plain and taper turning operations to create jobs as per given specification.
2. Understand the forging and grinding operations to create a job.
3. Create simple solid pattern using wood turning and apply it during sand moulding.
4. Understand the gas and arc welding process and apply for welding joints.
5. Understand and apply the sand moulding processes.
6. Understand the machine tools, mechanisms and accessories used in various production processes.

Course Contents

Each candidate shall be required to complete and submit the following term work:

A. Jobs:

- a. Plain and Taper turning – one job
- b. Forging and grinding of lathe tool with one knife and other end – one job
- c. Making a simple solid pattern involving wood turning – one job
- d. Welding (gas or arc) – one job
- e. Sand Molding – one job

B. Journal & Demonstration:

Assignments on machine tools will be in the form of a journal based on demonstrations on machine tools. This should include sketches and relevant descriptions as given below:

1) Block Diagrams (Any Two)

- a. Lathe
- b. Universal milling machine
- c. Radial drilling machine
- d. Cylindrical grinder.

2) Mechanisms (Any Two) a) All geared headstock of a center lathe.

- a. Spindle arbor (assembly) drive of milling machine
- b. Crank and slotted lever quick return drive of shaping machine.
- c. Spindle assembly in a drilling machine.

3) Accessories (Any Two)

- a. Taper turning attachment for a center lathe.
- b. Universal dividing head.
- c. Milling cutters.

Rules regarding ATKT, Continuous Assessment and award of Class A. T. K. T.

- A candidate who is granted term for B. Tech. Semester-I will be allowed to keep term for his/her B. Tech. Semester-II examination even if he/she appears and fails or does not appear at B. Tech. Semester-I examination.
- A candidate who is granted term for B. Tech. Semester - III will be allowed to keep term for his/her B. Tech. Semester-IV examination even if he/she appears and fails or does not appear at B. Tech. Semester-III examination.
- A candidate who is granted term for B. Tech. Semester-V will be allowed to keep term for his/her B. Tech. Semester-VI examination if he/she appear and fails or does not appear at B. Tech. Semester-V examination.
- A candidate who is granted term for B. Tech. Semester-VII will be allowed to keep term for his/her B. Tech. Semester-VIII examination if he/she appears and fails or does not appear at B. Tech. Semester-VII examination.
- A candidate shall be allowed to keep term for the B. Tech. Semester-III course if he/she has a backlog of not more than 3 Heads of passing out of total number of Heads of passing in theory examination at B. Tech. Semester-I & II taken together.
- A candidate shall be allowed to keep term for the B. Tech. Semester-V of respective course if he/she has no backlog of B. Tech Semester-I & II and he/she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 heads of passing in term work and practical examination or term work and oral examination.
- A candidate shall be allowed to keep term for the B. Tech. Semester-VII course if he/she has no backlog of B. Tech. Semester-III & IV and he/she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 Heads of passing in term work and practical examination or term work and oral examination.

CONTINUOUS ASSESSMENT

- In respect of Term work at B. Tech. Semester-I & II, B. Tech. Semester-III & IV and B. Tech. Semester-V & VI, target date shall be fixed for the completion of each job, project experiment or assignment as prescribed in the syllabus and the same shall be collected on the target date and assessed immediately at an affiliated college by at least one pair of the concerned teachers for the subject and the marks shall be submitted at the end of each term to the Principal of the college.
- Termwork and performance of Practical/Oral examination shall be assessed on the basis of the depth of understanding of the principles involved, correctness of results and not on ornamental or colorful presentation.

- For B. Tech. Semester-VII & VIII, term work assessment will be done by external and internal examiners jointly during the examination schedule declared by the university. The record of continuous assessment shall be made available to the examiners during Term work and practical and Term work and oral examinations. Examiner shall use this record for overall assessment of the performance of the student. Every practical/term work assignment shall be assessed on the scale of 25 marks and weightage of 25 marks shall be distributed as follows:

Sr. No.	Activity	Marks
1	Timely Submission	07
2	Presentation	06
3	Understanding	12

- Marks obtained out of 25 for all assignments together will be converted on scale of marks assigned to term work of respective subject in the structure of the course.

CLASS

The class should be awarded to the student on the basis of aggregate marks obtained together in both the semesters of the respective year by him. The award of class shall be as follows.

A	Aggregate 66% or more marks	First Class with Distinction
B	Aggregate 60% or more marks but less than 66%	First Class
C	Aggregate 55% or more marks but less than 60%	Higher Second Class
D	Aggregate 50% or more marks but less than 55%	Second Class
E	Aggregate 40% or more marks but less than 50%	Pass Class

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY) Pune.

College of Engineering, Pune- 411043
The Structure of the Curriculum: 2014 Course
Choice Based Credit System (CBCS)

COURSE STRUCTURE AND SYLLABUS

(Choice Based Credit System - 2014 Course)

B. TECH. MECHANICAL: SEMESTER- III & IV

Programme: B. Tech. Mechanical

Vision of the Bharati Vidyapeeth (Deemed to be University) College of Engineering is:

To be a World Class Institute for Social Transformation through Dynamic Education

Missions of the Bharati Vidyapeeth (Deemed to be University) College of Engineering are:

- To provide quality technical education with advanced equipment, qualified faculty members, infrastructure to meet needs of profession & society.
- To provide an environment conducive to innovation, creativity, research and entrepreneurial leadership.
- To practice and promote professional ethics, transparency and accountability for social community, economic & environmental conditions.

Goals of the Bharati Vidyapeeth (Deemed to be) University College of Engineering are:

- Recruiting experienced faculty.
- Organizing faculty development programs.
- Identifying socio-economically relevant areas & emerging technologies.
- Constant review &up gradation of curricula.
- Up gradation of laboratories, library & communication facilities.
- Collaboration with industry and research & development organizations.
- Sharing of knowledge, infra-structure and resources.
- Training, extension, testing and consultancy services.
- Promoting interdisciplinary research.

Vision of the Mechanical Engineering Department is:

To develop, high quality Mechanical Engineers through dynamic education to meet social and global challenges.

Mission Statements of the Mechanical Engineering Department are:

- To provide extensive theoretical and practical knowledge to the students with well-equipped laboratories and ICT tools through motivated faculty members.
- To inculcate aptitude for research, innovation and entrepreneurial qualities in students.

- To acquaint students with ethical, social and professional responsibilities to adapt to the demands of working environment.

Program Educational Objectives (PEOs) of the B. Tech. Mechanical are:

Graduates will be able,

- To fulfill need of industry and society with theoretical and practical knowledge.
- To engage in research, innovation, lifelong learning and continued professional development.
- To fulfill professional ethics and social responsibilities.

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Statements of Programme Specific Outcomes (PSOs)

PSO1: Apply the knowledge of thermal, design, manufacturing engineering and computational sciences to solve Mechanical Engineering problems.

PSO2: Apply Mechanical Engineering principles for research, innovation and develop entrepreneurial skills.

PSO3: Apply concepts of mechanical engineering to asses' societal, environmental, health and safety issues with professional ethics.

B. TECH. MECHANICAL: SEMESTER- III (2014 Course)

S.N	Course	Teaching Scheme (Contact Hrs./week)			Examination Scheme (Marks)							Total Credits		
		L	P/D	T	End Sem. Exam	Continuous Assessment: Unit Test	Attendance	Assignments	TW/OR	TW/PR	Total	TH	TW	Total
C201	Solid Mechanics	4	-	-	60	20	10	10	-	-	100	4	-	4
C202	Fluid Mechanics	4	2	-	60	20	10	10	-	50	150	4	1	5
C203	Engineering Thermodynamics	3	2	-	60	20	10	10	50	-	150	3	1	4
C204	Engineering Mathematics III	3	-	-	60	20	10	10	-	-	100	3	-	3
C205	Computer Programming and Simulation	3	2	-	60	20	10	10	-	50	150	3	1	4
C206	Professional skill Development-III	4	-	-	100	-	-	-	-	-	100	4	-	4
C207	Production Practice- II #	-	2	-	-	-	-	-	-	50	50	-	1	1
	Total	21	08	0	400	100	50	50	50	150	800	21	4	25

L: Lectures, P/D: Practical/ drawing, T: Tutorial, TH: Theory, TW: Term work

Practical examination of duration 3 Hours.

B. TECH. (MECHANICAL) SEM.-IV (2014 COURSE)

S.N	Course	Teaching Scheme (Contact Hrs./week)			Examination Scheme (Marks)							Total Credits		
		L	P/D	T	End Sem Exam	Continuous Assessment: Unit Test	Attendance	Assignments	TW/OR	TW/PR	Total	TH	TW	Total
C208	Mechanisms of Machines*	4	2	-	60	20	10	10	50	-	150	4	1	5
C209	Manufacturing Process	3	-	-	60	20	10	10	-	-	100	3	-	3
C210	Material Science	3	2	-	60	20	10	10	-	50	150	3	1	4
C211	Turbomachinery	3	-	-	60	20	10	10	-	-	100	3	-	3
C212	Numerical. Methods. and Optimization Techniques	3	2	1	60	20	10	10	--	50	150	3	2	5
C213	Professional skill Development -IV	4	-	-	100	-		-	-	-	100	4	-	4
C214	Production Practice – III #	-	2	-	-	-	-	-	-	50	50	-	1	1
	Total	20	8	1	400	100	50	50	50	150	800	20	5	25

L: Lectures, P/D: Practical/ drawing, T: Tutorial, TH: Theory, TW: Term work

* End Semester examination of duration 4 Hours.

Practical examination of duration 3 Hours.

Total Credits Sem. III– 25

Total Credits Sem. IV – 25

Grand Total - 50

Rules for Conducting Tests

Mode of the test

- In each semester for each subject three tests shall be conducted. The schedule for the same will be declared at the commencement of academic year in the academic calendar.
- Each test shall carry 20 marks.
- University examination pattern has given weightage of 20 marks for the tests.
- To calculate these marks following procedure is followed:
  - i) Out of the three tests conducted during the semester, the marks of only two tests in which the candidate has shown his/her best performance shall be considered, to decide the provisional marks in each subject.
  - ii) Average marks obtained in two tests in which students have performed well, shall be considered as provisional marks obtained by the student in the tests.
  - iii) If the candidate appears only for two tests conducted during the semester, he/ she will not be given benefit of the best performance in the tests.
  - iv) If the candidate appears only for one test conducted during the semester, to calculate the marks obtained in the tests it will be considered that the candidate has got 0 (zero) marks in other tests.
  - v) The provisional marks obtained by the candidate in class tests should reflect as proportional to theory marks. In cases of disparity of more than 15% it will be scaled down accordingly; these marks will be final marks obtained by the student. No scaling up is permitted.
  - vi) If the candidate is absent for theory examination or fails in theory examination his final marks for tests of that subject will not be declared. After the candidate clears the theory, the provisional marks will be finalized as above.
- Paper pattern for tests
  - i) All questions will be compulsory with weightage as following

Question 1	-	7 marks
Question 2	-	7 marks
Question 3	-	6 Marks

  - ii) There will not be any sub-questions.
- For granting the term it is mandatory to appear for all three tests conducted in each semester.
- Roll nos. allotted to students shall be the examination nos. for the tests.

Programme: B. Tech. Mechanical

Solid Mechanics
(Course Code:- C201)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04Hours/ Week		
Tutorial:- -- Hours/Week	End Semester Examination60Marks	Theory:- 04
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 00 Marks	
	Total 100 Marks	04

Course Pre-requisites:

Student should have knowledge of

1. Engineering Mathematics
2. Engineering Mechanics
3. Engineering Science

Course Objectives:

To provide the knowledge of

1. To acquire basic knowledge of stress, strain due to various types of loading.
2. To draw Shear Force and Bending Moment Diagram for transverse loading.
3. To determine Bending, Shear stress, Slope and Deflection on Beam.
4. To solve problems of Torsional shear stress for shaft and Buckling for the column.
5. To apply the concept of Principal Stresses and Theories of Failure.

Course Outcomes: Students should be able to

1. Understand the concept of various types of stresses and strain developed in materials and analyze stress strain.
2. Understand the concept of principal stresses and theories of failure to analyze determine stresses.

3. Understand the concept of SFD and BMD and evaluate the forces acting on components.
4. Understand the concept of Torsional, bending and axial force acting on the shaft and evaluate torsional shear stress in shaft and buckling on column.
5. Understand the concept of Bending stresses and shear stresses and analyze bending stress distribution and shear stress distribution for various cross sections of beam.
6. Understand the basic concept of Design process and apply it to design a simple machine components

Unit I **08 Hours**

Simple stresses & strains

Revision of Concept of stresses & strains (linear, lateral, shear, thermal & volumetric). Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Stress-strain diagrams for ductile & brittle materials. Various strengths of material- Yield strength, Ultimate tensile strength etc, Concept of 3D stress state. Interrelation between elastic constants, Proof stress & True stress & strain. Axial force diagrams, stresses and strains in determinate & indeterminate homogeneous & composite bars under concentrated loads & self weight. Temperature stresses in simple & composite members. Strain energy due to axial load (gradual, sudden & impact), strain energy due to self weight.

Unit II **08 Hours**

Principal stresses & strains

Normal & shear stresses on any oblique plane. Concept of principal planes derivation of expression for principal stresses & maximum shear stress, position of principal planes & planes of maximum shear, graphical solution using Mohr's circle of stresses, combined effect of axial force, bending moment & torsional moment on circular shafts (solid as well as hollow) Theories of elastic failure: Maximum principal stress theory, maximum shear stress theory, maximum distortion energy theory, maximum strain theory – their applications & limitations.

Unit III **08 Hours**

Shear Force & Bending Moment Diagrams

Shear forces & bending moments of determinate beams due to concentrated loads, uniformly distributed loads, uniformly varying loads & couples, relation between SF & BM diagrams for cantilevers, Simply supported beam. Maximum bending movement & positions of points of contra flexure, construction of loading diagrams & BMD from SFD & construction of loading Diagram & SFD from BMD. Slope & deflection of beams - relation between BM & slope, slope & deflection of determinate beams, double integration method (Macaulay's method), derivation of formula for slope & deflection for standard cases

Unit IV **08 Hours**

Torsion and Buckling of columns

Stresses, strain & deformations in determinate shafts of solid & hollow, homogeneous & composite circular cross section subjected to twisting moment, derivation of torsion equation, stresses due to combined torsion, bending & axial force on shafts .Concept of buckling of columns, derivation of Euler's formula for buckling load for column with hinged ends, concept of equivalent length for various end conditions. Limitations of Euler's formula, Rankine's formula, safe load on columns

Unit V **08 Hours**

Stresses in Machine Elements

Bending stresses: Theory of simple bending, assumptions, derivation of flexural formula, second moment of area of common cross sections(rectangular, I,T,C) with respective centroidal & parallel axes, bending stress distribution diagrams, moment of resistance & section modulus calculations.

Shear stresses: Concept, derivation of shear stress distribution formula, shear stress distribution diagrams for common symmetrical sections, maximum and average shears stresses, shear connection between flange & web

Unit VI **08 Hours**

Design Process

Machine Design, Traditional design methods, Basic procedure of Machine Design, Forming Design specifications, Design for:- 1) functional requirement, 2) customer orientation 3) Safety requirement & 4) Analysis for use.

Requisites of design engineer, Design of machine elements, Sources of Design data, Use of Design data book, Use of standards in design, Selection of preferred sizes, Design Synthesis, Creativity in design. Use of internet for gathering information & Consideration of energy requirement, product life cycle & design for environment.

Design of Simple Machine parts:

Factor of safety, Service factor, Design of simple machine parts - Cotter joint, Knuckle joint and Levers, Eccentric loading , Stresses in curved beams (for circular cross-section only).

Assignment:

1. Minimum five to six theory questions on simple stresses and strains.
2. Minimum five to six problems on simple stresses and strains
3. Minimum five to six theory questions of principle stresses and strains.
4. Minimum five to six problems of principle stresses and strains.
5. Minimum five to six problems on shear force and bending moment diagrams.
6. Minimum five to six theory questions on shear force and bending moment diagrams.
7. Minimum five theory questions on torsion and deflection of beam.
8. Minimum five problems on torsion and deflection of beam.
9. Minimum five to six problems on bending stresses and shear stresses.
10. Minimum five theory questions on bending stresses and shear stresses.
11. Minimum five to six problems on design of simple machine parts.
12. Minimum five to six theory on design of simple machine parts.

Textbooks:

1. Timoshenko & Young, Engineering Mechanics, Tata McGraw Hill Book Publishing co. Ltd. 1981.
2. James Gere, Mechanics of Materials, Thomson Learning
3. S Ramamrutham, Strength of Materials
4. V. B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publication
5. J. E. Shigley, Mechanical Engineering Design, McGraw Hill

Syllabus for Unit Test:

Unit Test-I Unit-I,II, III

Unit Test-II Unit-IV, V, VI

Fluid Mechanics
(Course Code :- C 202)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04Hours/ Week		
Practical:- 02 Hours/Week	End Semester Examination 60 Marks	Theory:-04
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical:- 01
	Total 150 Marks	05

Course Pre-requisites:

Student should have knowledge of

1. Basic knowledge of Fundamentals of Mechanical Engineering.
2. Basic knowledge of Physics and Engineering Mechanics.
3. Basic knowledge of Calculas.

Course Objectives:

To provide the knowledge of

1. To provide knowledge of fluid properties and hydrostatic law
2. To teach about fluid kinematics and dynamics.
3. To provide knowledge of laminar and turbulent fluid flows
4. To explain about flow through pipes, flow over immersed bodies and dimensional analysis.

Course Outcomes: Students should be able to

1. understand the concepts of fluid kinematics and analyze related phenomena.
2. understand the concepts of fluid statics; and analyze related phenomena.
3. understand the concepts of fluid dynamics; and analyze related phenomena.
4. understand the concepts of laminar fluid flows and flow around immersed bodies; and also analyze related phenomena.

5. understand the concepts of fluid flow through pipes; and also analyze head losses through pipes.
6. understand the concepts of turbulent fluid flows, boundary layer theory and dimensional analysis; and also analyze related phenomena.

Unit I **08 Hours**

Fluid Kinematics:

Types of flow- steady, unsteady, uniform, non-uniform, laminar, turbulent, One, Two and Three dimensional, compressible, incompressible, rotational, Irrotational. Stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates, flow net.

Unit II **08 Hours**

Fluid Statics:

H Hydrostatic law, Pascal's law, Pressure at a point, Total Pressure, Centre of pressure, Liquid pressure on a plane(Horizontal, Vertical, Inclined) & Curved surfaces, Archimedes Principle, Buoyancy and stability of floating and submerged bodies, Metacentric height.

Unit III **08 Hours**

Fluid Dynamics:

Introduction to Navier-Stoke's Equation, Euler equation of motion along a stream line, Bernoulli's equation, application of Bernoulli's equation to Pitot tube, Venturimeter, Orifices, Orifice meter, Triangular Notch & Rectangular Notch .(Without considering Velocity of Approach)

Unit IV **08 Hours**

Laminar Flow & Flow around Immersed Bodies:

Definition, relation between pressure and shear stresses, laminar flow through round pipe, fixed parallel plates. Introduction to CFD Methodology (Elementary Treatment).Lift and Drag, Classification of Drag, Flow around circular cylinder and Aerofoil, Development of lift on Aerofoil.

Unit V **08 Hours**

Flow through Pipes:

TEL, HGL , Energy losses through pipe, Darcy-Weisbach equation, Moody diagram, Minor losses in pipes, pipes in series and parallel, Syphon, Transmission of power, Water hammer in pipes ,

Unit VI **08 Hours**

Turbulent Flow, Boundary Layer & Dimensional Analysis:

Turbulent Flow, Velocity Distribution, Development of Boundary Layer on a flat plate, Laminar and Turbulent Boundary Layers, Laminar sub layer, Separation of Boundary Layer and Methods of Controlling. Dimensions of physical quantities, dimensional homogeneity, Buckingham pi Theorem, Important dimensionless numbers, Model analysis (Reynolds, Froude and Mach).

List of Assignments

1. At least Five theory questions on Fluid Kinematics.
2. At least theory questions on Fluid Statics.
3. At least Five theory questions on Fluid Dynamics.
4. At least Five theory questions on flow and flow around immersedbodies.
5. At least Five theory questions on flow though Pipes.
6. At least Five theory questions on turbulent flow.
7. At least Five numerical questions on Fluid Kinematics.
8. At least Five numerical questions on Fluid Statics.
9. At least Five numerical questions on Fluid Dynamics.
10. At least Five numerical questions on flow and flow around immersed bodies.
11. At least Five numerical questions on flow though Pipes.
12. At least Five numerical questions on turbulent flow.

Text Books/ Reference Books

1. Dr. P.N. Modi and Dr. S.M. Seth, “Hydraulics and Fluid Mechanics including Hydraulic Machines”, Standard Book House.

2. Dr. R.K. Bansal, “Fluid Mechanics and Hydraulic Machines – l”, Laxmi Publication Pvt. Ltd., New Delhi.
3. Streeter V. L. and Wylie E. B. Fluid Mechanics McGraw Hill International Book Co.
4. Garde R. J. and Mirajgaonkar,Engineering Fluid Mechanics, Nem Chand & Bros, Roorkee, SCITECH, Publication (India) Pvt. Ltd.
5. Cengel & Cimbla Fluid Mechanics, TATA McGraw-Hill.
6. Irving Shames, “Mechanics of Fluid”, McGraw Hill Publication.

Syllabus for Unit Tests:

Unit Test-I Unit-I, II, III

Unit Test-II Unit- IV, V, VI

Engineering Thermodynamics
(Course Code :- C 203)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03Hours/ Week		
Practical:- 02 Hours/Week	End Semester Examination 60 Marks	Theory:- 03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical:- 01
	Total 150 Marks	04

Course Pre-requisites:

Student should have knowledge of

1. Fundamentals of Mechanical Engineering
2. Higher Secondary Physics
3. Engineering Mathematics

Course Objectives:

To provide the knowledge of

1. laws of thermodynamics and their applications
2. steam generators and their performance analaysis.
3. reciprocating and rotary compressors.
4. fuels, combustion and introduce availability.

Course Outcomes:

Students should be able to

1. understand concepts of second law of thermodynamics and entropy
2. understand construction and working of steam generators; and analyze their performance.
3. apply the knowledge of properties of steam for different vapour processes and power cycles.
4. understand construction and working of reciprocating air compressors and analyze their performance.

5. understand operations of rotary air compressors and analyze their performance.
6. understand the concept of availability and analyze exhaust gas composition.

Unit I **06 Hours**

Second Law of Thermodynamic and Entropy:

Second Law of Thermodynamics: Limitations of first law of thermodynamics, heat engine, refrigerator and heat pump, Kelvin-Planck's statement & clausius statement, equivalence of Kelvin-Planck's and clausius statements, perpetual motion machine of second kind, carnot cycle & carnot heat engine. Entropy: Entropy as a property, second law analysis for entropy, clausius inequality, principle of increase of entropy, irreversibility

Unit II **06 Hours**

Steam Generators:

Classification, constructional details of process and power boiler, boiler mountings and accessories, equivalent evaporation, boiler efficiency, energy balance, boiler controls, boiler draught.

Unit III **06 Hours**

Ideal Gas and Properties of Steam and Vapour Power Cycle:

Ideal Gas definition, Gas Laws: Boyle’s law, Charle’s law, Avagadro’s Law, Equation of State, Specific Gas constant and Universal Gas constant, Ideal gas processes- on P-V and T-S diagrams, Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-V, T-S and Mollier diagram for steam,. Non flow and steady flow vapor processes, work transfer & heat transfer, use of P-V, T-S, H-S diagrams for steam, determination of dryness fraction, and study of calorimeters. Vapour Power Cycle: Carnot cycle using steam, ideal rankine cycle, calculation of thermal efficiency, specific steam consumption, work ratio, comparison of carnot and rankine cycle, effect of superheat.

Unit IV **06 Hours**

Single Stage and Multi stage Reciprocating Air Compressor:

Uses of compressed air, classification, constructional details of single stage compressor, computation of work done, isothermal work done, isothermal efficiency, effect of clearance, volumetric efficiency, FAD, theoretical and actual indicator diagrams, method of improving volumetric efficiency. Need of multi staging, multi stage compressor, work done, volumetric efficiency, condition for maximum efficiency, intercooling, actual indicator diagram.

Unit V **06 Hours**

Rotary Compressor:

Introduction, classification and working principles of different types of compressors, comparison between reciprocating and rotary compressors, positive displacement and rotodynamic compressors, static and total head, work done efficiencies, surging, and choking, stalling, characteristics curves for rotodynamic compressors. selection of compressors for various applications.

Unit VI **06 Hours**

Fuels and Combustion and Availability:

Mass fraction, mole fraction, combustion equation, theoretical air , excess and deficient air, stoichiometric and actual air to fuel ratio, analysis of products of combustion, gravimetric and volumetric analysis and their conversions, method to determine flue gas analysis - CO, CO2, O2, HC, NOx, smoke. Availability: High and low grade energy, available and unavailable energy, loss of available energy due to heat transfer through a finite temperature difference.

Term Work:

1. Determination of calorific value using bomb calorimeter.
2. Demonstration of exhaust gas analysis by using any commercially available test rig.
3. Test on reciprocating air compressor to determine volumetric efficiency, isothermal efficiency and FAD.
4. Determination of dryness fraction using any commercial available test rig.
5. Study of boiler mounting and accessories
6. Study of package boiler / modern boiler
7. Report on visit to any process industry, which uses boiler.
8. Performance test on rotary air compressor/ blower.
9. Trial on boiler to determine boiler efficiency, equivalent evaporation and energy balance sheet.
10. Study of rotary type positive displacement compressor.

Assignment:

1. At least five theory questions based on Second law of thermodynamic.
2. At least five numerical questions based on Second law of thermodynamic.
3. At least five theory questions based on cannot cycle& cannot heat engine.

4. At least five theory questions based on boiler mounting & accessories. boiler mounting & accessories.
5. At least five numerical questions based on equivalent evaporation and boiler efficiency.
6. At least five theory questions based on Ideal gas and properties of steam.
7. At least five numerical questions based on properties of steam.
8. At least five theory questions based on single stage & multistage reciprocating Air compressor.
9. At least five numerical questions based on reciprocating air compressor.
10. At least five theory questions based on rotary compressor.
11. At least five numerical questions based on rotary compressor.
12. At least five theory questions based on fuels and combustion.
13. At least five theory questions based on availability.

Textbooks:

1. P. K. Nag, Engineering Thermodynamics, Tata McGraw Hill Publications
2. P. L. Ballany, Thermal Engineering, Khanna Publications
3. V. P. Vasandani and D. S. Kumar, Heat Engineering Metropolitan book Company, New Delhi
4. R.K.Rajput, Engineering Thermodynamics, EVSS Thermo Laxmi Publications
5. Y. Cengel & Boles, Thermodynamics -An engineering approach, Tata McGraw Hill Publications
6. Kothandarman & Domkundwar, Thermodynamics & Heat Engines
7. Rayner Joel, Engineering Thermodynamics, ELBS Longman
8. Hawkins G. A., "Engineering Thermodynamics", John Wiley and Sons.

Syllabus for Unit Tests:

Unit Test-I Unit-I,II ,III

Unit Test-II Unit-IV,V,VI

Engineering Mathematics -III
(Course Code :- C 204)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours/ Week	End Semester Examination 60 Marks	Theory:- 03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Total 100 Marks	03

Course Pre-requisites:

Student should have knowledge of

1. Student should have Basic Knowledge of differential and Integral calculus
2. Student should have Basic Knowledge of statistics and Probability

Course Objectives:

To provide the knowledge of

1. Effectively formulate mathematical model using PDE
2. Analyze numerical data using statistical methods
3. Obtain z- score of normal distribution

Course Outcomes: Students should be able to

1. Understand the mathematical modeling of systems using differential equations and ability to solve linear differential equations with constant coefficient. imaginary points using argand diagram.
2. Understand the concepts of Laplase Transform and Apply to formulate mathematical model using PDE.
3. Understand various forms of Partial differential equation
4. Understand Statistical methods and Apply to analyze the numerical data
5. Understand the concept of Correlation and Regression coefficient.
6. Understand the concept of Normal distribution

Programme: B. Tech. Mechanical

Unit I **Linear Differential Equations (LDE):** **6 Hours**

LDE with constant coefficients, Method of variation of parameters, Homogeneous Equations, Cauchy's and Legendre's DE. Simultaneous & Symmetric Simultaneous DE. Application to mechanical systems.

Unit II **06 Hours**

Transforms:

Laplace Transform (LT): LT of standard functions, properties and theorems, Inverse LT, method of finding Inverse LT , Application of LT to solve LDE.

Fourier Transform (FT): Fourier Integral theorem, Fourier transform Fourier Sine &Cosine transform, Inverse Fourier Transform.

Unit III **06 Hours**

Partial Differential Equations (PDE):

Basic concepts, modeling: Vibrating String, Wave equation. Method of separation of variables, Use of Fourier series, Heat equation: one and two dimensional heat flow equations, Solution by Fourier Transforms, modeling of two dimensional wave equation

Unit IV **06 Hours**

Measures of central value:

Arithmetic mean , median and mode, geometric mean and harmonic mean, dispersion, mean deviation, standard deviation, skeweness, Moments and kurtosis.

Unit V **06 Hours**

Correlation and Regression:

Significance of the study of correlation, types of correlation, coefficient of correlation, difference between correlation and regression . Regression euations, standard error of estimate.

Unit VI **06 Hours**

Probability and Distribution :

Basics of probability, conditional probability, bayes theorem, mathematical expectations, random variable and Binomial, Poisson , normal probability distribution. Testing of hypothesis- Z test, chi square test and goodness of fit, F test.

Assignments

1. At least Five numerical questions on Linear Differential Equations
2. At least Five numerical questions on Transforms.
3. At least Five numerical questions on Partial Differential Equations
4. At least Five numerical questions on Measures of central value
5. At least Five numerical questions on Correlation and Regression
6. At least Five numerical questions on Probability and Distribution

Textbooks:

1. Advanced Engineering Mathematics by Peter V. O'Neil (Cengage Learning).
2. Advanced Engineering Mathematics by Erwin Kreyszig (Wiley Eastern Ltd.).
3. Engineering Mathematics by B.V. Raman (Tata McGraw-Hill).
4. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).
5. S. P. Gupta: statistical methods- schand and sons.
6. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
7. Applied Mathematics (Volumes I and II,III) by P. N. Wartikar& J. N. Wartikar (Pune VidyarthiGrihaPrakashan, Pune).

Syllabus for Unit Tests:

Unit Test-I Unit-I,II ,III

Unit Test-II Unit-IV,V,VI

Computer Programming & Simulation
(Course Code :- C 205)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours/ Week		
Practical:- 02 Hours / Week	End Semester Examination 60 Marks	Theory : 03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical:-01
	Total 150 Marks	04

Course Prerequisites:-

Student should have knowledge of

1. Engineering Mathematics II

Course Objectives:

To provide the knowledge of

1. To provide the fundamental knowledge of modeling, system and simulation
2. To provide the knowledge of monte carlo methods of simulation
3. To provide knowledge of random variable and distributions
4. To provide knowledge of time and event based simulation with real life applications

Course Outcomes: Students should be able to:

1. Understand the fundamental knowledge of Programming, modeling, system and simulation
2. Understand monte carlo methods of simulation and apply them in real life problems
3. Understand concept of random variable, distributions and apply them in probalistic engineering models
4. Understand concepts of time based simulation and apply them in real life problems
5. Understand concepts of event based simulation and apply them in real life problems
6. Understand concept of simulation experiments

Unit I **08 Hours**

Concept of System and Type of Models

Physical model, Mathematical model, Types of mathematical model, Dynamic Versus Static Models, Continuous-Time Versus Discrete-Time, Dynamic Models, Quantitative Versus Qualitative Models, Mechanical system modeling examples.

Unit II **08 Hours**

Concept of Simulation

Simulation Basics, When Simulation Is the Appropriate Tool, when Simulation Is Not Appropriate, Advantages and Disadvantages of Simulation, Areas of Application, Steps in a Simulation Study Simulation and analytical methods, Basic nature of simulation, The simulation process, Types of system simulation, Generation of random numbers .Monte Carlo Simulation.

Unit III **08 Hours**

Probability Used in Simulation

Basic Probability Concepts, Discrete Random Variable, Expected Value and Variance of a Discrete Random Variable, Measure of Probability Function, Continuous Random Variable, Exponential Distribution, Mean and Variance of Continuous Distribution, Normal Distribution.

Unit IV **08 Hours**

Continuous an Discrete Systems Simulation

Introduction, Simulation of Pure pursuit problem, exponentional growth model, simulation of water reservoir system, Trajectory simulation, suspension system, simulation of pendulum.

Unit V **08 Hours**

Simulation of Queuing Systems and Inventory Systems and inventory systems

Discrete Simulation, Continuous System Simulation. Simulation of Queuing Systems, Inventory Control Models

Unit VI **08 Hours**

Design of Simulation Experiments

Introduction, development of simulation experiments, principles of verification, validation and accreditation, Simulation experimentation, classical experimental design, validation of simulation experiments, evaluation of simulation experiments. Simulation Languages

Term work

Following assignment using MATLAB

1. Creating a One-Dimensional Array (Row / Column Vector) Creating a Two-Dimensional Array
2. Performing matrix manipulations – Concatenating, Indexing, and Sorting Normal Distribution
3. Simulation of water reservoir system
4. Trajectory simulation
5. Suspension system
6. Simulation of pendulum
7. Simulation of any one Discrete Simulation, Continuous System Simulation, Simulation of Queuing Systems, Inventory Control Models.

Assignments:

1. At least five theory questions on basics of simulation.
2. At least five theory questions on Monte-Carlo simulation.
3. At least five theory questions on various distributions.
4. At least five simulation questions on various continuous models.
5. At least five simulation questions on various discrete models.
6. At least five theory questions on advanced simulation and simulation language.
7. At least five numerical questions on Monte-Carlo simulation.
8. At least five numerical questions on various distribution
9. At least five numerical questions on various continuous models.
10. At least five numerical questions on various discrete models.
11. At least five MATLAB programs on continuous models.
12. At least five MATLAB programs on discrete models.

Text Books/ Reference Books

1. Robert E. Shannon, “System Simulation The art and science”, Prentice Hall, New Jersey, 1995.
2. D.S. Hira, “System Simulation”, S. Chand and company Ltd, New Delhi, 2001.
3. Geoffrey Gordon, System Simulation; Prentice Hall.
4. Robert E. Shannon ; System Simulation: The Art and Science ;Prentice Hall
5. J. Schwarzenbach and K.F. Gill Edward Arnold; System Modelling and Control
6. M Close and Dean K. Frederick; Modeling and Analysis of Dynamic Systems ;Houghton Mifflin

Syllabus for Unit Test:

Unit Test-I Unit-I,II

Unit Test-II Unit-III,IV

Professional Skills Development-III
(Course Code :- C 206)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04 Hours/ Week	End Semester Examination 100 Marks	Theory : 04
	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation -- Marks	
	Term Work / Oral -- Marks	
	Total 100 Marks	04

Course Pre-requisites:

Student should have knowledge of

1. Knowledge of basic Math and reasoning
2. Awareness of phrasal verbs
3. Basic knowledge of writing techniques taught to them in the earliear semester
4. Basic knowledge of self awareness
5. Awareness about leadership skills and presentation skills

Course Objectives:

To provide the knowledge of

1. To develop students' skills in aptitude and reasoning whereby enhancing employability skills.
2. To flourish the skills of learning advance vocabulary and use them for professional communication
3. To promote grooming skills in graduates and make them competent to excel in business communication and presentation

Course Outcomes: Students should be able to

1. Understand short tricks of the aptitude and reasoning and apply them in recruitment and competitive examinations

2. Understand the advance idioms, phrases and apply them to present themselves with finesse for corporate ventures
3. Understand the process conversion of thoughts and ideas into written communication in an effective coherent and logical way
4. Understand the self appraisal process and apply the techniques of SWOT to accelerate conversion of weaknesses into strengths
5. Understand the kinds of leaderships and apply them to groom themselves into potential leader
6. Understand the trick and techniques of power point presentation and apply them in designing an effective business presentation

Unit I **18 Hours**

Aptitude (Maths, Logical Reasoning, English)

- Maths
  - Enjoy maths + Number system
  - Number system
  - Percentage, profit and loss
- Logical Reasoning
  - Coding, Decoding, Number series,
  - Blood relation Directions, cubes & dices
- English
  - Vocabulary-1
  - Confusing words-1(Homonyms)

Unit II **06 Hours**

Essential Grammar - III

- Idioms and phrases
- Usage of Idioms & phrases in daily conversation
- Activities
- Academic word list- Words to be used in business communication

Unit III **04 Hours**

Written Communication- II

- Essay writing
- Mnemonics to develop ideas and write essays
- Structure of essays
- Technical writing
- Report writing

Unit IV **06 Hours**

SWOT Analysis

- Introduction to SWOT
- Importance to SWOT
- Individual & Organizational SWOT Analysis
- Identifying strengths, weaknesses, threats & opportunities
- Short term goals& Long term goals, Career planning

Unit V **04 Hours**

Interpersonal Skills - III

- Introduction to leadership skills
- Importance of leadership skills
- Types of leadership skills
- Are leaders born or made?

Unit VI **04 Hours**

Presentation Skills

- Introduction to PowerPoint presentation
- Structure & flow of presentation
- Importance of body language
- Presentation by students-evaluation& feedback by trainers

Textbooks:

1. APAART: Verbal Ability.
2. APAART: Logical Reasoning.
3. APAART: Quantitative Aptitude.
4. APAART: Speak Well 1 (English Language and Communication).
5. APAART: Speak Well 2 (Soft Skills).
6. APAART: Verbal Ability

Production Practice-II
(Course Code :- C 207)

Teaching Scheme	Examination Scheme	Credit Scheme
Practical:- 2 Hours/ Week	End Semester Examination-- Marks	
	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation-- Marks	
	Term Work 50 Marks	Practical:- 01
	Total 50 Marks	01

Course Pre-requisites:

Student should have knowledge of

1. Basic knowledge of Engineering Graphics
2. Basic knowledge of workshop Technology and Production practice I

Course Objectives:

To provide the knowledge of

1. To acquire the skills of TIG/MIG and arc welding process.
2. To acquire the skills of pattern making.
3. To acquire the skills of sand testing.
4. To acquire the skill of sand moulding.

Course Outcomes: Students should be able to,

1. Understand the TIG, MIG and arc welding processes and apply for welding joints.
2. Understand the pattern making operations to create the patterns using wood turning operation.
3. Understand the different core making practices and apply them in pattern making.
4. Understand the properties of sand by caring out sand testing and apply them for sand molding processes.
5. Understand the sand moulding processes and create a sand mould.
6. Apply the moulding process to create the sand casting.

Term Work

Each candidate shall be required to complete and submit the following jobs:

1. Welding-TIG / MIG OR Arc Welding (One Job)
2. Pattern making: A solid pattern consisting of wood turning or a core box. (One Job) It should follow the colour code in pattern making..
3. Sand Testing.(Any Two)
4. Sand Moulding.. (One Job)

Note

Practical examination of 3 hours duration based on above term work will be Conducted at the end of semester.

Mechanisms of Machines
(Course Code:- C208)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04Hours/ Week		
Practical:- 02 Hours/Week	End Semester Examination 60 Marks	Theory: 04
	Unit Test 20 Marks	Practical: 01
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	
	Total 150 Marks	05

Course Pre-requisites:

1. Student should have knowledge of
1. Engineering Mathematics
2. Engineering Mechanics

Course Objectives:

To provide the knowledge of

1. To make the students conversant with kinematic analysis of mechanisms applied to real life and industrial applications.
2. To give basic knowledge on kinematic, kinetic and dynamic design of machinery.
3. To develop the competency to analyze the velocity and acceleration in mechanisms using analytical and graphical approach.
4. To develop the skill to propose and synthesize the mechanisms using graphical and analytical technique.

Course Outcomes:

Students should be able to

1. Understand the concept of kinematics, Kinematic pair, kinematic chains, mechanisms and inversions and Evaluate DOF.

2. Understand the concept velocity and acceleration of any planar mechanism and Analyze it by using relative velocity or acceleration method and ICR method.
3. Understand the concept of velocity and acceleration and Analyze it by using Coriolis component and Klein's construction.
4. Understand the concept kinematic analysis of mechanisms and evaluate it by using analytical method.
5. Understand the fundamental concept of synthesis of linkages and Analyze by using the graphical and analytical techniques.
6. Understand the basic concept of static and dynamic force analysis and Evaluate forces acting on reciprocating engine.

Unit I **08 Hours**

Basic Kinematics:

Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Mechanism, Machine, Degree of freedom (Mobility), Kutzbach criterion, Grubler's criterion. Four bar chain and its inversions, Grashoff's law, Slider crank chain and its inversions, Double slider crank chain and its inversions. Pantograph, Steering gear mechanisms: Condition for correct steering, Davis steering gear mechanism, Ackermann steering gear mechanism.

Unit II **08 Hours**

Velocity and Acceleration Analysis of Mechanisms: Graphical Methods-I

Relative velocity method: Relative velocity of a point on a link, Angular velocity of a link, Sliding velocity, Velocity polygons for simple mechanisms.

Relative acceleration method: Relative acceleration of a point on a link, Angular acceleration of a link, Acceleration polygons for simple mechanisms.

Instantaneous center of rotation (ICR) method: Definition of ICR, Types of ICRs, Methods of locating ICRs, Kennedy's Theorem, Body and space centrode.

Unit III **08 Hours**

Velocity and Acceleration Analysis of Mechanisms: Graphical Methods-II

Velocity and acceleration diagrams for the mechanisms involving Coriolis component of acceleration. Klein's construction

Unit IV **08 Hours**

Kinematic Analysis of Mechanisms : Analytical Methods

Analytical method for displacement, velocity and acceleration analysis of slider cranks mechanism. Position analysis of links with vector and complex algebra methods, Loop closure equation, Chace solution, Velocity and acceleration analysis of four bar and slider crank mechanisms using vector and complex algebra methods. Hooke's joint, Double Hooke's joint.

Unit V **08 Hours**

Introduction to Synthesis of Linkages

Steps in synthesis process: Type, number and dimensional synthesis.Tasks of Kinematic synthesis: Path, function and motion generation (Body guidance). Precision Positions, Chebychev spacing, Mechanical and structural errors, Branch defect and order defect, Crank Rocker mechanisms. Graphical synthesis: Two and three position synthesis using relative pole method and inversion method for single slider crank and four bar mechanism, three position motion synthesis of four bar Mechanism. Analytical synthesis: Derivation of Freudenstein's equation, three position function generation using Freudenstein's equation.

Unit VI **08 Hours**

Static and Dynamic Force Analysis

Theory and analysis of Compound Pendulum, Concept of equivalent length of simple pendulum, bifilar suspension, Trifilar suspension. Dynamics of reciprocating engines: Two mass statically and dynamically equivalent system, correction couple, static and dynamic force analysis of reciprocating engine mechanism (analytical method only), Crank shaft torque, Introduction to T-θ diagram.

<u>Assignments:</u>

1 At least five theory questions on Basic Kinematics.

2 At least five theory questions on Steering gear mechanism.

3 At least five problems on velocity and Acceleration analysis of Mechanism: Graphical Method –I.

4 At least five problems based on Instantaneous center of rotation (ICR) method.

5 At least five problems based on velocity and acceleration diagrams for the mechanisms involving Coriolis component of acceleration

6 At least five problems on velocity and Acceleration analysis of Mechanism: Graphical Method –II.

7 At least five problems on Velocity and acceleration analysis of four bar and slider crank mechanisms using vector and complex algebra methods

8 At least five problems on kinematic analysis of mechanisms: - Analytical Method.

9 At least five problems on introduction to synthesis of linkages.

10 At least five theory questions on introduction to synthesis of linkages.

11 At least five problems on static force analysis and dynamic force analysis.

12 At least five theory questions based on T-θ diagram.

Term work

Any two of the following experiments shall be performed

1. To determine the mass moment of inertia of a connecting rod using a compound pendulum method.
2. To determine the mass moment of inertia of a flat bar using bifilar suspension method.
3. To determine the angular displacements of input and output shafts of single Hooke's joint for different shaft angles and verification of the results using computer programme.

Drawing Assignments (4 sheets of ½ imperial size)

1. To study and draw (any four) mechanisms for practical applications such as: Straight line mechanisms like Peaucellier Mechanism, Hart's Mechanism, Watt's Mechanism and Grasshopper Mechanism etc., for various link positions.
2. Two problems on velocity and acceleration analysis using Graphical methods i.e., polygons or ICR (Based on Unit 2).
3. Two problems on velocity and acceleration analysis using Graphical methods i.e., polygons involving Coriolis component or Klein's construction (Based on Unit 3).
4. Two problems based on graphical three position function generation, using either relative pole method or inversion method.

Text Books/ Reference Books

1. Rattan S. S., "Theory of Machines", Tata McGraw Hill.
2. Ballaney P. L., "Theory of Machines", Khanna Publishers, Delhi.
3. Thomas Bevan, "Theory of Machines", CBS Publishers & Distributors, Delhi.

4. Shigley J.E. and Uicker J.J., "Theory of Machines and Mechanisms", McGraw Hill, Inc.
5. Ghosh Amitabh and Malik A.K., "Theory of Machines and Mechanisms", East-west Press.
6. Groover M.P., "Industrial Robotics", McGraw Hill International.
7. Hall A.S., "Kinematics and Linkages Design", Prentice-Hall.
8. Hartenberg and Denavit, " Kinematic Analysis and Synthesis of Mechanisms".
9. Erdman, A. G. & Sandor, G.N., "Mechanism design, Analysis and synthesis", Vol 1, Prentice –Hall of India.
10. Erdman, A. G. & Sandor, G.N., "Advance Mechanism design", Vol 2, Prentice –Hall of India.

Syllabus for Unit Tests:

Unit Test-I Unit-I,II, III

Unit Test-II Unit-IV, V, VI

Manufacturing Processes
(Course Code:- C 209)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- -03- Hours/ Week	End Semester Examination 60 Marks	Theory:-03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral -- Marks	
	Total 100 Marks	03

Course Pre-requisites:

Student should have knowledge of

1. Basic knowledge of manufacturing Processes
2. Basic Knowledge of Joining and Castings
3. Basic knowledge of Materials

Course Objectives:

To provide the knowledge of

1. To acquire knowledge of sheet metal working processes and introduce to use of jigs and fixtures
2. To introduce Various non-conventional machining processes and concepts of CNC programming and robotic applications.
3. To acquire knowledge of heat treatment of steels, alloys and introduce to the procedure of processing composites

Course Outcomes:

Students should be able to

1. Understand the different press working operations, Dies and evaluate process parameters in manufacturing of sheet metal components
2. Understand the design concepts of Jigs and Fixtures and apply for the manufacturing processes .

3. Understand the different non-conventional machining processes and apply in manufacturing of components.
4. Understand the Concepts of CNC programming and robotic applications in manufacturing industries and apply for multidisciplinary applications.
5. Understand the different heat treatment processes and apply it for engineering applications
6. Understand the stages of powder manufacturing techniques, composite materials and apply for manufacturing components.

Unit I **06 Hours**

Expendable mould and permanent mould casting processes:

Sand casting, Types of pattern materials, pattern making allowances, core prints,Moulding sand- properties and testing, Hand and machine moulding, core, core making melting and pouring, Melting furnaces- Cupola, fuel fired, electric arc, Induction furnaces, Defects in casting, lost foam process, Shell moulding , Investment casting. Die casting low pressure perment mould castings hot and cold chamber processes, Centrifugal casting, Semi-centrifugal casting. Centrifuging, Continuous casting

Unit II **06 Hours**

Hot working processes, Cold working processes

A) Hot working processes:

Principle, rolling, forging - drops, press, upset. Rolling, forging- extrusion, drawing, spinning, effect of hot working.

B) Cold working processes

Cold rolling, swaging, forging extrusion- forward backward impact. Roll forging, tube drawing, wire drawing, spinning, shot peening, high energy rate forming, sheet metal, working- types of press, drives, different operations, and types of dies.

Unit III **06 Hours**

Joining process:

a) welding process-

i) Arc welding – theory SMAW, GTAW, GMAW, FCAW, Submerged arc welding stud welding.

ii) Resistance welding- Theory, spot, seam, projection welding processes.

iii) Gas welding

iv) Friction welding, ultrasonic welding, thermit welding, electron beam and laser welding.

b) Use of adhesives for joining.

Classification of adhesives, types of adhesives and their applications, surface preparation and various joints

Unit IV **06 Hours**

Turning , boring related process

Introduction, function, types, construction accessories operations, thread cutting, single and multi start thread cutting, different tools, tool materials, Tool Geometry, concept of speed, feed, depth of cut, Introduction to boring machines general arrangement and nature of work done.

Unit V **06 Hours**

Drilling ,milling machines

A) Drilling :

Fundamentals of drilling process, twist drill geometry, tool holders, Types of drilling machines, drilling operations. Types of drills, reaming process.

B) milling machines:

Fundamentals of milling process, cutters-types and geometry, Operations performed on milling machines. Dividing head, methods of indexing. Gear train calculations for helical and cam milling

Unit VI **06 Hours**

Abrasive machining processes, Plastics & Plastic Moulding

A) Abrasive machining processes:

Abrasive machining, abrasives -types, size and geometry, Grinding, grinding wheels, wheel marking, wheel selection. Wheel mounting. Types of grinding machines, Grinding faults, Honing, lapping, super finishing, buffing, burnishing process.

B) Plastics & Plastic Moulding:

Moulding characteristics of plastic, Moulding process- compression, transfer, and injection blow moulding. Mould design- Materials and construction, bulk factor, shrinkage, moulding parameters, moulding machines, extruders

Assignment

1. At least five questions on expendable mould casting processes.
2. At least five questions on Permanent mould casting processes.
3. At least five questions on hot working Processes
4. At least five questions on cold working Processes.
5. At least five questions on different joining processes.
6. At least five questions on turning and related processes.
7. At least five questions on boring and related processes.
8. At least five questions on drilling machines and operations of drilling machines
9. At least five questions on milling machines and operations of milling machines
10. At least five questions on abrasive machining processes.
11. At least five questions on Plastics and Plastic molding process.
12. At least five questions on ceramics & composite manufacturing.

Textbooks:

1. Chapman W.A.J.: "workshop technology" volume I, II, III. ELBS.
2. Hajarachoudhary S. K., Bose S. K.: "Elements of Workshop technology" – Volume I, II.
3. Begman: Manufacturing processes.
4. HMT: production technology. TMH Publishing Co. New Delhi.
5. Roy A. Lindberg: processes and metables of manufacturing fourth edition practice Hall of India New Delhi.
6. Manufacturing process, P C Pandey

Syllabus for Unit Tests:

Unit Test-I Unit-I,II ,III

Unit Test-II Unit-IV,V, VI

Material Science
(Course Code:- C 210)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- -03- Hours/ Week		
Practical:- 02- Hours/Week	End Semester Examination 60 Marks	Theory:-03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical:-01
	Total 150 Marks	04

Course Pre-requisites:

Student should have knowledge of

1. Knowledge of basic concept of Physics and chemistry
2. Basic information of engineering materials.
3. Basic knowledge of manufacturing processes.

Course Objectives:

To provide the knowledge of

1. To explain basic concepts in plastic deformations of metals.
2. To calculate the mechanical properties of engineering materials.
3. To explain applications of equilibrium phase diagrams in the manufacturing processes.
4. To acquire knowledge of elements of steels, cast irons , non ferrous materials and its multidisciplinary applications.

Course Outcomes: Students should be able to

1. Understand the concept of basics of crystal structure, mechanism of plastic deformation, and remember in annealing and re- crystallization
2. Understand mechanical testing of materials and evaluate the properties of materials to obtain an engineering system.
3. Understand the equilibrium phase diagram and analyse the properties of materials from phases .

4. Understand the steels ,cast irons properties and apply in multidisciplinary applications.
5. Understand different nonferrous materials for different components and apply in engineering applications
6. Understand basics of corrosion and apply Prevention of corrosion by different methods for industrial applications

Unit I **08 Hours**

Study of Engineering materials and Plastic Deformation:

classification of Engineering materials , Introduction to Non metallic materials, Study of crystal structure, Indexing of planes and directions, Imperfections in crystals, Mechanism of plastic deformation, Polycrystalline metals, , Work Hardening ,Cold and hot working, Annealing and re -crystallization.

Unit II **08 Hours**

Mechanical Testing of Metals:

Study of destructive testing, Tensile test , Engineering stress and true stress strain, Numerical based on Evolution of properties, Hardness testing such as Brinell, Rockwell, Vickers and Micro hardness test, Impact test, Fatigue test, Creep test, Cupping test, Non Destructive testing such as Liquid dye penetrate test, Magnaflux test, Eddy current test , Ultrasonic testing and Radiography testing

Unit III **08 Hours**

Study of Equilibrium Diagrams

Related terms and their definitions, Hume Ruther's rule of solid solubility, Allotropy and polymorphism, Solidification, Dendritic growth, Cooling curves, Plotting of Equilibrium diagrams, Lever rule, Coring, Eutectic system, Partial eutectic and eutectoid system, Non Equilibrium cooling and its effects

Unit IV **08 Hours**

Study of Steel and Cast Irons.

Production of steel and cast Irons, Allotropy of Iron, Iron and Iron Carbide

Equilibrium Diagram, Classification of Steels, Specifications of steels, Plain Carbon steel, Applications and microstructure of steels, Study of cast iron, Classification and applications of cast irons, Properties and manufacturing methods, Effect of alloying elements, Alloy cast irons etc.

Unit V **08 Hours**

Study of Non Ferrous Materials

Introduction, Copper and it's alloy, Alpha and alpha beta brasses, Zinc Equivalent , Copper Nickel alloy, Bronzes, Aluminum and it's alloy, Precipitation and age hardening ,Dispersion strengthening , Nickel and it's alloy, Metals at High and Low Temperature, Bearing Materials etc.

Unit VI **08 Hours**

Corrosion and Prevention:

Introduction, Types of corrosion, Oxide film growth laws, Action of hydrogen, Polarization, Stress corrosion, Season Cracking, Prevention of corrosion, Design of component, Modification of environment, Cathodic Protection, Deposition and coating, Ion Implantation, PVD, CVD, Powder coating etc.

List of Assignments

1. At least five theory questions on classification of engineering materials.
2. At least five theory questions on Study of crystal structure.
3. At least five theory questions on plastic deformation
4. At least five theory questions on mechanical testing of methods
5. At least five theory questions on non-destructive testing
6. At least five theory questions on Plotting of Equilibrium diagrams.
7. At least five theory questions on study of equilibrium diagrams
8. At least five theory questions on study of steel and cast irons.
9. At least five theory questions on Iron and Iron Carbide Equilibrium Diagram.
10. At least five theory questions on study of non-ferrous materials
11. At least five theory questions on corrosion and methods of its prevention.
12. At least five theory questions on Powder coating.

Term Work:

List of Experiments: (Any Eight)

1. Tensile test to determine strength and other mechanical properties.
2. .Hardness test Brinell and Vickers.
3. Rockwell and Poldi hardness test.
4. .Study of Microstructure of plane carbon steel.
5. Study of Microstructure of cast irons.
6. Magnetic Particle test.
7. Liquid penetrate test.
8. Utrasonic Test.
9. Eddy Current test
10. Visual inspection of casting and welded components.
11. Study of nonferrous material and alloys.

Practical Examinations:

Term work and Practical Examinations will be based on above syllabus.

Textbooks:

1. “Material Science and Physical Metallurgy”,Dr.V.DKodgere, Everest Publication, Pune.
2. “Physical Metallurgy”, S H Avner , McGraw Hill Publication.
3. “Material science and metallurgy”, O P Khanna, Khanna Publication, Delhi.
4. “Material Science and Engineering”, R K Rajput S K Kataria and Sons Publication, Delhi.

Unit Tests-

Unit Test-I Unit-I,II III

Unit Test-II Unit-IV ,V, VI

Turbo Machinery
(Course Code:- C 211)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours/ Week	End Semester Examination 60 Marks	Theory:-03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral -- Marks	
	Total 100 Marks	03

Course Pre-requisites:

Student should have knowledge of

1. Fundamentals of Mechanical Engineering
2. Fluid Mechanics
3. Engineering Mathematics

Course Objectives:

To provide the knowledge of

1. To impart students with knowledge of impulse momentum principle and its applications, velocity triangles and their analysis.
2. To inculcate concepts of impulse and reaction water turbines.
3. To provide knowledge of flow through steam nozzles and steam turbines
4. To provide knowledge of pumps and compressors

Course Outcomes:

Students should be able to

1. Understand the concepts of impulse momentum principle and impulse turbine; and apply the principle to various cases.
2. Understand concepts of reaction turbines and analyze their overall performance
3. Understand concepts of steam turbines and steam nozzles; and analyze their overall performance.
4. Understand concepts of centrifugal pump; and analyze its overall performance.
5. Understand concepts of centrifugal compressor; and analyze its overall performance.
6. Understand concepts of axial flow compressor; and analyze its overall performance.

Unit I **08 Hours**

Introduction of Turbo Machinery and Impulse Water Turbines

Introduction of Turbo Machinery

Impulse-momentum principle ,fixed and moving flat plates, curved vanes , with jet striking at the centre of vane and jet striking tangentially on to the vane, Impact of jet on hinged plates ,Impact of jets on series of flat plates and vanes, water wheels, velocity ri angles and their analysis, work done and efficiency calculations

Impulse Water Turbines

Main components and constructional features of Pelton wheel, Concept of centrifugal head, general energy equation for turbine, Velocity diagrams and analysis, Important non-dimensional parameters such as speed ratio, jet ratio, flow ratio, Condition for maximum hydraulic efficiency.

Unit II **08 Hours**

Reaction Water Turbines

Classifications, Francis, Propeller, Kaplan Turbines, construction features, velocity diagrams and analysis, DOR, draft tubes- types and analysis, cavitations causes and remedies, specific speed, performance characteristics and governing of reaction turbines, selection of turbines.

Unit III **08 Hours**

Steam Turbines

Steam nozzles: types and applications, Equation for velocity and mass flow rate [Elementary treatment only]

Steam Turbines: Classifications (Axial and Radial), construction details, compounding of steam turbines, velocity diagrams and analysis of Impulse and reaction turbines (single & multi stage), governing, performance characteristics, selection of turbines.

Unit IV **08 Hours**

Centrifugal Pumps

Classification, components of centrifugal pump, various terms associated with centrifugal pump, various heads, velocity triangle and their analysis, effect of outlet blade angle, capitation, NPSH, Thomas Cavitations factor, priming of pumps, installation, specific speed, Performance characteristics of centrifugal pump, Axial thrust, maintenance, trouble and remedies, series and parallel operation of pumps, system resistance curve, water hammer problem in pumping system, selection of pumps.

Unit V **08 Hours**

Centrifugal Compressor

Classification of rotodynamic compressors, blowers, fans. Centrifugal compressor: Construction, flow process on T-S Diagram, velocity diagram and Euler's work, slip factor and its effect on work input, actual work input, dimension parameters, pre-whirl losses, surging, choking, stalling characteristics

Unit VI **08 Hours**

Axial Compressor

Construction, stage velocity triangles and its analysis, enthalpy entropy diagram, dimensionless parameters, flow through the blade rows, pressure rise across the stage, stage losses and efficiencies, performance characteristics

Assignments

1. At least Five theory questions on Impulse turbine.
2. At least Five numerical questions on Impulse turbine.
3. At least Five theory questions on Reaction water turbine.
4. At least Five numerical questions on Reaction water turbine.
5. At least Five theory questions on steam turbines.
6. At least Five numerical questions on steam turbines.
7. At least Five numerical questions on centrifugal pumps.
8. At least Five theory questions on centrifugal pumps.
9. At least Five theory questions on centrifugal compressor.
10. At least Five numerical questions on centrifugal compressor.

11. At least Five theory questions on axial compressor.
12. At least Five numerical questions on axial compressor.

Text Books

1. P. N. Modi and Dr. S. M. Seth, "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi.
2. R. K. Rajput, "Hydraulic Machines", S.Chand Publishers, New Delhi.
3. Turbines, Compressors & Fans, S.M. Yahya, Tata-McGraw Hill.
4. Turbomachines, B. U. Pai, Wiley India.
5. Fluid Mechanics & Hydraulic Machines S.C. Gupta 1e Pearson Education.
6. Thermal Turbo machines, Dr. Onkar Singh, Wiley India.
7. Fluid Mechanics and Hydraulic Machines by R.K.Bansal.
8. Basic concepts in Turbo machinery by Grant Ingram.

Syllabus for Unit Test:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V, VI

Numerical Methods and Optimization Techniques (Course No. C212)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03- Hours/ Week	End Semester Examination 60 Marks	Theory:-03
Tutorial:- 01Hours/Week	Unit Test 20 Marks	
Practical:- 02- Hours/Week	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical:-02
	Total 150 Marks	05

Course Pre-requisites:

Students should have basic knowledge of:

1. Basics of statistics
2. Basics of Probability

Course Objectives:

To provide the knowledge of

1. To find roots of any equation by iterative method
2. To solve simultaneous linear equation by iterative and matrix method
3. To curve fitting and interpolation
4. To numerical differentiation, numerical integration, ordinary differential equation
5. To single variable and multi variable optimization

Course Outcomes:

Students should be able to

1. Understand iterative methods to find the roots of any equation and apply them in engineering problems
2. Understand matrix and iterative methods to solve simultaneous linear equations and apply them in engineering problems
3. Understand methods of curve fitting and interpolation and apply them in engineering problems

4. Understand methods to solve numerical differentiation, numerical integration, ordinary differential equation and apply them in engineering problems
5. Understand classical and numerical methods to optimize a single variable equation and apply these methods in engineering problems
6. Understand classical and numerical methods to optimize a multi-variable equation and apply these methods in engineering problems

Unit I **08 Hours**

Roots of Equations:

Significant figures, Accuracy and Precision, Error definition, Round-Off errors, Truncation error, Total numerical error. Bracketing methods-Bisection and False position method. Open methods, Newton Raphson method

Unit II **08 Hours**

Linear Algebraic Equation:

Navie Gauss elimination, pitfalls of Gauss Elimination, techniques of improving solutions, complex numbers.

Unit III **08 Hours**

Curve Fitting and Interpolation:

Least-Square Regression-Linear regression,. Interpolation-Newton's divided difference interpolating polynomial. Lagrange's interpolating polynomial

Unit IV **08 Hours**

Numerical differentiation and Integration:

Trapezoidal rule, Simson's rules, integration with unequal segment, multiple integral, derivatives of unequally spaced data. Engineering Applications.

Ordinary Differential Equations:

Euler's method, improvement of Euler's method, Runge-Kutta method, system of equations

Unit V **08 Hours**

Single Variable Optimization

Optimum problem formulation, Engineering optimization problem, Optimality Criteria, Bracketing methods, region-Elimination method, Point Estimate Method, Gradient Based method

Unit VI **08 Hours**

Multivariate Variable Optimization

Optimality criteria, Unidirectional search, Direct search method- Evolutionary optimization, simplex search, Gradient Based Methods- Steepest Descent method, Newton's method.

Assignment

1. At least five MATLAB codes based on Bisection Method
2. At least five MATLAB codes based on Gauss elimination method.
3. At least five MATLAB codes based on Trapezoidal Method.
4. At least five MATLAB codes based on Laplace interpolation.
5. At least five MATLAB codes based on Euler's method.
6. At least five MATLAB codes based on Least square method
7. At least five numerical questions based on Bisection Method
8. At least five numerical questions based on Gauss elimination method.
9. At least five numerical questions based on Trapezoidal Method.
10. At least five numerical questions based on Laplace interpolation.
11. At least five numerical questions based on Euler's method.
12. At least five numerical questions based on Least square method

Term Work:

Minimum six program on from each unit using Matlab.

Text books

1. Optimization for Engineering Design: Algorithms and Examples By Kalyanmoy Deb, Prentice-Hall of India Private Limited, New Delhi.
2. Introduction to Optimum Design, Jasbir S Arora, Elsevier Academic Press.
3. Numerical Methods for Engineers, Steven Chaptra and Raymond Canale, McGraw Hill.
4. Numerical Methods for Scientific and Engineering Computations, M. K. Jain, S.R.K. Ayengar and R. K. Jain.

Syllabus for Unit Test:

Unit Test-I Unit-I,II ,III

Unit Test-II Unit-III,IV ,VI

Professional Skills Development-IV
(Course Code:- C 213)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- -04- Hours/ Week	End Semester Examination 100 Marks	Theory:-04
	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation -- Marks	
	Term Work / Oral -- Marks	
	Total 100 Marks	04

Course Pre-requisites:

Students should have basic knowledge of

1. Basic concepts of Maths, Logical reasoning and English Grammar taught in the last semester.
2. An overall idea about the difference in personal and professional communication in terms of vocabulary used
3. Knowledge of writing skills, importance of professionalism in emails and letters
4. They should be aware of concepts of self-esteem, self-assessment and its importance in setting long term and short term goals.
5. Awareness of the interpersonal skills like team work and introduction to Leadership taught during the last semester.
6. Body language and importance of non-verbal communication to maintain professionalism.

Course Objectives:

To provide the knowledge of

1. To acquaint them with the level of complexity presented in recruitment tests and also provide them techniques
2. To learn word list, various strategies of conflicts/disputes and concepts of leadership.
3. To focuses on the higher aspects of soft skills such as grooming them on corporate etiquettes and various formats of email/ letter writing so that can present themselves as professionals further both in oral and written communication.

Programme: B. Tech. Mechanical

Course Outcomes: Students should be able to

1. Understand the concepts of Maths, Logical reasoning and English grammar and apply short cuts/ tricks to solve questions in less time from the recruitment point of view.
2. Understand and apply academic word list in the right context of both academically and professionally.
3. Understand the importance of email etiquettes, types of letter writing and distinguish between the format of formal and informal emails/letters which are useful in their coroporate life.
4. Understand and Apply various strategies of conflict resolution and handling criticism through amicable and positive ways to settle team conflicts/disputes.
5. Understand the major concepts of leadership like coaching, mentoring and learn effective time management strategies- Pareto principle (the 80-20 rule of time management) which students can apply in the corporate life.
6. Understand the importance of grooming, body language, etiquettes and apply various telephonic interview startergies to conduct themselves in a professional life with impressively and confidently.

Unit I **18 Hours**

Aptitude (Maths, Logical Reasoning, English)

- Maths
  - Simple Interest and Compound Interest
  - Ratio, Proportion and Average
  - Mixture and Allegation
- Logical Reasoning
  - Data Interpretation
  - Data Sufficiency
- English
  - Grammar I
  - Vocabulary - Analogies

Unit II **04 Hours**

Essential Grammar - IV

- Vocabulary – Academic word List

Unit III **04 Hours**

Written Communication- III

- Email writing and etiquettes – formal and informal email writing, format of various types of email, do's and don'ts of email writing
- Letter writing – formal letters, job application letter, and cover letter.
- Essay writing – mnemonics top develop ideas and write essays, structure of essays

Unit IV **04 Hours**

Self-Awareness and Conflict Resolution

- Self-assessment & Perception & attitudes.
- Analyzing skills & weaknesses and habits.
- Developing positive attitude & handling criticism positively
- Handling conflicts in the personal and corporate sector
- Causes of conflicts in work scenario.
- Ways and methods for conflict resolution

Unit V **04 Hours**

Interpersonal Skills - III

- Mentoring, Difference between Leadership and Management
- Leading with examples
- Time management -The Time Management Matrix, Pareto Principle

Unit VI **04 Hours**

Aptitude (Maths, Logical Reasoning, English)

- Maths
  - Simple Interest and Compound Interest
  - Ratio, Proportion and Average
  - Mixture and Allegation
- Logical Reasoning
  - Data Interpretation
  - Data Sufficiency
- English
  - Grammar I
  - Vocabulary - Analogies

Text Books

1. APAART: Verbal Ability
2. APAART: Logical Reasoning
3. APAART: Quantitative Aptitude
4. APAART: Speak Well 1 (English Language and Communication)
5. APAART: Speak Well 2 (Soft Skills)
6. APAART: Verbal Ability

Production Practice-III
(Course Code:- C 214)

Teaching Scheme	Examination Scheme	Credit Scheme
Practical:- 2 Hours/ Week	End Semester Examination -- Marks	
	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation -- Marks	
	Term Work 50 Marks	Practical : 01
	Total 50 Marks	01

Course Pre-requisites:

Students should have basic knowledge of

1. Basic knowledge of Production practice I and Production practice II
2. Basic knowledge of Material science
3. Basic Knowledge of Manufacturing processes

Course Objectives:

To provide the knowledge of

1. To acquire skills for different turning operations and its calculations
2. To acquaint the skills for indexing and gear cutting operation on milling machine
3. To understand the CNC lathe machine operations
4. To acquire the knowledge of single spindle automated lathe operations
5. To acquire skills for grinding operations

Course Outcomes:

Students should be able to

1. Understand various operations to be carried out on lathe machine to create jobs as per given drawing.
2. Understand the indexing mechanisms on milling machine.

3. Apply the knowledge of indexing mechanism to create a gear cutting job on milling machine.
4. Understand CNC lathe machine, CNC programming and apply it to create job as per given specification.
5. Understand different operations on single spindle automated lathe machine to create a job.
6. Understand the different operations to be carried out on the grinding machines and apply to create a job.

<u>Term Work:</u>

Each Candidate shall be required to complete and submit the following jobs (Any Two)

1. One Composite job consisting of 3 to 4 pieces as below Machining of components covering all operations on Lathe (Including Internal and external threading, Taper Matching, Knurling) One Job Grinding operation on Above (Turning) Job
2. Gear Cutting One Job
3. One job on CNC Machine. (Turning).
4. One job on Single Spindle Automate Lathe

Note:

Write a journal/term book based on above syllabus.

Rules regarding ATKT, Continuous Assessment and award of Class A. T. K. T.

- A candidate who is granted term for B. Tech. Semester-I will be allowed to keep term for his/her B. Tech. Semester-II examination even if he/she appears and fails or does not appear at B. Tech. Semester-I examination.
- A candidate who is granted term for B. Tech. Semester - III will be allowed to keep term for his/her B. Tech. Semester-IV examination even if he/she appears and fails or does not appear at B. Tech. Semester-III examination.
- A candidate who is granted term for B. Tech. Semester-V will be allowed to keep term for his/her B. Tech. Semester-VI examination if he/she appear and fails or does not appear at B. Tech. Semester-V examination.
- A candidate who is granted term for B. Tech. Semester-VII will be allowed to keep term for his/her B. Tech. Semester-VIII examination if he/she appears and fails or does not appear at B. Tech. Semester-VII examination.
- A candidate shall be allowed to keep term for the B. Tech. Semester-III course if he/she has a backlog of not more than 3 Heads of passing out of total number of Heads of passing in theory examination at B. Tech. Semester-I & II taken together.
- A candidate shall be allowed to keep term for the B. Tech. Semester-V of respective course if he/she has no backlog of B. Tech Semester-I & II and he/she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 heads of passing in term work and practical examination or term work and oral examination.
- A candidate shall be allowed to keep term for the B. Tech. Semester-VII course if he/she has no backlog of B. Tech. Semester-III & IV and he/she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 Heads of passing in term work and practical examination or term work and oral examination.

CONTINUOUS ASSESSMENT

- In respect of Term work at B. Tech. Semester-I & II, B. Tech. Semester-III & IV and B. Tech. Semester-V & VI, target date shall be fixed for the completion of each job, project experiment or assignment as prescribed in the syllabus and the same shall be collected on the target date and assessed immediately at an affiliated college by at least one pair of the concerned teachers for the subject and the marks shall be submitted at the end of each term to the Principal of the college.
- Termwork and performance of Practical/Oral examination shall be assessed on the basis of the depth of understanding of the principles involved, correctness of results and not on ornamental or colorful presentation.

- For B. Tech. Semester-VII & VIII, term work assessment will be done by external and internal examiners jointly during the examination schedule declared by the university. The record of continuous assessment shall be made available to the examiners during Term work and practical and Term work and oral examinations. Examiner shall use this record for overall assessment of the performance of the student. Every practical/term work assignment shall be assessed on the scale of 25 marks and weightage of 25 marks shall be distributed as follows:

Sr. No.	Activity	Marks
1	Timely Submission	07
2	Presentation	06
3	Understanding	12

- Marks obtained out of 25 for all assignments together will be converted on scale of marks assigned to term work of respective subject in the structure of the course.

CLASS

The class should be awarded to the student on the basis of aggregate marks obtained together in both the semesters of the respective year by him. The award of class shall be as follows.

A	Aggregate 66% or more marks	First Class with Distinction
B	Aggregate 60% or more marks but less than 66%	First Class
C	Aggregate 55% or more marks but less than 60%	Higher Second Class
D	Aggregate 50% or more marks but less than 55%	Second Class
E	Aggregate 40% or more marks but less than 50%	Pass Class

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY) Pune.

College of Engineering, Pune- 411043
The Structure of the Curriculum: 2014 Course
Choice Based Credit System (CBCS)

COURSE STRUCTURE AND SYLLABUS

(Choice Based Credit System - 2014 Course)

B. TECH. MECHANICAL: SEMESTER- V & VI

Programme: B. Tech. Mechanical

Vision of the Bharati Vidyapeeth (Deemed to be University) College of Engineering is:

To be a World Class Institute for Social Transformation through Dynamic Education

Missions of the Bharati Vidyapeeth (Deemed to be University) College of Engineering are:

- To provide quality technical education with advanced equipment, qualified faculty members, infrastructure to meet needs of profession & society.
- To provide an environment conducive to innovation, creativity, research and entrepreneurial leadership.
- To practice and promote professional ethics, transparency and accountability for social community, economic & environmental conditions.

Goals of the Bharati Vidyapeeth (Deemed to be) University College of Engineering are:

- Recruiting experienced faculty.
- Organizing faculty development programs.
- Identifying socio-economically relevant areas & emerging technologies.
- Constant review &up gradation of curricula.
- Up gradation of laboratories, library & communication facilities.
- Collaboration with industry and research & development organizations.
- Sharing of knowledge, infra-structure and resources.
- Training, extension, testing and consultancy services.
- Promoting interdisciplinary research.

Vision of the Mechanical Engineering Department is:

To develop, high quality Mechanical Engineers through dynamic education to meet social and global challenges.

Mission Statements of the Mechanical Engineering Department are:

- To provide extensive theoretical and practical knowledge to the students with well-equipped laboratories and ICT tools through motivated faculty members.
- To inculcate aptitude for research, innovation and entrepreneurial qualities in students.

- To acquaint students with ethical, social and professional responsibilities to adapt to the demands of working environment.

Program Educational Objectives (PEOs) of the B. Tech. Mechanical are:

Graduates will be able,

- To fulfill need of industry and society with theoretical and practical knowledge.
- To engage in research, innovation, lifelong learning and continued professional development.
- To fulfill professional ethics and social responsibilities.

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Statements of Programme Specific Outcomes (PSOs)

PSO1: Apply the knowledge of thermal, design, manufacturing engineering and computational sciences to solve Mechanical Engineering problems.

PSO2: Apply Mechanical Engineering principles for research, innovation and develop entrepreneurial skills.

PSO3: Apply concepts of mechanical engineering to asses' societal, environmental, health and safety issues with professional ethics.

B. TECH. MECHANICAL: SEMESTER- V (2014 Course)

S. N.	Course	Teaching Scheme (Contact Hrs. /week)			Examination Scheme (Marks)							Total Credits		
		L	P/ D	T	EndSem. Exam.	Continuous Assessment					Total	TH	TW	Total
						Unit Test	Attendance	Assignments	TW/OR	TW/PR				
C301	Machine Design –I*	3	2	-	60*	20	10	10	50	--	150	3	1	4
C302	Theory of Machines	4	2	-	60	20	10	10	50	--	150	4	1	5
C303	Advanced Computer Graphics & Solid Modelling	3	2	-	60	20	10	10	--	50	150	3	1	4
C304	Heat and Mass Transfer	4	2	-	60	20	10	10	50	--	150	4	1	5
C305	Advanced Manufacturing Processes	3	--	-	60	20	10	10	--	--	100	3	--	3
C306	Professional skill Development-V	4	--	-	100	-		-	--	--	100	4	--	4
	Total	21	08	0	400	100	50	50	150	50	800	21	4	25

* End Semester examination of duration 4 Hours.

B. TECH. MECHANICAL: SEMESTER- VI (2014 Course)

S. N.	Course	Teaching Scheme (Contact Hrs. /week)			Examination Scheme (Marks)							Total Credits		
		L	P/ D	T	End Sem. Exam	Continuous Assessment					Total	TH	TW	Total
						Unit Test	Attendance	Assignments	TW/OR	TW/PR				
C307	Machine Design –II*	4	2	--	60*	20	10	10	50	--	150	4	1	5
C308	Refrigeration Air Conditioning	3	2	--	60	20	10	10	50	--	150	3	1	4
C309	Internal Combustion Engines	3	2	-	60	20	10	10	-	50	150	3	1	4
C310	Mechanical Measurement & Metrology	4	2	--	60	20	10	10	--	50	150	4	1	5
C311	Elective -I	3	--	--	60	20	10	10	--	--	100	3	--	3
C316	Professional skill Development-VI	4	--	--	100	-		-	--	--	100	4	--	4
	Total	21	8	--	400	100	50	50	100	100	800	21	4	25

* End Semester examination of duration 4 Hours.

Total Credits Sem. V – 25

Total Credits Sem. VI – 25

Grand Total - 50

Elective-I

1) Machine Tool Design
2) Energy Audit and Management
3) Reliability Engineering
4) Design of Pumps, Blowers and Compressors
5) Management Information System

Rules for Conducting Tests

Mode of the test

- In each semester for each subject three tests shall be conducted. The schedule for the same will be declared at the commencement of academic year in the academic calendar.
- Each test shall carry 20 marks.
- University examination pattern has given weightage of 20 marks for the tests.
- To calculate these marks following procedure is followed:
  - i) Out of the three tests conducted during the semester, the marks of only two tests in which the candidate has shown his/her best performance shall be considered, to decide the provisional marks in each subject.
  - ii) Average marks obtained in two tests in which students have performed well, shall be considered as provisional marks obtained by the student in the tests.
  - iii) If the candidate appears only for two tests conducted during the semester, he/she will not be given benefit of the best performance in the tests.
  - iv) If the candidate appears only for one test conducted during the semester, to calculate the marks obtained in the tests it will be considered that the candidate has got 0 (zero) marks in other tests.
  - v) The provisional marks obtained by the candidate in class tests should reflect as proportional to theory marks. In cases of disparity of more than 15% it will be scaled down accordingly; these marks will be final marks obtained by the student. No scaling up is permitted.
  - vi) If the candidate is absent for theory examination or fails in theory examination his final marks for tests of that subject will not be declared. After the candidate clears the theory, the provisional marks will be finalized as above.
- Paper pattern for tests
  - i) All questions will be compulsory with weightage as following

Question 1 - 7 marks

Question 2 - 7 marks

Question 3 - 6 Marks

  - ii) There will not be any sub-questions.
- For granting the term it is mandatory to appear for all three tests conducted in each semester.
- Roll nos. allotted to students shall be the examination nos. for the tests.

Machine Design I
(Course No: C301)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination60 Marks	Theory : 03
Practical:- 02 Hours/Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical : 01
	Total 150 Marks	04

Course Pre-requisites:

Student should have knowledge of

1. Engineering drawing
2. Mechanical Engineering Drawing
3. Solid Mechanics

Course Objectives:

1. To study basic concepts of machine design, aesthetic and ergonomic.
2. To Design of different types of machine elements and to analyze the forces acting on machine element.
3. To Design of machine component for finite and infinite life and subjected to fluctuating load

Course Outcomes: Students Will be able to

1. Understand the basic concept of machine design, engineering material, aesthetic and ergonomic consideration in design
2. Understand the fundamental concepts for design of shaft, keys and coupling and evaluate forces and dimensions.
3. Understand the concept to design Power Screws and analyze it for various applications.

4. Understand the Design concept of spring and evaluate its strength and stiffness.
5. Understand the concept of fasteners and welded joints; analyze when it is subjected to different loading conditions.
6. Understand the basic concept of fluctuating loads and Analyze design of components under fluctuating loads.

Unit I **06 Hours**

Basic Concept of Machine Design

Traditional types of design methods, basic procedure of machine design, introduction to use of standards in design, selection of preferred series, introduction to aesthetic and ergonomic consideration in design. Engineering materials- properties, designation, and selection of material. Weighted point method. Castiglione's theorem.

Unit II **06 Hours**

Design of Shafts, Keys & Couplings

Shaft design on strength basis, shaft design on torsional rigidity basis, ASME code of shaft design, keys – saddle, sunk, feather, woodruff, square, flat, Kennedy key, key design, design of splines, types of couplings, muff coupling, flange coupling, flexible bush pin type coupling.

Unit III **06 Hours**

Design of Power Screws

Forms of threads, differential & compound screw, design of square & trapezoidal threads , self-locking screw, design of power screws, screw jack, recirculating ball screw, design of bolted joint.

Unit IV **06 Hours**

Design of Springs

Types, materials, stress & deflection equations for helical, tension & compression spring, torsional and multi leaf springs, styles of ends, nipping of leaf spring, shot peening, spring in series & parallel, concentric springs,

Unit V **06 Hours**

Design of Welded & Riveted Joints

Design of welded joint: advantages, limitations, butt & fillet welds, parallel & transverse fillet welds, axially loaded unsymmetrical welded joint, eccentric loading in plane of weld, welded joint subjected to bending & torsional moment, basic types of riveted joints, different parameters of a riveted joints, uses of riveted joints, failure of riveting joint, strength of riveting joint and efficiency of riveting joints.

Unit VI **06 Hours**

Design for Fluctuating Load

Stress concentration - causes & remedies, fluctuating stresses, fatigue failures, S-N curve, endurance limit, notch sensitivity, endurance strength modifying factors, design for finite and infinite life, cumulative damage in fatigue failure, Soderberg, Gerber, Goodman, modified Goodman diagrams, fatigue design of components under combined stresses.

Assignment:

1. At least five theory of questions based on basic concept of machine design.
2. Two or three design projects which includes details and assembly drawing of shaft and bearing/ types of coupling.
3. Two or three design projects based on screw jack (Details and Assembly)
4. At least five numerical questions based on design of springs.
5. At least five numerical questions based on design of welding.
6. At least five numerical questions based on riveted joints.
7. At least five numerical questions based on design for fluctuating load.
8. At least five theory questions based on design of springs.
9. At least five theory questions based on design of welding.
10. At least five theory questions based on riveted joints.
11. At least five theory questions based on design for fluctuating load.
12. At least one design project by using Auto CAD.

Textbooks:

Term work shall consist of two design projects by using AutoCAD/manually. Design projects should be in the form of system design comprising of machine elements studied in syllabus. Design data book should be used extensively.

Four assignments on remaining topics.

Text Books

1. Shigley J. E. and Mischke C. R., “Mechanical Engineering Design”, McGraw Hill Publication Co. Ltd.
2. Spotts M. F. and Shoup T.E., “ Design of Machine Elements”, Prentice Hall International
3. Bhandari V. B, “Design of Machine Elements”, Tata McGraw Hill Publication Co. Ltd.
4. Juvinal R. C, “Fundamentals of Machine Components Design”, John Wiley and Sons.

Reference Books

1. Black P.H. and O. Eugene Adams, “Machine Design”, McGraw Hill Book Co. Inc.
2. Willium C. Orthwein, “Machine Components Design”, West Publishing Co. and Jaico Publications House.
3. Hall A. S., Holowenko A. R. and Laughlin H. G, “Theory and Problems of Machine Design”, Schaum’s Outline Series.
4. Sharma C. S. and Purohit Kamlesh, “Design of Machine Elements”, PHI Learing Pvt. Ltd.
5. D. K. Aggarwal & Sharma P. C., “Machine Design”, S.K Kataria and Sons
6. Gope P. C., “Machine Design: Fundamentals and Applications”, PHI Learing Pvt. Ltd.
7. “Design Data- P. S. G.” College of Technology, Coimbatore.
8. Bhandari, V. B. “Machine Design data book”, Tata McGraw Hill Publication Co. Ltd.

Syllabus for Unit Test:

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV, V and VI

Theory of Machines
(Course No: C302)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04 Hours/Week	End Semester Examination60 Marks	Theory: 04
Practical:-02 Hours/Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical : 01
	Total 150 Marks	05

Course Pre-requisites:

Student should have knowledge of

1. Fundamentals of engineering mechanics
2. Engineering Mathematics
3. Mechanism of Machine

Course Objectives:

1. To develop competency in understanding of theory of all types of gears and to understand the analysis of gear train.
2. To develop competency in understanding of different types of clutch, breakes and dynamometer.
3. To develop competency in drawing the cam profile and understand the follower motion
4. To develop competency in mechanisms for system control with Gyroscope and working mechanism of different types of governors

Course Outcomes: Learner will able to-

1. Understand the kinematics of spur gear, interference and undercutting and evaluate its performance.
2. Understand the kinematics of Helical, Bevel and Worm Gears and apply it to perform force analysis of gears.
3. Understand the concept of inertia of geared systems and gear trains and evaluate torque transmitting capacity and speed in gear trains.

4. Understand the dynamic behaviour principle and operations of clutches, brakes, dynamometers; and evaluate frictional losses and torque transmission capacity.
5. Understand the basics of cam and Follower and apply it to design cam profile for given follower motions.
6. Understand the basic concepts of gyroscopes and governors; and analyze the gyroscopic effect.

Unit I **08 Hours**

Kinematics of Spur Gears

Classification and applications of gears, terminology of gearing, law of gearing, velocity of sliding, conjugate action, forms of teeth, path of contact, arc of contact, interference, undercutting, methods to avoid interference and undercutting, effect of centre distance variation, friction between gear teeth, involutometry.

Unit II **08 Hours**

Kinematics of Helical, Bevel and Worm Gears

Helicalgears: Terminology, virtual number of teeth, torque transmitted, Spiral gears: terminology and efficiency.

Worm gears & bevel gears: Terminology, geometrical relationships, tooth forces, torque transmitted.

Unit III **08 Hours**

Inertia of Geared Systems and Gear Trains

Inertia of gear systems, types of gear trains - simple, compound, reverted and epicyclic gear trains, analysis of epicyclic gear trains, torque on sun and planet gears, compound epicyclic gear trains, bevel epicyclic gear trains.

Unit IV **08 Hours**

Friction, Clutches , Brakes & Dynamometers

Friction:

Friction and types of friction, laws of friction, Friction in turning pairs, Friction circle, Friction axis, Friction in 4 bars and single slider crank mechanism.

Friction Cutches:

Pivot and collar friction, plate clutches, cone clutch, centrifugal clutch, torque transmitting capacity

Brakes and Dynamometers:

Different types of brakes, Shoe brakes, External and internal shoe brakes, Block brakes, Band brakes, Band and block brakes, Braking torques, Different types of absorption and transmission type dynamometers

Unit V **08 Hours**

Cams & Followers

Types of cams and followers, analysis follower, determination of cam profiles analysis of cams with specified contours- of standard motions to the for given follower motions, circular arc cam, eccentric cam, methods of control: pressure angle, radius of curvature and undercutting, kinematically equivalent system, jump phenomenon. Introduction to advanced cam curves.

tangent cam,

Unit VI **08 Hours**

Gyroscopes and Introduction to Governors

Gyroscopes, concept of gyroscopic action, gyroscopic couple, effect of gyroscopic couple on ship, airplanes, and vehicles.

Introduction to Governors, Types centrifugal governor (Watt, Porter, and Hartnell governor only), controlling force, governor effort and governor power with numerical treatment, sensitivity, stability, isochronism and hunting, friction, insensitiveness. (No Numerical Treatment)

List of Assignments

1. Minimum five theory questions based on kinematics of spur gear.
2. Minimum five theory questions based on kinematics of helical and bevel gears
3. Minimum five theory questions based on kinematics of worm gear.
4. Minimum five theory questions based on types of gear trains.
5. Minimum five theory questions based on friction clutches.

6. Minimum five theory questions based on brakes & dynamometers.
7. Minimum five theory questions based on cams and followers.
8. Minimum five theory questions based on gyroscopes and governors.
9. Minimum five numerical questions based on helical gear.
10. Minimum five numerical questions based on bevel and worm gears.
11. Minimum five numerical questions based on compound gear trains.
12. Minimum five numerical questions based on brakes and clutches.
13. Minimum five numerical questions based on cams and followers.

(To be solved on drawing sheet).

Text Books/ Reference Books

1. Ratan S. S., "Theory of Machines", Tata McGraw Hill
2. Beven T ," Theory of Machines", Longman Publication
3. Ballaney P. L. "Theory of Machines", Khanna Publications

Term Work:

The term work shall consist of the following experiments:

1. To draw conjugate profile for any general type of gear tooth.
2. To generate involute gear tooth profile and to study the effect of undercutting and rack shift using model.
3. To study various types of gearboxes such as: Industrial gear box, Synchromesh gearbox, Differential gearbox, or PIV gearbox.
4. To measure transmitted torque and holding torque of an epicyclic gear train.
5. To study the slip in belt drives.
6. To draw cam profiles for various types of follower motions.
7. To verify gyroscopic couple.
8. To determine the characteristic curves for centrifugal governor and to find its coefficient of insensitiveness and stability.

Reference Books

1. Hannah and Stephans, "Mechanics of Machines", Edward Arnolde Publication.
2. Jagdish Lal, "Theory of Machines ", Metrapolitan Book Co. Pvt. Ltd. N. Delhi.
3. Khurmi, R. S. and Gupta, J. K." Theory of Machines", Eurasia Publishing House (Pvt.) Ltd., New Delhi.

4. Ghosh Malik, "Theory of Mechanism and Machines", East-West Pvt. Ltd..
5. Dr.V.P.singh,"Theory of machine", Dhanpatrai and son.
6. David H. Myszka, "Machines and Mechanism", PHI..

Syllabus for Unit Tests:

Unit Test-I Unit-I,II and III

Unit Test-II Unit-IV,V and VI

Advanced Computer Graphics & Solid Modelling (Course No: C303)

Teaching Scheme	Examination Scheme		Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination	60 Marks	Theory : 03
Practical:- 02 Hours / Week	Unit Test	20 Marks	
	Assignments	10 Marks	
	Internal Evaluation	10 Marks	
	Term Work / Pract.	50 Marks	Practical : 01
	Total	150 Marks	04

Course Pre-requisites:

1. Engineering Graphics
2. Mechanical engineering drawing

Course Objectives:

1. To introduce new and exciting field of Intelligent CAD with particular focus on engineering product design.
2. To introduce basic analytical concepts that are used to create and manipulate geometric models by using computer program.
3. To develop competency in engineering design by modern computational methods.
4. To develop 3-D geometric model of machine components including assembly and drafting.

Course Outcomes: Students Will able to:

1. Understand different algorithms and apply it to generate pixel position of points, lines, circles, ellipse and different polygons.
2. Understand the concepts of 2D transformations apply it for composite transformation using homogeneous co-ordinate systems.
3. Understand the concepts 3D transformation and apply for different types of projections.
4. Understand the concepts of geometric modeling and parametric representation apply it to draw analytic and synthetic curves.
5. Understand the concepts of surface modeling and parametric representation apply it for analytic and synthetic surfaces.
6. Understand steps required for solid modeling and the concept of CAD/CAM data exchange.

Unit I **06 Hours**

Output primitives

Points and Lines, Line Drawing Algorithms-DDA Algorithm, Bresenham's Line Drawing Algorithms, Thick Line Segments. Circle and Ellipse Generation Algorithm. Polygon-Polygon Filling, Flood Fill, Boundary Fill, Scan Line Fill.

Unit II **06 Hours**

Two Dimensional Transformations

Basic Transformation – Translation, Rotation, Scaling, Reflection, Shear, Matrix Representation and Homogeneous Co-Ordinates.

Composite Transformations.

Unit III **06 Hours**

Three-Dimensional Transformations

Introduction to 3D, Translation, Rotation, Scaling, Reflection, Shear, Affine and Perspective Geometry. Orthographic, Axonometric, Oblique Projection.

Unit IV **06 Hours**

Geometrical Modeling

Mathematical Representation of Curves, Wire Frame Model, Wire Frame Entities.

Parametric Representation of Analytic Curves- Lines, Circles, Ellipses. Parametric Representation of Synthetic Curves- Hermit, Cubic-Splines, Bezier Curve, B-Spline Curve.

Curve Manipulation: Displaying, Evaluating Points on Curve, Blending Segmentation.

Surface Manipulation: Displaying, Evaluating Points & Curve on Surfaces, Segmentation, Trimming, Intersection, Projection and Transformations.

Unit V **06 Hours**

Surface Modeling

Surface Models, Surface Entities, Surface Representation.

Parametric Representation of Analytic Surfaces- Plan Surfaces, Ruled Surfaces, Surface of Revolution, Tabulated Cylinder. Parametric Representation of Synthetic Surfaces- Hermit, Bi-cubic Surfaces, Bezier Surfaces, B-spline Surfaces.

Unit VI **06 Hours**

Solid Modeling

Solid Models, Solid Entities, Solid Representation, Fundamentals of Solid Modeling, Boundary Representation, Constructive Solid Geometry, Sweep Representation.

CAD/CAM Data Exchange: Evaluation of data exchange formation, IGES data representation & Structure, PDES Data representation, STEP Architecture.

Assignments:

1. At least five theory questions based on output primitives.
2. At least five theory questions based on two-dimensional transformation.
3. At least five theory questions based on three-dimensional transformation.
4. At least five theory questions based on geometrical modelling.
5. At least five theory questions based on surface modeling.
6. At least five theory questions based on solid modeling.
7. At least five problems based on algorithms to generate point, lines, circle, ellipse and different polygons.
8. At least five problems based on basic transformations in 2D modelling.
9. At least five problems based on transformations in 3D modelling.
10. At least five theory questions based on parametric representation of synthetic curves.
11. At least five theory questions based on parametric representation of synthetic surfaces.
12. At least five theory questions based on CAD/CAM data exchange.

Term Work:

The term work shall consist of record of eight experiments from the following:

1. DDA Line Drawing Algorithm.
2. 2 D Transformation.
3. 3D Transformation.
4. Assignment on 2-D sketching with geometrical and dimensional constraints using any commercially used solid modeling software.

5. Assignment on parametric solid modeling of a machine component using various commands and features of the software.
6. Assignment on solid modeling of the parts of a machine (min. 5 components).
7. Assignment on assembly modeling of the parts modeled in assignment 6 using proper mating conditions and generation of exploded view.
8. Generation of production drawings of the parts and assembly with appropriate tolerancing.

Reference Books

1. Ibrahim Zeid and R. Siva-Subramaniam – "CAD/CAM- Theory and Practice", Tata McGraw Hill, Publishing Co. 2009.
2. Rao P. N., "CAD/CAM", Tata McGraw Hill.
3. Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", Second edition, Addison–Wesley, 2000.
4. Martenson, E. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.
5. Hill Jr, F.S., "Computer Graphics Using OpenGL", Pearson Education, 2003.
6. Rao Singeresu S., "Engineering Optimization-Theory and Practice", New Age International Limited Publishers, 2000.
7. Ray C. Johnson. "Optimum Design of Mechanical Elements", Wiley, John & Sons, 1981.
8. Radhakrishnan P., Subramanyam S., "CAD/CAM/CIM", New Age International.
9. Ramamurti V., "Computer Aided Mechanical Design and Analysis", Tata McGraw Hill-1992.

Syllabus for Unit Tests:

Unit Test-I Unit-I,II and III

Unit Test-II Unit-IV,V and VI

Heat and Mass Transfer
(Course No: C304)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04 Hours / Week	End Semester Examination 60 Marks	Theory : 04
Practical:- 02 Hours / Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical : 01
	Total 150 Marks	05

Course Pre-requisites:

1. Engineering Thermodynamics
2. Engineering Mathematics
3. Fluid Mechanics

Course Objectives:

To provide the knowledge of

1. laws governing process of heat and mass transfer
2. One dimensional steady, unsteady heat conduction.
3. Natural and forced convection heat transfer, condensation and boiling
4. radiative heat transfer and heat exchangers.

Course Outcomes: Students Will be able to

1. Understand laws governing process of heat transfer and use them to analyze practical problems.
2. Understand the concepts of one-dimensional steady heat conduction and use them to analyze practical problems.
3. Understand the concepts of fins, unsteady heat conduction and use them to analyze practical problems.

4. Understand the concepts of natural and forced convection and use them to analyze practical problems.
5. understand the concepts of radiative heat transfer, condensation and boiling and use the concept of radiation to analyze practical problems
6. Understand the concept of mass transfer and analyze the performance of heat exchangers.

Unit I **Introduction and Basic Concepts** **08 Hours**

Overview of subject, Modes of heat transfer, Applications of heat transfer in different fields of engineering, Fourier's law of conduction, Newton's law of cooling, Stefan- Boltzmann's law of radiation, Isotropic and anisotropic materials, Three dimensional heat conduction equation in Cartesian coordinate for anisotropic material for steady state condition, and reduction to Fourier equation, Laplace equation and Poisson's equation, Three dimensional heat conduction equation in cylindrical and spherical coordinates (no derivation), Thermal diffusivity.

One dimensional steady state heat conduction:

One dimensional steady state heat conduction through a plane wall, cylindrical wall and sphere, Analogy between heat flow and electricity, heat conduction through a composite slab, cylinder and sphere, Overall heat transfer coefficient, Concept of thermal resistance and conductance.

Unit II **08 Hours**

Thermal Insulation

Purpose of insulation, critical radius of Insulation, Economic thickness of Insulation, Thermal contact resistance, thermal conductivity and it's variation with temperature for metals, non metallic solids, gases and liquids, one dimensional problems of variable thermal conductivity. One Dimensional Steady State Heat Conduction with Internal Heat

Generation:

Symmetrical boundary condition in plane wall, conduction in solid, hollow cylinder and sphere, practical problems of heat generation.

Unit III **Extended Surfaces** **08 Hours**

Heat transfer through extended surfaces, Classification of fins, Derivation of differential equation for fins with constant cross sectional area with insulated tip boundary conditions, Effectiveness and efficiency of a fin,

design of thermo well.

Unsteady state heat conduction : System with negligible internal resistance, Biot & Fourier numbers, Criteria for neglecting internal temperature gradient, Concept of time constant

Unit IV **08 Hours**

Convection

Introduction to hydrodynamic and thermal boundary layer, Laminar & turbulent flow over & closed conducts, convection heat transfer coefficients & order of magnitude, Dimensional analysis of free & forced convection, physical significance of the dimensionless ,parameters, Nusselt's number, Reynold's number, Prandtl's number, Grashoff's number, Stanton number, Rayleigh number.

Forced Convection

Empirical correlations for heat transfer in laminar and turbulent flow over a flat plate and in a circular pipe, Concept of hydraulic diameter, reference temperature.

Natural Convection

Flow patterns, Empirical correlations for free convection, heat transfer over horizontal, vertical plate

Unit V **08 Hours**

Thermal Radiation

Fundamental concepts, Black body radiation, Kirchoff's law, Planck's distribution law, Wein's displacement law, Stefan Boltzmann law, Surface emission, relative properties of a surface, Grey, black and real surface, solid angle and intensity of radiation, Lambert's Cosine law, Heat exchange by radiation between two finite black surfaces, Radiation shape factor, use of shape factor charts, Irradiation, radiosity, Electrical network, Heat exchange between two infinitely parallel planes and cylinders, Radiation shields.

Condensation and Boiling

Film and drop-wise condensation, heat transfer coefficient for laminar film condensation on vertical and inclined plate (descriptive treatment), Correlations for condensation on and inside tubes, modes of pool boiling, critical heat flux, pool boiling.

Unit VI **08 Hours**

Heat Exchangers

Classification, Applications of heat exchangers, Heat exchanger analysis,

Logarithmic Mean Temperature Difference for parallel and counter flow heat exchangers, LMTD correction factors, fouling factor. The effectiveness: NTD method for parallel and counter flow heat exchangers, Design considerations for heat exchanger.

Mass Transfer

Introduction, Modes of mass transfer, Analogy between heat and mass transfer, Mass diffusion (Mass basis, Mole basis), Fick's law of diffusion

Assignments

1. At least five theory questions based on basics concepts of heat transfer.
2. At least five theory questions based on insulation of heat conduction with internal heat generation.
3. At least five theory questions based on extended surfaces and unsteady heat transfer.
4. At least five theory questions based on forced convection.
5. At least five theory questions based on natural convection.
6. At least five theory questions based on radiation and condensation &boiling.
7. At least five theory questions based on heat exchanger and mass transfer.
8. At least five numerical questions based on basics concepts of heat transfer.
9. At least five numerical questions based on insulation of heat conduction with internal heat generation.
10. At least five numerical questions based on extended surfaces and unsteady heat transfer.
11. At least five numerical questions based on forced convection.
12. At least five numerical questions based on natural convection.
13. At least five numerical questions based on thermal radiation and condensation &boiling.

Term Work:

Term work shall consist of any eight experiments

1. Determination of thermal conductivity of insulating powder.
2. Determination of thermal conductivity of metal rod.
3. Determination of thermal conductivity of different materials in composite wall.
4. Temperature distribution along a length of a fin and determination of fin effectiveness and fin efficiencies.
5. Determination of film heat transfer coefficient on a hollow vertical tube heated from inside.
6. Determination of film heat transfer coefficient for turbulent flow inside a pipe.
7. Determination of emissivity of a non black surface.
8. Determination of Stefan-Boltzmann constant.
9. Performance of a parallel flow and counter flow heat exchanger.
10. Calibration of thermocouple.
11. Demonstration of a heat pipe.
12. CFD simulation of conduction or convection problem.

Textbooks:

1. Incropera F. P., Dewitt D. P., "Fundamentals of Heat and Mass Transfer", John Wiley.
2. Cengel Y. A. and Ghajar A. J., "Heat and Mass Transfer – Fundamentals and Applications", Tata McGraw Hill Education Private Limited.
3. Sukhatme S. P., "A Textbook on Heat Transfer", Universities Press.
4. Mills A. F., "Basic Heat and Mass Transfer", Pearson.

Reference Books

1. Venkatesan S. P., "Heat Transfer", Ane Books Pvt. Ltd.
2. Holman J. P., "Fundamentals of Heat and Mass Transfer", McGraw – Hill publication.
3. Nag P. K., "Heat & Mass Transfer", McGraw Hill Education Private Limited.
4. Thirumaleshwar M., "Fundamentals of Heat and Mass Transfer", Pearson Education India.
5. Sachdeva R.C., "Fundamentals of Engineering Heat and Mass Transfer", New Age Science

Syllabus for Unit Tests:

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV, V and VI

Advanced Manufacturing Processes
(Course No: C305)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination 60 Marks	Theory : 03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Total 100 Marks	03

Course Prerequisites:-

Student should have knowledge of

1. manufacturing processes, Mechanical engineering drawing
2. Basic information of material science

Course Objectives:

1. To acquire knowledge of sheet metal working processes and introduce to use of jigs and fixtures.
2. To introduce various non-conventional machining processes and concepts of CNC programming and robotic applications.
3. To acquire knowledge of heat treatment of steels, alloys and introduce to the procedure of processing composites

Course Outcomes: Learner will be able to

1. Understand the different press working operations, Dies and evaluate process parameters in manufacturing of sheet metal component
2. Understand the design concepts of Jigs and Fixtures and apply for the manufacturing processes.
3. Understand the different non-conventional machining processes and apply in manufacturing of components.
4. Understand the Concepts of CNC programming and robotic applications in manufacturing industries and apply for multidisciplinary applications.
5. Understand the different heat treatment processes and apply it for engineering applications

6. Understand the stages of powder manufacturing techniques, composite materials and apply for manufacturing components.

Unit I **06 Hours**

Sheet Metal Working

Study of various press tools and presses, Study of various processes like Piercing, Notching forming, drawing, coining etc. Elements of dies and punches. Types of dies – simple, compound, combination and progressive dies and punches for various press working operations such as punching, blanking, drawing, bending, forming, coining etc. Calculations of clearances, centre of pressure, forces, press tonnage, blank size, number of draws, strip layout, sheet utilization, ratio. Methods of reducing forces. Design of simple blanking die, Progressive die, & Deep Drawing die.

Unit II **06 Hours**

Jigs and Fixtures

Definitions, elements, Basic principles and guide lines for design. Location, types of locators and their selection. Clamping, basic principles, types and their selection, indexing methods. Design of drilling jigs. Design of milling& Turning fixtures.

Unit III **06 Hours**

Non-Conventional Machining

Concept of non-conventional machining. Study of processes like, Electrochemical Machining, Electro Discharge Machining, Abrasive Jet Machining, Plasma Machining, LASER Machining, Ion beam Machining, Ultrasonic Machining, Electron Beam Machining with reference to process capabilities, working principle, Material removal rate, Advantages and limitations.

Unit IV **06 Hours**

C. N. C. Machine Tools & Robotics

Principle of operation of CNC, Types, Features, Direct numerical control (DNC) and its applications. NC part programming, axes nomenclature of CNC machines. Manual part programming using. Computer aided part programming using APT. Types of Robots, construction and operation of robots, robot axes and configuration, robot applications, robot selection and economic justification. FMS, FMC and Adaptive Control.

Unit V **06 Hours**

Heat Treatment of Steels and Alloys

Iron and Iron Carbide Equilibrium Diagram, Transformation product of Austenite, Martensite transformation, Time- Temperature. Transformation curve, Heat treatment of steels, Annealing, Normalizing, Hardening and tempering, Hard ability, Jominy End quench test, Surface hardening heat treatments, Carburizing, Nitriding, Carbo-nitriding, Induction and flame hardening, Tool steels, Classification, Properties and application of tool steels, Heat treatment of tool steels.

Unit VI **06 Hours**

Powder Metallurgy , Ceramics and Composite Manufacturing

Important characteristics and methods of powder production, different techniques - pressing, extruding, isostatic moulding, fiber metal process, sintering and hot pressing.

Introduction to composite materials, basic concepts, constituent materials for composites, advantages, limitations of composites and application of composites. Manufacturing of Composites: Introduction, molding process for polymer matrix composites, metal matrix composites, ceramic matrix composites.

Assignments:

1. At least five numerical questions based on LMTD, NTD and mass transfer.
2. At least five theory questions based on sheet metal working.
3. At least five theory questions based on jigs and fixtures.
4. At least five theory questions based on non-conventional machining.
5. At least five theory questions based on CNC machine tools and robotics.
6. At least five theory questions based on heat treatment of steels and alloys.
7. At least five numerical questions based on calculations of clearances in sheet metal working.
8. At least five numerical questions based on design of simple blanking die.
9. At least five numerical questions based on design of drilling jigs.
10. At least five numerical questions based on design of milling and turning fixtures.
11. At least five theory questions based on economic justification of robot.
12. At least five theory questions based on powder metallurgy.
13. At least five theory questions based on ceramics &composite manufacturing.

Text Books

1. Kodgere V. D., “Material Science and Physical Metallurgy”, Everest Publication, Pune
2. Donaldson, Lacain and Goold, “Tool Design”, Tata McGraw Hill
3. Kempster M. H. A., “Introduction to Jigs and Fixtures Design”, Viva Books Ltd.
4. ASTME, “Tools Engineering Handbook”
5. Sharma P. C., “Production Engineering”, Khanna Publication
6. Hoffman, “Introduction to Jigs and Fixture”, Galgotia Publishers
7. Radhakrishnan P. and Subramanyan CAD/ CAM/CIM Wiley Eastern Ltd.
8. Rao P. N., Tewari N. K. and Kundra T. K., “Computer Aided Manufacturing”, Tata McGraw Hill
9. Groover M. P., “Automation, Production System and Computer Integrated Manufacturing”,

Reference Books

1. Amstead B. H., Philip F, Ostwald and Myron L, Begeman, “Manufacturing Processes" John Wiley and sons, eighth edition.
2. Benidict G. F., “Advanced Manufacturing Processes": Marcel Deker Publisher
3. Cook N. “Manufacturing Analysis", Addison- Wesley Publishing Co., 1966.
4. Weller, “Non-traditional Machining Process": SME Publications.
5. Mishra P. K., “Non-Conventional Machining Process”, Narosa Publication.
6. “Production Technology: HMT Ltd", McGraw-Hill Pub. 1986.
7. “Machining Data Handbook: 3rd (Third) edition” Machinability Data Center Technical Staff, 1980

Syllabus for Unit Test:

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV, V and VI

Professional Skill Development-V
(Course No: C306)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04 Hours / Week	End Semester Examination 100 Marks	Theory : 04
Practical:- -- Hours / Week	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation -- Marks	
	Total 100 Marks	04

Course Pre-requisites:

Student should have knowledge of

1. Basic knowledge of PSD-I, PSD-II, PSD-III and PSD-IV
2. Knowledge of advance vocabulary
3. Awareness of public speaking
4. Basic knowledge of writing skills
5. Basic knowledge of handling criticism and teamwork

Course Objectives:

1. To acquaint students with the advance skills in aptitude and reasoning whereby enhancing the employability skills
2. To develop the skills of advance professional communication through advance vocabulary
3. To promote grooming skills in graduates through mock group discussions, mock presentations and mock interviews

Course Outcomes: Learner will able to-

1. Understand advance short tricks of the aptitude and reasoning and apply them in recruitment and competitive examinations
2. Understand the mnemonics for writing a convincing paragraph and apply them in the presentation while handling complex topics in group discussion

3. Understand the various strategies of conflict resolution through amicable way to settle team conflicts/disputes and apply them in handling criticism
4. Understand the various strategies of problem-solving skills and apply them in handling group and team problems
5. Understand the effective time management strategies- Pareto principle (the 80-20 rule of time management) and apply them in the corporate life.
6. Understand the handling Case studies effectively and incorporate the right approach towards Case Studies asked during the recruitment process

Unit I **24 Hours**

Aptitude (Maths, Logical Reasoning, English)

Maths

- Time, Speed & Distance
- Time & Work
- Simple Interest & Compound Interest in continuation
- Maths Revision

Logical Reasoning

- Data Interpretation
- Data Sufficiency
- Set Theory & Syllogisms
- Reasoning Revision

English

- Grammar – II – (Adjective, Verb, Sub- Verb Agreement)
- Grammar- (Tenses)
- Vocabulary
- Verbal Ability- Revision

Unit II **24 Hours**

Soft Skills & English Communication

- Situational Conversation
- Situational Writing
- GD Orientation
- Mock GD-1
- Mock GD-2
- Mock GD-3
- Conflict Resolution
- Problem Solving Skills

- Time- Management Skills
- Handling Case Studies
- Management Games
- Business Meeting Etiquettes

Textbooks:

1. APAART: Verbal Ability
2. APAART: Logical Reasoning
3. APAART: Quantitative Aptitude
4. APAART: Speak Well 1 (English Language and Communication)
5. APAART: Speak Well 2 (Soft Skills)

Machine Design II
(Course No: C307)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04 Hours / Week	End Semester Examination 60 Marks	Theory : 04
Practical:- 02 Hours / Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral 50 Marks	Practical : 01
	Total 150 Marks	05

Course Pre-requisites:

Student should have knowledge of

1. Solid Mechanics
2. Theory of Machines
3. Machine Design-I

Course Objectives:

1. To design and analyze spur and helical gear.
2. To analyze and selection rolling and sliding contact bearings for required application.
3. To study belt, rope and chain drive and evaluate forces acting on it.

Course Outcomes: Learner will be able to-

1. Understand the concepts of design for various manufacturing process and apply it for different mechanical process.
2. Understand the concepts of designing spur gear and apply it to design a spur gear.
3. Understand the concepts of designing Helical gear and apply it to design a helical gear.
4. Understand the concepts of different types of rolling contact bearings and apply selection procedure different applications.
5. Understand the concepts of different types of sliding contact bearings and evaluate parameters of bearing design.
6. Understand technical details about belt, rope and chain drive and evaluate forces acting on belt drive.

Unit I **08 Hours**

Design For Manufacture

General principles of design for manufacture & assembly (DFM & DFME), Principles of design of casting & forging, Design for machining, Design for powder metallurgy, Design for welding.

Unit II **08 Hours**

Design of Spur Gears

Gear drives, Classification of gears, Selection of types of gears, Standard system of gear tooth. Spur Gears: Number of teeth & face width, Types of gear tooth failure, Desirable properties & selection of gear materials, Force analysis, Beam strength, Velocity factor, Service factor, Load concentration factor, Effective load on gear, Wear strength, Estimation of module based on beam & wear strength, Gear design for maximum power capacity, Estimation of dynamic tooth load by velocity factor, Spott's equation, Buckingham's equation, Methods of gear lubrication. Introduction to Gear design standards like AGMA, IS.

Unit III **08 Hours**

Design of Helical Gears

Transverse & normal module, virtual number of teeth, Force analysis, Beam & wear strength, Effective load on gear tooth, Estimation of dynamic load by velocity factor, Spott's equation, Buckingham's equation.

Unit IV **08 Hours**

Rolling Contact Bearing

Equivalent bearing load, Load life relationship, Selection of bearing life, Selection from manufacturer’s catalog, Taper roller bearing, Design for cyclic load & speed, Bearing with probability of survival other than 90%, Lubrication & mounting construction materials, Selection of oil seals & gaskets, Pre loading, Types of failure of bearings and its remedies.

Unit V **08 Hours**

Sliding Contact Bearing

Basic modes for lubrication, Viscosity. Effect of temperature on viscosity, Viscosity index, Additives, Greases, Selection of lubricants. Viscous flow through rectangular slot, Load carrying capacity & flow requirement of hydrostatic step bearing, Energy losses, Hydrodynamic lubrication, Reynolds equation, Summerfield number, Raimondi & Boyd's method, Temperature rise in hydrodynamic bearings, Parameters of bearing design, Length to diameter ratio, Unit bearing pressure, Radial clearance,

Minimum oil film thickness, Constructional details of bearings, Bearing materials & their selection, Sintered metal bearings, Comparison of rolling & sliding contact bearing.

Unit VI **08 Hours**

Belts, Ropes and Chain Drives

Materials and construction of flat and V belts, geometric relationships for length of belt, power rating of belts, concept of slip & creep, initial tension, effect of centrifugal l tension, maximum power condition, selection of flat and V belts from manufacturer's catalogue, belt tensioning methods, relative advantages and limitations of flat and V belts, construction and applications of timing belts .Wire Ropes (Theoretical Treatment Only): Construction of wire ropes, lay of wire ropes, stresses in wire rope, selection of wire ropes, rope drum construction and design. Chain Drives (Theoretical Treatment Only): Types of power transmission chains, Geometry of chain Polygonal effect of chain, Modes of failure for chain, Lubrication of chains

Assignments:

1. At least five theory questions based on basics of design for manufacture.
2. At least five theory questions based on design of spur gears.
3. At least five theory questions based on design of helical gears.
4. At least five theory questions based on rolling contact bearing.
5. At least five theory questions based on sliding contact bearing.
6. At least five theory questions based on belts and ropes drive.
7. At least five theory questions based on chain drives.
8. At least five numerical questions based on design of spur gears.
9. At least five numerical questions based on design of helical gears.
10. At least five numerical questions based on rolling contact bearing.
11. At least five numerical questions based on sliding contact bearing.
12. At least five numerical questions based on belts, ropes and chain drives.
13. At least one design project comprising of machine elements by using Auto CAD.

Term Work

1. Term work shall consist of two design projects by using AUTOCAD/manually. Design projects should be in the form of system design comprising of machine elements studied in syllabus. Design data book should be used extensively.
2. Four assignments- based on remaining topics.
3. Report- Industrial visit to gear manufacturing unit.

Reference Books

1. Black P. H. and O. Eugene Adams, “Machine Design”, McGraw Hill Book Co. Inc.
2. Willium C. Orthwein, “Machine Components Design”, West Publishing Co. and Jaico Publications House.
3. Hall A.S., Holowenko A.R. and Laughlin H.G, “ Theory and Problems of Machine Design”, Schaum’s Outline Series.
4. Sharma C. S. and Kamlesh Purohit, Design of Machine Elements, PH I Learing Pvt. Ltd.
5. Aggarwal D. K. & Sharma P.C., “Machine Design”, S. K. Kataria and Sons
6. P. C. Gope, “Machine Design: Fundamentals and Applications”, PHI Learing Pvt. Ltd.
7. “Design Data - P.S.G.” College of Technology, Coimbatore.
8. Bhandari, V. B., “Machine Design data book”, Tata McGraw Hill Publication Co. Ltd.
9. Mahadevan K.,Balveera ReddyK., “Design Data Hand book for Mechanical Engineers”,CBS Publishers

Unit Tests-

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV, V and VI

Refrigeration and Air Conditioning
(Course No: C308)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination 60 Marks	Theory : 03
Practical:- 02 Hours / Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation10 Marks	
	Term Work / Oral 50 Marks	Practical : 01
	Total 150 Marks	04

Course Pre-requisites:

1. Knowledge of basic concepts in heat transfer.
2. Basic information of thermodynamics.
3. Basic knowledge of fluid mechanics.

Course Objectives:

1. To study fundamental principles and different methods of refrigeration and air conditioning.
2. Study of various refrigeration cycles and evaluate performance using Mollier charts and/ or Refrigerant property tables.
3. Comparative study of different refrigerants with respect to properties, applications and Environmental issues.
4. Understand the basic air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning.
5. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

Course Outcomes: Students Will be able to understand-

1. Different methods of refrigeration systems.
2. Simple vapour compression system and different multi-pressure systems

3. Vapour absorption system and different types of refrigerants
4. Various psychrometric processes used in air conditioning
5. Different components of refrigeration and air conditioning systems
6. Details of ducts for air conditioning system

Unit I **06 Hours**

Methods of Refrigeration

Ice refrigeration, evaporative refrigeration, refrigeration by expansion of air, refrigeration by throttling of gas, vapour refrigeration system, steam jet refrigeration system, refrigeration by using liquid gases, Thermoelectric and ultrasound refrigeration.

Air refrigeration system: Definition, refrigeration load, unit of refrigeration, Reverse Carnot cycle, Bell Coleman cycle, Methods of air refrigeration systems, simple air cooling system, boot strap system, reduced ambient system, regenerative system.

Unit II **06 Hours**

Simple Vapour Compression System

Limitations of air refrigeration system, development of vapour compressor cycle, effect of operating parameters on VCC, use of P-H charts, actual vapour compression cycle.

Multi Pressure Systems Introduction to multistage compression, two stage compression with flash gas removal, with liquid intercooler, Cascade systems.

Unit III **06 Hours**

Vapour Absorption System

Introduction, Simple Vapour absorption system, practical vapour absorption system, COP of an ideal vapour absorption system, Water ammonia system, Electrolux refrigerator, Lithium-Bromide absorption System, Comparison between VCC and VAC (no mathematical treatment).

Refrigerants: Desirable properties of refrigerants, classification of refrigerants, secondary refrigerants, alternative refrigerants for CFC's, HCFC'S, ozone depletion potential (ODP), Global warming Potential (GWP).

Unit IV **06 Hours**

Psychrometry

Introduction, Psychrometric terms, Use of Psychrometric charts, Psychrometric processes, adiabatic saturation temperature, evaporative cooling, by pass factor of coil, efficiency of coil, adiabatic mixing of two air streams, Air washers, Thermodynamics of human body with environment effective temperature, comfort chart, factors influencing human comfort.

Unit V **06 Hours**

Air Conditioning Systems

Definition, factors, equipment used, classification, all air system, all water system, air water system, unitary and central air conditioning, in filtration and ventilation loads, concepts of SHF, RSHF, ERSHF, ADP.

Components of Refrigeration and Air Conditioning System: Compressors, condensers, evaporators, expansion devices such as capillary tubes, automatic expansion valves, thermostatic expansion valves and controls such as thermostats, humidistat, Solenoid, Installation, charging, testing and maintenance, study of modern trends in RAC

Unit VI **06 Hours**

Ducts

Introduction, classification of ducts, duct material, pressure in ducts, flow through duct, pressure losses in duct, friction losses, dynamic losses, air flow through simple duct system, equivalent diameter, for determination of duct size.

Food Preservation: Cold storage, control and modified atmosphere (CAMA) storages, mobile refrigeration and air conditioning, refrigerant piping selection, pressure drop, valves, fitting, insulating materials.

Term Work:

The term work shall consist of record of any eight experiments from the following:

1. Test on vapour compression test rig.
2. Test on air conditioning test rig.
3. Test on ice plant test rig.
4. Study of non-conventional refrigeration system.
5. Determination of cooling load of air conditioning system (case study).

6. Determination of refrigeration load in cold storage (case study / visit).
7. Study of installation /operation/maintenance practices for refrigeration system.
8. Visit to any refrigeration or air conditioning plant.
9. Trial on heat pump test rig
10. Test on vapour absorption test rig.
11. Market survey of various refrigerating & air conditioning systems which include the equipments with related specifications, manufacturer, cost. (minimum 3 to 4 equipments)
12. Determination of energy efficiency of refrigeration or air conditioning system.

Text Books/ Reference Books

1. Arora C. P., "Refrigeration and Air Conditioning", Tata McGraw Hill
2. Arora S. C., Domkundwar S., "Refrigeration and Air Conditioning", Dhanpat Rai and Company
3. Dossat Ray I, "Principal of Refrigeration", Wiley Eastern Limited
4. Manohar Prasad, "Refrigeration and Air Conditioning", Wiley Eastern Limited
5. Khurmi R. S. and Gupta J. K., "Refrigeration and Air Conditioning", Eurasia Publication House (P) Ltd. New Delhi
6. Stocker W. F. and Jones J. W., "Refrigeration and Air Conditioning", McGraw Hill International Editions

Syllabus for Unit Tests:

Unit Test-I Unit-I,II and III

Unit Test-II Unit-IV,V and VI

Internal Combustion Engines
Course No. C309

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination 60 Marks	Theory : 03
Practical:- 02 Hours / Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Pract. 50 Marks	Practical : 01
	Total 150 Marks	04

Course Pre-requisites:

1. Knowledge of basic concept heat transfer.
2. Basic information of thermodynamics.

Course Objectives:

To provide the knowledge of

1. constructional features of IC engines and air standard cycles
2. various systems used in IC engines for their smooth operations
3. Performance analysis of IC engines.
4. phenomenon of combustion, fuels, emmissions and pollution control in IC engines

Course Outcomes: Students Will be able to,

1. Understand constructional features of IC engines and analyze air standard cycles.
2. Understand fuel supply systems in SI and CI engines and analyze performance of a simple carburetor.
3. Understand IC engine systems viz. ignition, cooling, governing and lubrication.
4. Understand terms related to IC engine testing and analyze their performance.
5. Understand phenomenon of combustion in SI and CI engines.
6. understand details of fuels, emmissions and pollution control in IC engines

Programme: B. Tech. Mechanical

Unit I **06 Hours**

Constructional Features of Reciprocating I. C. Engine

Engine components, Engine classification Cycle Analysis of I. C. Engines:

Fuel air cycle analysis, Comparison of P-V diagram of air standard cycles, Fuel air cycle & actual cycle

Unit II **06 Hours**

Fuel Supply Systems

S. I. Engines:

Carburetion, Mixture requirements, Essential parts of modern carburetor, Carburetors used on automobiles, Calculation of A/F ratio, M.P.F.I. system for modern automobile engines.

C. I. Engines:

Functional requirements of an injection system, Typical arrangement of solid injection system, Types of fuel injection system, Fuel pump & fuel injectors, Quantity of fuel & size of nozzle orifice.

Unit III **06 Hours**

I. C. Engine Systems

Ignition System:

Battery & coil ignition system, Magneto ignition system, Electronic ignition system, Advantage over mechanical contact breaker point system.

Engine Cooling System:

Air cooling, Water cooling, Thermostatic radiators

Lubrication System:

Dry sump lubrication, Wet sump lubrication – Fully pressurized, Oil filters

Governing System:

Quality governing, Quantity governing, Hit & miss governing

Unit IV **06 Hours**

Testing & Performance of I. C. Engine

Determination of brake power, Indicated power,

Friction power, Determination of brake thermal efficiency, Mechanical efficiency, Volumetric efficiency, Energy balance, Performance characteristics.

Supercharging:

Objects of supercharging, Effects on performance, Limits, Methods of Supercharging & turbocharging, Limitation of turbocharging.

Unit V **06 Hours**

Combustion in S. I. Engines

Stages of combustion, Effect of engine variables on ignition lag & flame propagation, Abnormal combustion: Theories, Effects & Controlling measures, Combustion chambers for S. I. engines. Combustion in C. I. Engines:

Stages of combustion, Ignition delay & factors influencing delay period, Diesel knock & its control, Combustion chambers for C. I. engines.

Unit VI **06 Hours**

Emissions & Pollution Control

Emissions from S. I. and C. I. engines & their harmful effects, Catalytic convertors, Contemporary & proposed emission norms, BHARAT STAGE-

I to IV emission norms, EGR system.

Fuels: Types of fuels for I. C. engines, Rating of S. I. & C. I. engine fuels, Alternative fuels for I. C. engines & future trends, Hybrid vehicles.

Assignment

1. At least five theory questions based on constructional features of I.C. engines &cycle analysis of I.C. engine.
2. At least five theory questions based on fuel supply system.
3. At least five theory questions based on I.C. engine system
4. At least five theory questions based on engine testing & performance.

5. At least five theory questions based on combustion of SI Engine.
6. At least five theory questions based on combustion of CI Engine.
7. At least five theory questions based on emissions & pollution control.
8. At least five numerical questions based on constructional features of I.C. engines & cycle analysis of I.C. engine.
9. At least five numerical questions based on fuel supply system.
10. At least five numerical questions based on I.C. engine system
11. At least five numerical questions based on engine testing & performance.
12. At least five numerical questions based on combustion of SI Engine.
13. At least five numerical questions based on combustion of CI Engine.
14. At least five numerical questions based on emissions & pollution control.

Term Work:

1. Study of carburetor / MPFI system
2. Study of fuel pump & injector.
3. Trial on multi cylinder petrol engine – Morse Test.
4. Trial on diesel engine to determine energy balance & variable load performance.
5. Variable speed trial on petrol / diesel engine.
6. Trial on computerized I. C. engine to plot P – è diagram.
7. Trial / demonstration of smoke meter & exhaust gas analyzer.
8. Study of battery, magneto & electronic ignition system.
9. Study of superchargers & turbochargers.
10. Study of combustion chambers in S. I. & C. I. engines.
11. Study of recent hybrid cars in market

Reference Books

1. Ganesan V., Internal Combustion Engines, Tata McGraw Hill Publishing House
2. M. L. Mathur& R. P. Sharma, A Course in I. C. Engines, DhanpatRai& Sons
3. V. M. Domkundwar, A Course in I. C. Engines, DhanpatRai& Co.
4. Shrinivasan, Automobile Engines, Tata McGraw Hill Publishing House – CBS Publication

Syllabus for Unit Tests:

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV, V and VI

Mechanical Measurement & Metrology (Course No: C310)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04 Hours / Week	End Semester Examination 60 Marks	Theory : 04
Practical:- 02 Hours / Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Pract. 50 Marks	Practical : 01
	Total 150 Marks	05

Course Pre-requisites:

Student should have knowledge of

1. Students should have Basic knowledge of Mechanical terms Force, Pressure, Temperature, and Electronics terms like as Voltage, Resistance and Current.
2. Students should have Basic knowledge of Measuring Units, Mathematics, and Various Measurement terms.

Course Objectives:

Student should be able to

1. Use various precision measuring instruments viz. Vernier caliper, micrometer etc.
2. Acquire knowledge of different sensors and transducers
3. Acquire knowledge of tolerances, gauges and measurement of surface finish

Course Outcomes: Students Will be able to

1. Understand static and dynamic characteristics of measurement systems
2. Know different devices used for linear and angular measurement
3. Measure temperature, pressure, strain and fluid flow using different sensors for various applications
4. Using of concepts like limits, fits and tolerances for designing the limit gauges.
5. Use displacement, velocity, position, force, torque, level sensors for specific applications
6. Measure various screw thread or gear tooth parameters using specific equipment’s.

Unit I **08 Hours**

Introduction to Measurement systems

Significance of Measurements, Mechanical Measurements, Classification of Measuring Instruments, Generalized Measurements Systems.

Static Characteristics of Measurement Systems: Sensitivity, Calibration, Accuracy, Linearity, Static Error, Precision, Reproducibility, Threshold, Resolution, Hysteresis, Drift, Span, Range.

Dynamic Characteristics of Measurement Systems: Speed of response and measuring lag, fidelity and dynamic error, overshoot, dead time and dead zone. Standard test inputs: Step. Ramp, Impulse and Sinusoidal Inputs.

Errors in Measurements: Types & Sources of Errors and Uncertainty Analysis in Measurements. Probable Errors.

Unit II **08 Hours**

Introduction to Metrology

Meaning of metrology & its Importance.

Linear Measurement :

Standards - line standard, end standard, wave length standard, classification of standards, precision, and non-precision measuring instrument, slip gauges, Different types of Vernier, Micrometer, Dial Gauges. Concept of Magnification.

Angular Measurement:

Sine bar, Sine center, Uses of sine bar, angle gauge, Auto Collimator, Angle Dekkor, angle slip gauges, Constant Deviation Prism.

Unit III **08 Hours**

Sensors and Transducers

Concept of sensors and transducers. Significance of Transducers in Measurement and Instrumentation System. Classification and Selection Parameters of Transducers. Basic components of DAQ, Concept of signal conditioning.

Strain Measurement: Theory & Classification of Strain gauges, Gauge Factor, Temperature compensation, Wheatstone Bridge Circuit.

Temperature measurement: Resistance Temperature Detector(RTD), Thermocouples & Laws of thermocouples, Resistance Thermometers & Thermistors, Optical Pyrometers

Pressure measurement: Diaphragm Pressure Gauge, Bourdon Tube, Bellows, McLeod Gauge, Piezoelectric Sensor, Tactile Sensor

Flow measurement: Hot Wire anemometer, Thermal flow meters, Electromagnetic flow meter, Ultrasonic Flow meter, Turbine Meter

Unit IV **08 Hours**

Tolerances and Gauging

Limits, Fits, Tolerances:

Meaning of limit, Fits and Tolerance, Cost-Tolerance relationship, concept of Interchangeability, Indian Standard System (ISS).

Design of Limits Gauges:

Types, Uses, Taylor's principle, Design of limit gauges. Inspection of geometric parameters: Straightness, Parallelism, Concentricity, Squareness and circularity.

Comparators: Uses, types, advantages and disadvantages of various types of comparators.

Advances in Metrology: Introduction of CMM, Types of CMM

Unit V **08 Hours**

Displacement, Velocity and Position Sensors, Force and Torque, Level Thickness Measurement

Displacement, Velocity and Position Sensors: Potentiometer, LVDT, Hall Effect Sensor, optical encoders, Proximity Sensors, Tachogenerator.

Force and Torque Measurement: Load Cell and its different types, Torque measurement using strain gauges, Torsion Meter.

Acceleration Sensors: Displacement Seismic Accelerometer, Strain gauge Accelerometer, Piezoelectric Accelerometer, Potentiometric Accelerometer

Level measurement & Thickness Measurement: Electrical Methods (Resistive & Capacitive), Laser Level Sensor, Ultrasonic Liquid Level Detector. Thickness measurement using contact and non-contact type devices

Unit VI **08 Hours**

Measurement of Surface finish, Screw Thread, Gear Metrology

Surface Finish Measurement:

Surface texture, Meaning of RMS and CLA values, Tomlinson's Surface meter, Taylor-Hobson surface meter, grades of roughness, specifications

Screw Thread Metrology:

External screw threads terminologies, floating carriage instruments, pitch and flank measurement of external screw thread, application of Tool Makers Microscope, use of profile projector.

Gear Metrology:

Spur gear parameters, gear tooth thickness measurement, gear tooth Vernier caliper, constant chord method, span micrometer, base tangent comparator.

Interferometry:

Introduction, flatness testing by interferometry, NPL flatness interferometer. Study of measuring machines, recent trends in engineering metrology.

Assignments

1. At least five theory questions based on static & dynamic characteristics of measurement systems measurement system
2. At least five theory questions based on errors in measurements measurement system
3. At least five theory questions based on linear measurement in metrology
4. At least five theory questions based on angular measurement in metrology
5. At least five theory questions based on strain and temperature measurement sensors.
6. One small project based on strain measurement and temperature measurement using sensors.
7. At least five theory questions based on pressure & flow measurement sensors.
8. At least five theory questions based on tolerances, gauging & comparators.
9. At least five numerical questions based on tolerances & gauging.
10. At least five theory question based on velocity and displacement sensors.

11. At least five theory question based on force, torque sensors.
12. One small project based on force measurement for different applications.
13. At least five theory question based on level & acceleration sensors.
14. One small project based on level measurement for different applications.
15. At least five theory question based on level measurement & thickness measurement sensors.
16. At least five theory question based on surface finish measurement.
17. At least five theory question based onscrew thread metrology.
18. At least five theory question based on gear metrology.
19. At least five theory question based on interferometry.

Term Work:

1. Study & Calibration of Thermocouples (J & K-Type)/RTD(PT-100)
2. Study & Calibration of Pressure Measurement, & Vacuum Measurement
3. Measurement of Load/Force using Load Cells
4. Displacement & Angle measurement using LVDT & Encoder Sensor
5. Study of Different Switches & Relays
6. Vibration Measurement using Accelerometer.
7. Level Measurement using Capacitive Transducer.
8. Study of Data Acquisition System and Interfacing of sensors with computer using DAQ Cards (NI DAQ Card)
9. Study of Linear and Non Linear Measuring Instruments.
10. Measurement of the surface roughness.
11. Measurement of angle by sine bar/sine center.
12. Measurement of optical surface using Interferometer.
13. Measurements of screw tread parameters using Floating Carriage Micrometer.
14. Measurement of gear tooth thickness using gear tooth vernier caliper and span micrometer
15. Study and experiment on profile projector/Tool makers microscope
16. Industrial visit to Automation Company and Inspection & Quality control division of any Industry with detail report.

Practical Examinations:
Term work and Practical Examinations will be based on above syllabus.

Textbooks:

1. Ramchandran K. P., Vijyaraghavan G. K., Balasundaram M. S., "Mechatronics: Integrated Mechanical Electronic Systems", John Wiley & Sons, 2008.
2. Bolton W., "Mechatronics - A Multidisciplinary approach", 4th Edition, Prentice Hall, 2009.
3. Kumar D. S., "Mechanical Measurement & Control", Metropolitan Book Co. Pvt. Ltd. New Delhi, 2007
4. Singh M. D. and Joshi J. G., "Mechatronics", 3rd Edition, Prentice Hall, New Delhi, 2009.
5. Beckwith T. G., Marangoni R. D., Lienhard J.H.,"Mechanical Engineering Measurements", Pearson Prentice Hall, 2007
6. Jain R. K., "Engineering Metrology", Khanna Publishers
7. Hume K. J., "Engineering Metrology", Macdonald, 1950
8. Sharp K. W. B., "Practical Engineering Metrology", Pitman Publication, 1970
9. Kuber S. S., "Metrology and Quality Control", Nirali Prakashan

Reference Books

1. Doebelin Ernesto, "Measurement Systems", McGraw Hill International Publication Co. New York, 4th Edition,1990.
2. Sawhney A. K. and Sawhney P., "Mechanical Measurement and Control", Dhanpat Rai and Company Pvt. Ltd., New Delhi, 12th Edition,2010.
3. Figliola R. S., Beasley D. E., "Theory and design for mechanical measurements", , Wiley India Edition.
4. Alciatore & Histand, "Introduction to Mechatronics and Measurement System", 4th Edition, Mc-Graw Hill publication, 2011.
5. Bishop (Editor), "Mechatronics – An Introduction", CRC Press, 2006.

Unit Tests-

Unit Test-I Unit-I,II and III
Unit Test-II Unit-IV,V and VI

Machine Tool Design
(Course No: C311)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination 60 Marks	Theory : 03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Total 100 Marks	03

Course Pre-requisites:

1. Fundamentals of Mechanical Engineering
2. Production Practice- I, Production Practice- II, Manufacturing Process Production Practice – III Advanced Manufacturing Processes
3. Material Science, Theory of Machines, Machine Design -I

Course Objectives:

To study

1. Introduction to machine tool drive, mechanisms and regulation of speed and feed rates.
2. Design of machine tool structures, guide ways and power screws
3. Design of spindle, spindle supports and acceptance test for machine tools
4. Automatic drives for machine tools and maintenance /repair of machine tools

Course Outcomes: Students should be able to

1. Understand the fundamentals of machine tool design
2. Understand and apply concepts in multispeed gear box to get required speed steps in machine tool applications
3. Understand the design considerations for machine tool structures
4. Analyze the guide ways and use of the power screws in machine tool applications
5. Analyze spindles, bearings for spindle supports and understand use of standard acceptance tests
6. Understand mechanization of automatic drives and basics of maintenance , restoration techniques of machine tools

Unit I **06 Hours**

Introduction to Machine Tool Drives and Mechanisms

General Principles of Machine Tool Design: Working and Auxiliary Motions in Machine Tools. Parameters Defining. Working Motions of a Machine Tool. Machine Tool Drives. Hydraulic Transmission and its Elements. Mechanical Transmission and its Elements. Techno-Economical Prerequisites for Undertaking the Design of New Machine Tool. General Requirements of Machine Tool Design. Engineering Design Process Applied to Machine Tools. Layout of Machine Tools, Modular Concept of Machine tool design.

Unit II **06 Hours**

Regulation of Speed and Feed Rates

Aim of speed and feed rate regulation. Stepped regulation of Speed: Design of speed box – Design of Feed Box – Machine Tool Drives using Multiple Speed Motions–Special Cases of Gear Box Design–General

Recommendations for Developing the Gearing Diagram–Step less Regulation of Speed and Feed Rates, VFD and VVFD drives-Design Considerations. Motors: three phase induction motors-stepper motor, servo motor and universal motor.

Unit III **06 Hours**

Design of Machine Tool Structures

Functions of Machine Tool Structures and their requirements – Design criteria for machine tool structures – Materials of machines Tools structures – Static and Dynamic stiffness – Profiles of machine tool structures – Basic Design procedure of machine tool structures – Design of Beds – Design of Columns – Design of Housings – Design of Bases and Tables – Design of Cross Rails, Arms, Saddles and carriages – Design of Rams.

Unit IV **06 Hours**

Design of Guide-ways and Power Screws

Functions and types of Guide-ways – Design of Slide-ways – Design criteria and calculations for slide-ways – Guide-ways operative under liquid friction conditions. Design of Anti-Friction Guide-ways – Combination Guide ways – Protecting devices for slide-ways Design of power screws (Sliding & Rolling friction), Preloading of power screws. Design with reference to advanced machine tools.

Unit V **06 Hours**

Design of Spindles and Spindle Supports

Functions of Spindle Unit and requirements – Materials of Spindles – Effect of machine tool compliance on machining accuracy- Design calculations of spindles Anti friction bearing – Sliding bearings. Preloading of bearings. Bearings selection for machine tools.

Acceptance tests for Machine Tools:

Acceptance tests: Object and Procedure for acceptance test, Instruments required, sequence of acceptance test, standard acceptance test chart.ISO 230-1: 1996, ISO-2:2014.

Unit VI **06 Hours**

Automatic Drives for Machine Tools

Principles of automation. Automatic lathes with mechanical control. Design of cams for automatic screw cutting machines. Automatic loading and feeding of work pieces. Transfer devices in automatic machine tool systems. Modular design and unit heads for machine tools. Automatic in- process gauging.

Maintenance and repair of Machine Tools:

Types of Maintenance, Break down and preventive Maintenance, Organization of Maintenance department, Economic aspects of Preventive Maintenance, Restoration techniques.

Assignments

1. At least five theory questions based on machine tool drives & mechanisms.
2. At least five theory questions based on layout of machine tool.
3. At least five theory questions based on regulation of speed & feed rates.
4. At least five theory questions based on design of feed box.
5. At least five theory questions based on types of motors used in machine tool.
6. At least five theory questions based on VFD and VVFD drives.
7. At least five theory questions based on design of machine tool structure.

8. At least five theory questions based on design of guide ways and power screws.
9. At least five theory questions based on design of spindles.
10. At least five theory questions based on design of spindle supports.
11. At least five theory questions based on acceptance tests for machine tools.
12. At least five theory questions based on automatic drives for machine tools.
13. At least five theory questions based on transfer devices in automatic machine tool systems.

Text Books

1. Basu S. K., “Design of Machine Tools”, Allied Publisher, 1989.
2. Sen G. S. & Bhattacharya, “Principles of Machine Tools”, New Central Book Agency, Calcutta – 1986.
3. Acherkan N., “Machine Tool Design”, Vol. 2 & 3 Mir publishers, Moscow, 1968.
4. Mehta N. K., “Machine Tool Design”, TMII.
5. Russe W. Henke, “Introductionto Fluid Power Circuits and Systems”, Addison Wesley, 1970
6. Koenigs Berger & Tlusty, “Design of Machine Tools”, Pergaman Press 1970.

Syllabus for Unit Test:

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV, V and VI

Energy Audit and Management
(Course No: C312)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination 60 Marks	Theory : 03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Total 150 Marks	03

Course Pre-requisites:

Student should have knowledge of

1. Fundamentals of Electrical Engineering
2. Engineering Thermodynamics
3. Heat and Mass Transfer

Course Objectives:

To provide the knowledge of

1. energy conservation, management, economics and Audit
2. material and energy balance
3. thermal and electrical energy management

Course Outcomes: Students Will be able to

1. Understand the concepts of energy conservation, audit and management
2. Understand the concepts of material and energy balance and perform analysis of systems.
3. understand the concepts of economics, retrofit and analyze systems using energy economics
4. understand the concepts of electrical energy management and analyze electrical systems using these concepts
5. understand the concepts of thermal energy management and analyze thermal systems using these concepts
6. understand the concepts of energy audit instruments and apply the concepts of

energy audit and management to real life problems

Unit I **06 Hours**

Energy Conservation:

Energy Conservation and its Importance; Energy Strategy for the Future; The Energy Conservation Act, 2001 and its Features

Energy Management: Definition & Objectives of Energy Management; Importance; Indian need of Energy Management; Duties and responsibilities of energy managers.

Unit II **06 Hours**

Material and Energy Balance

Basic Principles, Sankey diagrams, Material balances for different processes, Energy balances, heat balances, Methods for preparing process flow chart, Procedure to carry out the material and energy balance in different processes.

Unit III **06 Hours**

Economic Analysis of Energy Conservation Measures

Retrofit: Power plant retrofit, Home energy retrofit.

Economics:

Fundamentals: Cash flows, Inflation Rates, Time Points and Periods, Discount Rates, Cost of Capital, Present value, Taxes, Uncertainty and Risk Economic Measures: Net Present Value, Total Life-Cycle Cost, Revenue Requirements, Internal Rate of Return, Modified Internal Rate of Return, Simple Payback Period, Discounted Payback Period, Benefit-to-Cost Ratios, Savings-to-Investment Ratios, Profitability index estimation

Unit IV **06 Hours**

Electrical Energy Management

Supply side: Methods to minimize supply-demand gap, renovation and modernization of power plants, reactive power management, HVDC, and FACTS.

Demand side: conservation in motors, pumps and fan systems; energy efficient motors.

Case Studies on Electrical Energy Management

Unit V **06 Hours**

Thermal energy Management

Energy conservation in boilers, steam turbines and industrial heating systems; Application of FBC; Cogeneration and waste heat recovery; Thermal insulation; Heat exchangers and heat pumps; Building Energy Management. Case Studies on Thermal Energy Management

Unit VI **06 Hours**

Energy Audit

Energy Audit: Types and Methodology; Scope of Energy Audit, Energy Audit Reporting Format; Understanding Energy Costs; Benchmarking and Energy Performance; Matching Energy Usage to Requirement; Maximizing System Efficiency; Fuel and Energy Substitution; Energy Audit Instruments; Duties and responsibilities of energy auditors. Energy Management of Buildings and Energy Audit of Buildings. - Energy management matrix monitoring and targeting Case Studies

Assignment

1. At least five theory questions based on energy conservation.
2. At least five theory questions based on energy management.
3. At least five theory questions based on material and energy balance.
4. At least five theory questions based on economic analysis of energy conservation measures.
5. At least five theory questions based on economic measures of energy conservation.
6. At least five theory questions based on electrical energy management.
7. At least five theory questions based on thermal energy management
8. At least five theory questions based on concept of energy audit.
9. At least five theory questions based on case studies of electrical energy management.
10. At least five theory questions based on building energy management.
11. At least five theory questions based on case studies of thermal energy management.
12. At least five theory questions based on case studies of energy audit.

Reference Books

1. Amlan Chakrabarti, “Energy Engineering and Management”, PHI Learning, New Delhi 2012
2. Mirjana Golusin, Sinisa Dodic, Stevan Popov, “Sustainable Energy Management”, Academic Press

3. Shaligram Pokharel, “Energy Analysis for Planning and Policy”, CRC Press, 2014
4. Trivedi P R, Jolka K R, “Energy Management”, Commonwelth Publications, New Delhi
5. Y P Abbi, Shashank Jain, “Handbook on Energy Audit and Environment Management”, TERI
6. General Aspects of Energy Management and Energy Audit, Buro of Energy Efficiency
7. Frank Krieth, D Yogi Goswami, “Energy Management and Conservation Handbook”, CRC Press
8. Alburt Thumann, William J Younger, Terry Niehus, “Handbook of Energy Audits”, 9th Ed, Better World Books

Syllabus for Unit Test:

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV, V and VI

Reliability Engineering
(Course No. C313)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination 60 Marks	Theory : 03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work / Oral -- Marks	
	Total 100 Marks	03

Course Pre-requisites:

Student should have knowledge of-

1. Engineering Mathematics
2. Engineering Science
3. Mechanical Measurement and Metrology

Course Objectives:

1. To provide a well-founded introduction to system reliability practices critically
2. To introduce various methods of reliability analysis with real time problems with constraints and basic concepts of maintenance and reliability.
3. To construct models for the estimation and improvement of reliability parameters of manufactured products and components.
4. To introduce the principles and techniques of Statistical Quality Control and their practical uses in product/process design and monitoring.

Course Outcomes: Student Will be able to

1. Understand the concept of reliability, common reliability functions, parameters and evaluate reliability measures.
2. Understand the importance of statistical distributions and apply it for failure data analysis.
3. Understand the concept of Reliability Systems and evaluate redundancy by various methods.

4. Understand the concepts of maintainability and availability of product/component systems and evaluate Reliability allocation using different methods.
5. Understand the concept of reliability functions and parameters of product/component systems apply it for fault tree analysis.
6. Understand different methods for reliability testing of a system.

Unit I **06 Hours**

Fundamental Concepts of Reliability and Reliability Measures

Brief history, concepts, terms and definitions, applications, the life cycle of a system, concept of failure, typical engineering failures and their causes

Reliability Measures: Reliability function–R(t), cumulative distribution function (CDF)–F(t), probability density function (PDF) – f(t), hazard rate function-λ(t), Mean time to failure (MTTF) and Mean time between failures (MTBF), typical forms of hazard rate function, bathtub curve

Unit II **06 Hours**

Probability Concepts and Failure Data Analysis

Theory of probability, rules of probability, Introduction to independence, mutually exclusive, conditional probability random variables, discrete and continuous probability distributions. Binomial, normal Comparison of probability distributions - , lognormal, Weibull, exponential, Standard deviation, variance, mean, mode and Central Limit Theorem.

Failure Data Analysis: Data collection and empirical methods, estimation of performance measures for ungrouped complete data, grouped complete data, analysis of censored data, fitting probability distributions graphically (Exponential and Weibull) and estimation of distribution parameters.

Unit III **06 Hours**

Reliability Evaluation of Systems

Reliability Improvement Redundancy, element redundancy, unit redundancy, standby redundancy -types of stand by redundancy, parallel components single redundancy, multiple redundancies, cut and tie set approach for reliability evaluation. Star and delta method, matrix method (Numerical).

Unit IV **06 Hours**

Maintainability and Availability

Concept of maintainability, measures of maintainability, mean time to repair (MTTR), analysis of downtime, repair time distributions, stochastic point processes, maintenance concept and procedures, availability concepts and definitions, important availability measures.

Introduction to Reliability allocation or apportionment, reliability apportionment techniques- equal apportionment, AGREE, ARINC, Minimum effort method (Numerical)

Unit V **06 Hours**

Design for Reliability and Maintainability

Reliability design process and design methods, reliability allocation, failure modes, effects and criticality analysis (FMECA), fault tree and success tree methods, symbols used, maintainability design process, quantifiable measures of maintainability, repair versus replacement.

Unit VI **06 Hours**

Reliability Testing

Introduction to reliability testing, Stress strength interaction, Introduction to Markov model, Testing for Reliability and Durability - Accelerated Life Testing and Highly Accelerated Life Testing (HALT), highly accelerated stress Screening (HASS)

Assignments:

1. At least five theory questions based on fundamental concepts of reliability.
2. At least five theory questions based on reliability measures.
3. At least five theory questions based on probability concepts
4. At least five theory questions based on failure data analysis.
5. At least five theory questions based on reliability evaluation systems
6. At least five theory questions based on maintainability & availability
7. At least five theory questions based on design for reliability& maintainability.
8. At least five theory questions based on reliability testing.
9. At least five numerical questions based on fundamental concepts of reliability.
10. At least five numerical questions based on reliability measures.
11. At least five numerical questions based on probability concepts

12. At least five numerical questions based on failure data analysis.
13. At least five numerical questions based on reliability evaluation systems
14. At least five numerical questions based on maintainability & availability
15. At least five numerical questions based on design for reliability & maintainability.
16. At least five numerical questions based on reliability testing.

Reference Books

1. Ebling C. E., 2004, "An Introduction to Reliability and Maintainability Engineering", Tata McGraw Hill Education Private Limited, New Delhi.
2. Srinath L. S., 1991, "Reliability Engineering", East West Press, New Delhi.
3. Birolini A., 2010, "Reliability Engineering: Theory and Practice", Springer.
4. Parkhi R. M., "Market Leadership by Quality and Reliability", Vidyanand Publications 2012.
5. Roy B. and Allan R. N., 1992, "Reliability evaluation of engineering systems: concepts and techniques", Springer.
6. Patrick D. T. Newton O'Conner, D., Bromley R., 2002, "Practical Reliability Engineering", John Wiley and Sons.
7. Rao S. S., 1992, "Reliability Based Design. Mcgraw-hill
8. Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, 2006, "Maintenance, Replacement and Reliability: Theory and Applications", CRC/Taylor and Francis.
9. Nachlas Joel A., 2005, "Reliability Engineering: Probabilistic Models and Maintenance Methods" Taylor and Francis.
10. Dhillon B. S., Singh C., 1981, "Engineering Reliability – New Techniques and Applications", John Wiley and Sons.
11. Dhillon B. S., 1999, "Engineering Maintainability", Prentice Hall of India.

Unit Tests-

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV, V and VI

Design of Pumps, Blowers and Compressors
(Course No: C314)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination 60 Marks	Theory : 03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Total 100 Marks	03

Course Pre-requisites:

Student should have knowledge of

1. Engineering Thermodynamics
2. Turbomachinery
3. Machine Design I

Course Objectives:

To provide the knowledge of

1. concepts of fluid machinery
2. theory and design of centrifugal pumps and compressors
3. theory and design of fans and blowers.

Course Outcomes: Student Will able to-

1. understand the concepts of fluid machinery and analyze their performance
2. understand the theory of centrifugal pumps and analyze their performance.
3. understand the design considerations for centrifugal pumps and apply them for basic pump design.
4. understand the theory of fans, blowers and analyze their performance.
5. understand the design considerations for fans, blowers and apply them for their basic design. understand the theory and design considerations of rotary compressors and apply them for basic compressor design

Unit I **06 Hours**

Review of Principles of Fluid Machinery

- Basic equations of energy transfer between fluid and rotor.
- Performance characteristics.
- Dimensionless parameters, specific speed, stage velocity triangles, work and efficiency.

Unit II **06 Hours**

Theory of Centrifugal Pumps

- Calculation of tangential and axial thrust methods to minimize axial thrust.
- Impellers, casings, volutes, vane velocity vector diagrams, work done and head developed by pumps.
- Efficiency and losses in pumps (mechanical, hydraulic etc.), specific speed.
- Calculation of power requirement, NPSH for pump selection, effects of cavitation on pump performance, operating characteristics.

Unit III **06 Hours**

Design of Pumps

- Introduction to design procedure of pumps.
- Thermal design- selection of materials for high temperature and corrosive fluids.
- Hydraulic design- selection of impeller and casing dimension using industrial manuals.

Unit IV **06 Hours**

Theory of Fans and Blowers

- Classification of blowers, basics of stationary and moving air, Euler's characteristics, velocity triangles and operating pressure conditions.
- Equations for blowers, losses and hydraulic efficiency, flow through impeller casing inlet nozzle, volute, diffusers, mechanical losses.

- Rotor design, airfoil theory, vortex theory, cascade effects, degree of reaction.
- Blade twist stage design, surge and stall, stator and casing, mixed flow impellers, applications of blowers and fans.

Unit V **06 Hours**

Design of Fans and Blowers

- Design procedure for selection of blowers, stage pressure rise, stage parameters and design parameters.
- Design of impeller and casing dimension in aerodynamic design.

Unit VI **06 Hours**

Theory and Design of Compressors

- Basic theory, classification and application, working with enthalpy-entropy diagram, construction and approximate calculation of centrifugal compressors.
- Impeller flow losses, slip factor, diffuser analysis, performance curves of centrifugal compressors.
- Basic design features of axial flow compressors; velocity triangles, enthalpy-entropy diagrams, stage losses and efficiency, work done factor, simple stage of axial flow compressors, applications of compressors.

Assignments:

1. At least five theory questions based on principles of fluid machinery.
2. At least five theory questions based on centrifugal pump.
3. At least five theory questions based on design of procedure of pump.
4. At least five theory questions based on fans.
5. At least five theory questions based on blowers.
6. At least five theory questions based on design of compressors.
7. At least five numerical questions based on fluid machinery for work and efficiency calculations.
8. At least five numerical questions based on calculation of tangential and axial thrust methods to minimize axial thrust of centrifugal pump.
9. At least five numerical questions based on calculations of power requirement and

selection of centrifugal pump.

10. At least five numerical questions based on hydraulic and thermal design of pump.
11. At least five numerical questions based on fans and blowers.
12. At least five numerical questions based on design of impeller.
13. At least five numerical questions based on design of centrifugal compressor.
14. At least five numerical questions based on axial flow compressors.

Reference Books

1. Shepherd, D. G., “Principles of Turbomachinery”, Macmillan, 1969.
2. Chruch A. H., “Centrifugal pumps and blowers”, John wiley and Sons, 1980.
3. Yahya S. M., “Turbine, Compressors and Fans”, Tata Mc-Graw Hill Publishing Company, 1996
4. Labanoff V. S. and Ross R., “Centrifugal Pumps Design and Applications”, Jaico P House.
5. Karassik I., “Pump Hand Book”, McGraw-Hill International Edition.
6. Sahu G. K. “Pump” New age international publishers.
7. Tuzson J., “Centrifugal Pump Design”, Wiley Publication.
8. Stepanff, A. J., "Blowers and Pumps", John Wiley and Sons Inc., 1965.

Unit Tests-

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV,V and VI

Management Information System
(Course No: C315)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours / Week	End Semester Examination 60 Marks	Theory : 03
	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Total 100 Marks	03

Course Pre-requisites:

1. Computer Programming and Simulation
2. Numerical Methods and Optimization Techniques
3. Manufacturing Process

Course Objectives:

To Study

1. Fundamental principles of Operations management and Information System
2. Basics of decision making and database management system Applications of management techniques and system implementation in manufacturing sector

Course Outcomes: Student will be able to

1. Understand various basic concepts related to operations management and information system
2. Understand computer aided information system and the concept of information communication
3. Analyze the different decision-making tools in Management Information System
4. Understand knowledge of data base management system and Database models
5. Understand and apply the Management Information System in different manufacturing sectors
6. Understand and apply various software design techniques and quality management for implementation of management information system.

Programme: B. Tech. Mechanical

Unit I **06 Hours**

Introduction

Operations management: concept, meaning, definition, scope and functions. Optimization: concept, meaning, definition, need and scope. Types of production, their merits and demerits. Types of operations layouts: - types, features, applications. Types of resources (7M). Data-meaning and types. Information-meaning and types.

Information system: need, concept, definition, features, objectives and examples. Need to integrate information systems and optimum utilization of 7M resources.

Unit II **06 Hours**

Information Systems

Role of computers in information systems. Management Information System (MIS); concept, definition, need & applications.

Computer aided information systems: (such as inventory records, operation schedule, consumables issues, tools issues, inspection and quality control reports, failure frequencies with reasons, efficiency and utility reports, maintenance records, produced power units per day, temperature at certain interval, etc.) need, importance, design considerations, software selection criteria, examples.

Information communication: Communication process; computer networks and its types, structures, need and applications, protocols - types, features, applications.

Unit III **06 Hours**

Decision Making

Concept, process behavioral decision making, organizational decision making, MIS and decision making. Building blocks of information system-Input, output, models, technology, database and control blocks. System development life cycle (SDLC) and its approach.

Unit IV **06 Hours**

Data Base Management System

Data management-concept, need, basic terminology used.

Data base: definition, meaning, importance, approach and architecture. Objectives of database organizations.

Data models: meaning, relationship and association, drawing schema, bubble chart &tree structure for suitable mechanical engineering application. Data Base Management System (DBMS) - definition, scope, importance, awareness about current software packages & their features, Relational Data Base Management System. (RDBMS) - concept, definition, features and applications. Preparation steps/ procedure for creating, storing, editing & retrieval of database on latest available database management software package.

Unit V **06 Hours**

Applications in Manufacturing Sectors

Application in Manufacturing sectors- Personnel management, financial management, production management, material management, marketing management, supply chain management.

Unit VI **06 Hours**

System implementation

Modern software design techniques, verification and validation, methods, performance of software systems, software matrix and models, software standards, introduction to Capability maturity model (CMM), and quality management in software organization.

Assignments:

1. At least five theory questions based on operation management.
2. At least five theory questions based on types of resources(7M)
3. At least five theory questions based on role of computer in MIS.
4. At least five theory questions based on information communication.
5. At least five theory questions based on system development life cycle(SDLC) and its approach.
6. At least five theory questions based on decision making
7. At least five theory questions based on database management system.
8. At least five theory questions based on relational database management system.

9. At least five theory questions based on application of MIS in manufacturing system
10. At least five theory questions based on system implementation.
11. At least five theory questions based on capability maturity model (CMM).
12. At least five theory questions based on supply chain management
13. At least five theory questions based on different software for implementation of MIS in industries.

Text Books/ Reference Books

1. Jawadekar W. S., "Management Information System 4/e".
2. O Brien J. A., "Management Information System 4/e"
3. Burch and Gruditski, "Information system-Theory and practice 5/e".
4. Ian Sommerville, "Software Engineering 6/e".
5. Turban E., Leidner P., et. al., "Information Technology for Management 6/e".
6. Laudon and Laudon, "Management Information System11/e"
7. Sadagopan S., "Management information system", PHI publication
8. Charry S. N., "Production and operations management". TMGH publication.
9. Buffa E. S. and Sarin R. K., "Modern production & operations management", John willy & sons publication

Unit Tests-

Unit Test-I Unit-I, II and III

Unit Test-II Unit-IV, V and VI

Professional Skill Development-VI
(Course No: C316)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04 Hours / Week	End Semester Examination 100 Marks	Theory : 04
Practical:- -- Hours / Week	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation-- Marks	
	Total 100 Marks	04

Course Pre-requisites:

Student should have knowledge of

1. Concepts of Maths, Logical reasoning and English Grammar taught in the last semester.
2. A basic knowledge of Group Discussion, DO's and Don'ts done in the previous sem.
3. Basic knowledge of writing skills, importance of professionalism in emails and letters.
4. Knowledge on the concepts of criticism, feedback and conflicts.
5. Awareness of the interpersonal skills like team work and introduction to Leadership taught during the last semester.
6. Brief idea about professional and business meeting etiquettes

Course Objectives:

1. To acquaint them with the level of complexity presented in recruitment tests and also provide them techniques
2. To solve such question with tricks/methods in a very short period
3. To focuses on the other important aspects of soft skills training students such as techniques of effectively handling Personal Interviews during placement process and understand the dynamics of structured Resume and Pis

Course Outcomes: Student Will be able to

1. Understand the concepts of Maths, Logical reasoning and English grammar and apply short cuts/ tricks to solve questions in less time.

2. Understand how to apply vocabulary questions such as synonyms and analogies in recruitment test and other competitive exams
3. Understand effective strategies for applying interview techniques, to win personal interviews during recruitment process.
4. Understand the differences between CV, Bio- Data and Resume and apply its correct format, methods and styles.
5. Understand various rules, appropriate tones and words to apply in business writing communication.
6. Understand the importance of social and corporate etiquettes to create the impressive Professional life.

Unit I **24 Hours**

Aptitude (Maths, Logical Reasoning, English)

Maths

- Permutation & Combination
- Probability
- Maths Revision -1
- Maths Revision - 2

Logical Reasoning

- Matching, Selection & Arrangement
- Clocks & Calendars, Visual Reasoning
- Input, Output & Flow Chart.
- Reasoning Revision- 1
- Reasoning Revision-2

English

- Grammar – III– (Prepositions& Conjunctions)
- Grammar- (Articles & Parallelism)
- Verbal Ability Revision- I

Unit II **24 Hours**

Soft Skills & English Communication

- Resume-I
- Resume- II
- Mock GD
- Mock GD
- Personal Interviews-I
- Personal Interviews-II
- Mock PI
- Mock PI
- Extempore Speeches, Group Interviews
- Written Skills- Revision
- Stress Management
- Business Writing Tones

Textbooks

6. APAART: Verbal Ability
7. APAART: Logical Reasoning
8. APAART: Quantitative Aptitude
9. APAART: Speak Well 1 (English Language and Communication)
10. APAART: Speak Well 2 (Soft Skills)

Rules regarding ATKT, Continuous Assessment and award of Class A. T. K. T.

- A candidate who is granted term for B. Tech. Semester-I will be allowed to keep term for his/her B. Tech. Semester-II examination even if he/she appears and fails or does not appear at B. Tech. Semester-I examination.
- A candidate who is granted term for B. Tech. Semester - III will be allowed to keep term for his/her B. Tech. Semester-IV examination even if he/she appears and fails or does not appear at B. Tech. Semester-III examination.
- A candidate who is granted term for B. Tech. Semester-V will be allowed to keep term for his/her B. Tech. Semester-VI examination if he/she appear and fails or does not appear at B. Tech. Semester-V examination.
- A candidate who is granted term for B. Tech. Semester-VII will be allowed to keep term for his/her B. Tech. Semester-VIII examination if he/she appears and fails or does not appear at B. Tech. Semester-VII examination.
- A candidate shall be allowed to keep term for the B. Tech. Semester-III course if he/she has a backlog of not more than 3 Heads of passing out of total number of Heads of passing in theory examination at B. Tech. Semester-I & II taken together.
- A candidate shall be allowed to keep term for the B. Tech. Semester-V of respective course if he/she has no backlog of B. Tech Semester-I & II and he/she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 heads of passing in term work and practical examination or term work and oral examination.
- A candidate shall be allowed to keep term for the B. Tech. Semester-VII course if he/she has no backlog of B. Tech. Semester-III & IV and he/she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 Heads of passing in term work and practical examination or term work and oral examination.

CONTINUOUS ASSESSMENT

- In respect of Term work at B. Tech. Semester-I & II, B. Tech. Semester-III & IV and B. Tech. Semester-V & VI, target date shall be fixed for the completion of each job, project experiment or assignment as prescribed in the syllabus and the same shall be collected on the target date and assessed immediately at an affiliated college by at least one pair of the concerned teachers for the subject and the marks shall be submitted at the end of each term to the Principal of the college.
- Termwork and performance of Practical/Oral examination shall be assessed on the basis of the depth of understanding of the principles involved, correctness of results and not on ornamental or colorful presentation.

- For B. Tech. Semester-VII & VIII, term work assessment will be done by external and internal examiners jointly during the examination schedule declared by the university. The record of continuous assessment shall be made available to the examiners during Term work and practical and Term work and oral examinations. Examiner shall use this record for overall assessment of the performance of the student. Every practical/term work assignment shall be assessed on the scale of 25 marks and weightage of 25 marks shall be distributed as follows:
- For B. Tech. Semester-VII & VIII, term work assessment will be done by external and internal examiners jointly during the examination schedule declared by the university. The record of continuous assessment shall be made available to the examiners during Term work and practical and Term work and oral examinations. Examiner shall use this record for overall assessment of the performance of the student. Every practical/term work assignment shall be assessed on the scale of 25 marks and weightage of 25 marks shall be distributed as follows:

Sr. No.	Activity	Marks
1	Timely Submission	07
2	Presentation	06
3	Understanding	12

- Marks obtained out of 25 for all assignments together will be converted on scale of marks assigned to term work of respective subject in the structure of the course.

CLASS

The class should be awarded to the student on the basis of aggregate marks obtained together in both the semesters of the respective year by him. The award of class shall be as follows.

A	Aggregate 66% or more marks	First Class with Distinction
B	Aggregate 60% or more marks but less than 66%	First Class
C	Aggregate 55% or more marks but less than 60%	Higher Second Class
D	Aggregate 50% or more marks but less than 55%	Second Class
E	Aggregate 40% or more marks but less than 50%	Pass Class

BHARATI VIDYAPEETH
(DEEMED TO BE UNIVERSITY) Pune.

College of Engineering, Pune- 411043
The Structure of the Curriculum: 2014 Course
Choice Based Credit System (CBCS)

COURSE STRUCTURE AND SYLLABUS

(Choice Based Credit System - 2014 Course)

B. TECH. MECHANICAL: SEMESTER- VII & VIII

Programme: B. Tech. Mechanical

Vision of the Bharati Vidyapeeth (Deemed to be University) College of Engineering is:

To be a World Class Institute for Social Transformation through Dynamic Education

Missions of the Bharati Vidyapeeth (Deemed to be University) College of Engineering are:

- To provide quality technical education with advanced equipment, qualified faculty members, infrastructure to meet needs of profession & society.
- To provide an environment conducive to innovation, creativity, research and entrepreneurial leadership.
- To practice and promote professional ethics, transparency and accountability for social community, economic & environmental conditions.

Goals of the Bharati Vidyapeeth (Deemed to be) University College of Engineering are:

- Recruiting experienced faculty.
- Organizing faculty development programs.
- Identifying socio-economically relevant areas & emerging technologies.
- Constant review &up gradation of curricula.
- Up gradation of laboratories, library & communication facilities.
- Collaboration with industry and research & development organizations.
- Sharing of knowledge, infra-structure and resources.
- Training, extension, testing and consultancy services.
- Promoting interdisciplinary research.

Vision of the Mechanical Engineering Department is:

To develop, high quality Mechanical Engineers through dynamic education to meet social and global challenges.

Mission Statements of the Mechanical Engineering Department are:

- To provide extensive theoretical and practical knowledge to the students with well-equipped laboratories and ICT tools through motivated faculty members.
- To inculcate aptitude for research, innovation and entrepreneurial qualities in students.

- To acquaint students with ethical, social and professional responsibilities to adapt to the demands of working environment.

Program Educational Objectives (PEOs) of the B. Tech. Mechanical are:

Graduates will be able,

- To fulfill need of industry and society with theoretical and practical knowledge.
- To engage in research, innovation, lifelong learning and continued professional development.
- To fulfill professional ethics and social responsibilities.

PROGRAM OUTCOMES

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Statements of Programme Specific Outcomes (PSOs)

PSO1: Apply the knowledge of thermal, design, manufacturing engineering and computational sciences to solve Mechanical Engineering problems.

PSO2: Apply Mechanical Engineering principles for research, innovation and develop entrepreneurial skills.

PSO3: Apply concepts of mechanical engineering to asses' societal, environmental, health and safety issues with professional ethics.

B.TECH.MECHANICAL: SEMESTER-VII (2014Course)

S.N.	Course	Teaching Scheme(Contact Hrs./week)			Examination Scheme(Marks)							Total Credits		
		L	P/D	T	End Sem. Exam.	Continuous Assessment					Total	TH	TW	Total
						Unit Test	Attendance	Assignments	TW/OR	TW/PR				
C401	Mechanical Vibration	3	2	-	60	20	10	10	50	-	150	3	1	4
C402	Automatic Control System	3	2	-	60	20	10	10	50	-	150	3	1	4
C403	Automobile Engineering	3	-	-	60	20	10	10	-	-	100	3		3
C404	Industrial Fluid Power	3	-	-	60	20	10	10	-	-	100	3		3
C405	Elective - II	3	-	-	60	20	10	10	-	-	100	3	-	3
C410	Inplant Training		-	-		-		-	50	-	50	-	4	4
C411	Project Stage -I		2						100		100	-	4	4
	Total	15	06	00	300	100	50	50	250	-	750	15	10	25

*End Semester examination of duration 4 Hours.

Total Credits Sem.V–25

Total Credits Sem.VI–25

Grand Total -50

Elective-II

1) Computational Fluid Dynamics
2) Industrial Engineering & Management;
3) Nanotechnology
4) Production Planning & Control
5) Experimental Methods in Mechanical Engineering

B.TECH.MECHANICAL: SEMESTER-VIII (2014Course)

S.N.	Course	Teaching Scheme(Contact Hrs./week)			Examination Scheme(Marks)							Total Credits		
		L	P/D	T	End Sem. Exam	Continuous Assessment					Total	TH	TW	Total
						Unit Test	Attendance	Assignments	TW/OR	TW/PR				
C412	Power Plant Engineering	4	2	-	60	20	10	10	50	-	150	4	1	5
C413	Industrial Product Design	3	2	-	60	20	10	10	50	-	150	3	1	4
C414	Optimum Design*	4	2	-	60*	20	10	10	50		150	4	1	5
C415	Elective-III	3	-	-	60	20	10	10	-		100	3	-	3
C420	Project Stage –II		4	-		-	-	-	200	-	200	-	8	8
C421	Environmental Sciences		-	-	100	-		-	-	-	100	3	-	3
	Total	14	10	00	240	80	40	40	350	00	750	14	11	25

*End Semester examination of duration 4 Hours.

Total Credits Sem. VII –25

Total Credits Sem. VIII –25

Grand Total -50

Elective-III

1) Industrial Automation & Robotics
2) Cryogenics
3) Project Management & Ethics
4) Total Quality Management
5) Finite Element Analysis

Rules for Conducting Tests

Mode of the test

- In each semester for each subject three tests shall be conducted. The schedule for the same will be declared at the commencement of academic year in the academic calendar.
- Each test shall carry 20 marks.
- University examination pattern has given weightage of 20 marks for the tests.
- To calculate these marks following procedure is followed:

  i) Out of the three tests conducted during the semester, the marks of only two tests in which the candidate has shown his/her best performance shall be considered, to decide the provisional marks in each subject.

  ii) Average marks obtained in two tests in which students have performed well, shall be considered as provisional marks obtained by the student in the tests.

  iii) If the candidate appears only for two tests conducted during the semester, he/she will not be given benefit of the best performance in the tests.

  iv) If the candidate appears only for one test conducted during the semester, to calculate the marks obtained in the tests it will be considered that the candidate has got 0 (zero) marks in other tests.

  v) The provisional marks obtained by the candidate in class tests should reflect as proportional to theory marks. In cases of disparity of more than 15% it will be scaled down accordingly; these marks will be final marks obtained by the student. No scaling up is permitted.

  vi) If the candidate is absent for theory examination or fails in theory examination his final marks for tests of that subject will not be declared. After the candidate clears the theory, the provisional marks will be finalized as above.
- Paper pattern for tests

  i) All questions will be compulsory with weightage as following

Question 1	-	7 marks
Question 2	-	7 marks
Question 3	-	6 Marks

  ii) There will not be any sub-questions.
- For granting the term it is mandatory to appear for all three tests conducted in each semester.
- Roll nos. allotted to students shall be the examination nos. for the tests.

MECHANICAL VIBRATION
(Course No.C401)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : 02 Hours/ Week	Unit Test 20 Marks	Practical : 01
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: 50 Marks	
	Total 150 Marks	4

Course Pre-requisites:

Student should have Basic Knowledge of

1. Engineering Mathematics
2. Fundamentals of Mechanical Engineering
3. Engineering Mechanics
4. Theory of Machines.
5. Machine design-I & II

Course Objectives:

1. To study basic concepts of vibration analysis
2. To analyze vibrations acting on mechanical systems by considering different types of vibrations.
3. To determine a complete solution to the modeled mechanical vibration problems.
4. To acquaint with the principles of vibration measuring instruments

Course Outcomes: Students will be able to:

1. Understand the basic concepts of vibrations.
2. Understand the concept of free undamped single DOF and evaluate vibrating parameters.

3. Understand the concept of free damped single DOF and evaluate vibrating parameters.
4. Understand the concepts of force single DOF and evaluate transmissibility and critical speed of shaft.
5. Understand the concept of free undamped multi DOF vibration system and analyze it for vibration parameters.
6. Understand different types of vibration measuring instruments and apply to measure the vibration.

Unit I **06 Hours**

Basic Concepts of Vibration

Vibration and oscillation, causes and effects of vibrations, Vibration parameters – spring, mass, damper, Damper models, Motion – periodic, non periodic, harmonic, non- harmonic, Degree of freedom, static equilibrium position, Vibration classification, Steps involved in vibration analysis.

Unit II **06 Hours**

Free Undamped Single Degree of Freedom Vibration System

Longitudinal, transverse, torsion vibration system, Methods for formulation of differential equations by Newton, Energy and Rayleigh's Method.

Unit III **06 Hours**

Longitudinal, transverse, torsion vibration system, Methods for formulation of differential equations by Newton, Energy and Rayleigh's Method.

Viscous damped system – under damped, critically damped, over damped; Logarithmic decrement; Coulomb's damping; Combined viscous and coulomb's damping.

Unit IV **06 Hours**

Forced Single Degree of Freedom Vibratory System

Analysis of linear and torsional systems subjected to harmonic force excitation and harmonic motion excitation (excluding elastic damper) Vibration Isolation and Transmissibility :Force Transmissibility, Motion Transmissibility Typical isolators& Mounts , Rotor Dynamics: Critical speed of single rotor, undamped and damped.

Unit V **06 Hours**

Free Undamped Multi Degree of Freedom Vibration System

Eigen values and Eigen vectors for linear system and torsional two degree of freedom; Holzer method for linear and torsional unbranched system; Two rotors, Three rotors and geared system; Dunkerley's and Rayleigh's method for transverse vibratory system

Unit VI **06 Hours**

Vibration Measurement

Introduction, Vibration measuring parameters- Displacement, Velocity and acceleration Vibration measuring devices: Accelerometers, Vibration exciters, FFT analyzer,

Introduction to signal analysis: Time domain & Frequency domain analysis of signals and Noise measurement.

Assignment:

Problems and/or theory questions on following topics:

1. Theory questions based on Basic Concepts of Vibration.
2. At least five numerical/theory questions on Free undamped Single Degree of Freedom Vibration System.
3. At least five numerical/theory questions on Free damped Single Degree of Freedom Vibration System.
4. At least five numerical/theory questions on Forced Single Degree of Freedom Vibratory System.
5. At least five numerical/theory questions on Free undamped Multi Degree of Freedom Vibration System.
6. Theory questions based on Vibration Measurement .

Term Work/Practical's: (Any 8)

1. To determine the natural frequency and periodic time of single degree freedom system.
2. To study forced vibration of damped system for different amount of damping.
3. To study torsional vibration of single rotor system.
4. To study damped torsional vibration of single degree freedom system.
5. To study torsional vibration of two rotor system and position of node.
6. To determine critical speed of shaft with single rotor.
7. To study undamped free vibration of equivalent spring mass system.
8. Demonstration of Noise measurement using vibration Analyzer.
9. Demonstration of vibration parameter measurement of beam using vibration analyzer.
10. Vibration analysis of mechanical system using MATLAB.

Text Books/ Reference Books

1. Mechanical Vibrations - G. K. Grover Nem Chand & Bros.
2. Mechanical Vibrations 4th edition- S. S. Rao - Pearson Education
3. Fundamentals of Mechanical Vibration - S.Graham Kelly - Tata McGraw Hill 4.
4. Vibration Analysis - P. Srineevasan - Tata McGraw Hill
5. Mechanical Vibrations - Schaum's outline series - S.Graham Kelly- McGraw Hill
6. Theory and Practice of mechanical vibrations - J. S. Rao, K. Gupta - New Age
7 Mechanical Vibrations, J.P. Den Hartog, Mc Graw Hill Book Company Inc.
8. Leonard Meirovitch, Introduction to Dynamics and Conti'oJ. Wiley, New York,
9. Benson H. Tongue, Principles of Vibration. Oxford University Press.
10. W. Thomson, Theory of Vibrations with Applications, Second Edition, Pearson Education).

Syllabus for Unit Test:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

AUTOMATIC CONTROL SYSTEM
(Course No.C402)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 03 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : 02 Hours/ Week	Unit Test 20 Marks	Pr/Oral : 01
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: 50 Marks	
	Total 150 Marks	4

Course Pre-requisites:

Student should have Basic Knowledge of

1 Engineering Mathematics-II, Fundamentals of Electrical Engineering

2. Computer Programming and Simulation, Numerical Methods and Optimization Techniques

3. Mechanical Measurement & Metrology

Course Objectives:

1. To prepare transfer function based mathematical model of simple engineering systems and analyze its performance

2 To calculate the time response specifications of simple engineering systems

3. To explain working and applications of signal conditioning devices used in control system

4. To acquire knowledge of elements of mechatronics, control actions, Programmable Logic Controller and its multidisciplinary applications

Course Outcomes: Students will be able to:

1. Understand the concept of mathematical modeling, Routh-Hurwitz Criterion and analyze the stability of a closed-loop control system

2. Understand block diagram algebra rules and apply to obtain an overall transfer function of an engineering system

3. Understand different time domain specification and evaluate time responses of the engineering system
4. Understand the concepts of analog and digital signal conditioning and apply in multidisciplinary applications
5. Understand different automatic control systems, control actions, controllers and apply in multidisciplinary applications
6. Understand the structure of Programmable Logic Controller, SCADA and select PLCs, create ladder diagram for industrial applications

Unit I **06 Hours**

Frequency Domain Modeling and Analysis

Transfer Function based modeling of Mechanical, Thermal and Fluid System; Concept of Poles & Zeros; Absolute vs Relative Stability; Stability Analysis using Routh Hurwitz Criterion; Mapping of Pole Zero Plot with Damping Factor, Natural Frequency and Unit Step Response

Unit II **06 Hours**

Block Diagram Algebra

Block Diagram Fundamentals, Canonical Form, Rules for Block Diagram Reduction, Reduction of Block Diagram, Reducing to Unity Feedback Systems, Examples on Block Diagram Reduction.

Unit III **06 Hours**

System Response

Introduction of Time Response of Control System, Standard Test Signals, Input-Output Model Equation, Instantaneous, Lagging and Delay Response, Transient Specifications for Unit Step Response, Concept of State, State Variable, State Vector, State Space and State Model.

Unit IV **06 Hours**

Signal Conditioning

Necessity of Signal Conditioning, Passive Circuits, Analog Signal Processing: Operational Amplifiers, Inverting and Non-inverting, Summing, Subtractor, Instrumentation. Digital Signal Processing: Timing Diagrams, Sequential Logic, Flip-Flops, Successive Approximation(SAR) type ADC and R-2R ladder DAC.

Unit V **06 Hours**

Automatic Control System

Concept of Automatic Control Systems, Mechatronics System & Its Examples, Mechatronics System Components, Open Loop and Closed Loop System, Effects of Feedback and Basic Characteristic of Feedback Control Systems. Applications of Feedback and Feed-Forward Control System. Basic Control Action and Controllers:-On-Off Control, Proportional, Integral, Derivative and PID

Unit VI **06 Hours**

Programmable Logic Controller

Introduction to PLCs, Basic Structure of a PLC, Principles of Operation, PLC Programming Languages, Ladder diagram, Latching and internal relays, Timers and Counters, Selection of a PLCs for Control System, Application of PLCs for Automatic Control System. Concept of SCADA and its Applications.

<u>Term Work/Practical's:</u>

Term work shall consist record of minimum 8 experiments from the following; Out of which Experiment no. 1, Experiment no. 3 and Experiment no. 9 are compulsory.

1. Analysis of following control system parameters using software like MATLAB/SIMULINK
   a. Plot the pole-zero configuration in s-plane for the given transfer function
   b. Stability analysis of given control system using Routh-Hurwitz's criterion
   c. Determine the transfer function for given closed loop system in block diagram representation.
   d. Plot unit step response of given transfer function and find peak overshoot, peak time, rise time and delay time.
2. Study of applications of Op-Amp Circuits.
3. Study of P, P+I, P+D, P+I+D control actions using any trainer kit / simulation software.
4. Study of XY position control systems.
5. Stabilizing Inverted Pendulum.

6. Study of A/D and D/A Converters.
7. Study the functions and applications of variable frequency drive(VFD).
8. To study AC servomotor and plot its Torque Speed characteristics.
9. Development of applications by using following instructions of the PLC
a. Latching b. Timers c. Counter d. Logic Gates
10. Sequencing of pick and place robot using PLC programming.
11. Identification of different control system components in PLC based mini assembly cell.
12. Development of applications using SCADA system for any automation application

List of Assignments

Problems and/or theory questions on following topics:

1.Theory questions based on Frequency Domain Modeling and Analysis.

2. At least five numerical/theory questions on Block Diagram Algebra.

3.At least five numerical/theory questions on System Response

4. At least five numerical/theory questions on Signal Conditioning.

5. At least five numerical/theory questions on Free Automatic Control System

6.Theory/ Numerical questions based on Programmable Logic Controller.

Text Books/ Reference Books

1. 1. Control System Engineering: Nagrath L.T. and Gopal. M., Wiley Eastern Ltd.
2. Alciatore and Histand, “Introduction to Measurement and Mechatronics Systems”, McGraw Hill.
3. W. Bolton, “Mechatronics”, Pearson Education.
4. M D Singh and J G Joshi, “Mechatronics”, PHI
5. Gary Dunning, “Programmable Logic Controllers”, Cengage Learning.
6. Mechatronics-Principles, Concepts and Application: Mahalik, McGraw Hill Education Pvt Ltd;
7. Process Control Instrumentation Technology, 8th Edition Curtis D. Johnson, University of Houston
8. Ogata, Katsuhiko: "Modern Control Engineering (5th Edition)", Prentice-Hall, Inc., 2009 (ISBN: 0-13-615673-8)

9. Madan Gopal, Control Systems Principles and Design, Tata McGraw Hill, seventh edition, 1997.
10. Nise, Control System Engineering, John Wiley & sons, 3rd Edition
11. Norman Nise, "Control System Engineering", Prentice Hall India, Fourth Edition
12. Anand Kumar, "Control System Theory", Prentice Hall India.
13. F. H. Raven, "Automatic Control Engineering", Third edition, McGraw Hill, 1983.
14. Dr. N. K. Jain, "Automatic Control Systems Engineering", Dhanpat Rai Publishing Company.

Syllabus for Unit Tests:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

AUTOMOBILE ENGINEERING (Course No.C403)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. Fundamental of Mechanical engineering
2. Internal Combustion Engine 3. Theory of Machine

Course Objectives:

1. basic principles of actual automobile systems
2 important systems in an automobile
3. recent and modern trends in automobile sector

Course Outcomes: Students will be able to:

1. understand fundamental concepts of fluid power and it's industrial applications.
2. understand the concepts of pumps, power units and accessories; and analyze performance of hydraulic pumps.
3. understand the concepts of fluid power control and use of control valves.
4. understand the concepts of actuators and analyze them for use in industrial circuits.
5. understand the concepts of pneumatics and vacuum.
6. understand the concepts of fluid power system design and analyze fluid power circuits

Unit I **06 Hours**

Classification of Automobiles

Broad classification of Automobiles, Major components & their functions, Types of vehicle layouts, Types of bodies, Body construction & materials, All wheel drive, Types of chassis & their construction.

Unit II **06 Hours**

Steering System & Transmissions

Function of steering, Steering system layout, Automotive steering mechanism Ackerman & Davis, Types of steering gear boxes, Condition for true rolling, Steering geometry Camber, Caster, King pin inclination, included angle, Toe-in & Toe-out, Wheel alignment, Under steer & Over steer, Types & working of power steering.

Transmissions: Necessity of gear box, Sliding mesh, Constant mesh, Synchromesh and epicyclic gear box, Overdrives and hydrodynamic torque converter, Trouble shooting and remedies.

Live axle and differential: Final drive, spiral, bevel, Hypoid and worm drives, Types of live axles, semi, three quarter and full floating axles. Necessity of differential, Conventional and non-slip differential, Trouble shooting and remedies.

Unit III **06 Hours**

Clutch & Braking System

Requirement of clutch, Types & functions, Single plate, Multiplate, Centrifugal, Cone clutch, Electromagnetic & Fluid clutches, Troubleshooting & automobile clutch.

Braking System : Function of automotive brake system, Types of braking mechanism Internal, Expanding & Disc brake, Mechanical, Hydraulic & Air brake system, Servo & power brakes, Antiskid braking, Calculation of braking force required, Stopping distance & dynamic weight transfer.

Unit IV **06 Hours**

Suspension & Wheels

Object of suspension, Basic requirement, Air suspension and its features, Independent suspension, Spring & unspring mass, Types of spring, Shock absorber, Torsion bars, Air suspension, Hydro pneumatic suspension, Pitching, rolling and bouncing.

Wheels and Tyres: Requirements of wheels and tyres, Constructional features, Types of tyres, Types of rim , Inflation Pressure and its importance, Application to ride and stability, Trouble shooting and remedies.

Unit V **06 Hours**

Electrical system

Battery: Types of battery, Lead-Acid, Alkaline, ZEBRA, Sodium Sulphur and

Swing, Ratings, charging, Maintenance and testing of Lead-Acid battery.

Starting system: Requirements, Various torque terms used, Starter motor drives; Bendix, Follo through, Barrel, Rubber compression, Compression Spring, Friction Clutch, Overrunning Clutch, Dyer. Starter motor solenoids and switches, Glow plugs.

Alternator: Principle of operation, Construction, Working, Rectification from AC to DC.

Unit VI **06 Hours**

Solid Modeling

Electronic Control module (ECM), operating modes of ECM (closed loop and open loop) Inputs required and output signals from ECM, Electronic Spark control, Air Management system, Idle speed control. Construction, working & application of temperature sensors, inductive sensors, Position sensors (rotary, linear). Hot wire and thin film air flow sensors, vortex flow/turbine fluid sensors, Optical sensor, Oxygen sensors, Light sensors, methanol sensors ,Rain sensor, New developments in the sensor technology.

Assignments:

1. Study of types of bodies and chassis of automobile.
2. Report on dismantling and assembly of steering mechanisms
3. Report on dismantling and assembly of brakes.
4. Report on dismantling and assembly of rear axle and differential.
5. Report on dismantling and assembly of suspension systems
6. Study of types of tyres and rims.
7. Report on battery charging and starting systems.
8. Study and understanding of different types of sensors used in automobile.
9. Report on industrial visit to any automobile Manufacturer.
10. Report on industrial visit to any Two wheeler/ Four Wheeler service station

Text Books/ Reference Books

1. Automotive Mechanics, William Cruose & Donald L. Anglin, Tata Mcgraw Hill
2. Automotive Mechanics , Joseph Heitner, East-West press pvt .Ltd
3. The Automobile Engineering, T. R. Banga & Nathu Singh, Khanna Publishers
4. The Automobile, Harbans Singh Reyat, S. Chand & Co.
5. Automobile Engineering, R. K. Rajput, Laxmi Publication
6. Basic Automobile Engineering, C.P.Nakra, Dhanpat Rai Publishing CO
7. Automobile Engineering, Kirpal Singh Vol I & II, Standard publishers Distributors ,Delhi
8. Automobile Engineering, K. K. Jain & R.B. Asthana, Tata Mcgraw Hill
9. Automotive Mechanics, S. Srinivasan, Tata Mcgraw Hill
10. Automobile Engineering, Vol I & II, R.K. Mohanty, Standard Book House

Syllabus for Unit Tests:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

INDUSTRIAL FLUID POWER
(Course No.C404)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory: -03Hours/ Week	End Semester Examination 60 Marks	Theory: 03
Practical: - 00 Hours/Week	Continuous Assessment: 40 Marks	
	Term Work / Oral --- Marks	
	Total 100 Marks	03

Course Pre-requisites:

1. Turbo machinery
2. Mechanical Measurements and Control

Course Objectives:

The Students should have knowledge of

1. fluid power systems and sources of fluid power
2. control devices, actuators and industrial fluid circuits
3. principles of pneumatics and fluid power system design

Course Outcomes: Students should be able to

1. Understand fundamental concepts of fluid power and it's industrial applications.
2. Understand the concepts of pumps, power units and accessories; and analyze performance of hydraulic pumps.
3. Understand the concepts of fluid power control and use of control valves.
4. Understand the concepts of actuators and analyze them for use in industrial circuits.
5. Understand the concepts of pneumatics and vacuum.
6. Understand the concepts of fluid power system design and analyze fluid power circuits

Unit I **Introduction to Fluid Power** **06 Hours**

Fluid power system: Components of fluid power system, advantages and limitations. Difference between electrical, pneumatic and fluid power systems. Applications in the fields of machine tools, material handling, aerospace, mobile and stationary machines, clamping devices and more applications of fluid power.

Types of hydraulic fluids, Seals, Conductors: Petroleum based, synthetic and water based. Properties of fluids, Pascal's Law, selection of fluids, additives, effect of temperature and pressure on hydraulic fluid. Seals, sealing materials. Types of pipes, hoses, material. Fluid conditioning through filters, strainers, sources of contamination and contamination control.

Unit II **06 Hours**

Source of Power

Pumps: Types, classification, principle of working and constructional details of gear pumps, vane pump, piston pump, power and efficiency calculations, characteristics curves, selection of pumps for hydraulic power transmission (Numerical Treatment).

Power units and accessories: Types of power units, reservoir assembly, sizing of reservoirs, constructional details, pressure switches, temperature switches. Accumulators: Types, selection procedure, applications of accumulators. ISO symbols for hydraulic and pneumatic Components

Unit III **06 Hours**

Fluid Power Control

Control of fluid power: Necessity of fluid control through pressure control, directional control and flow control valves.

Control valves: i) Principle of pressure control valves, direct operated and pilot operated pressure relief valves, pressure reducing valve, sequence valve. ii) Principle of flow control valves, pressure compensated and non-compensated flow control valves.iii) Principle of directional control valves, types of directional control valves, two-way, three-way, four-way valves, check valve and shuttle valve. Open centre, close centre, tandem centre valves.

Actuating devices- manually operated, mechanically operated, solenoid operated, pilot operated, lever operated.

Unit IV **06 Hours**

Actuators and Industrial Circuits

Actuators: (i) Linear and Rotary actuators (ii) Types of cylinders and mountings, Design considerations for cylinders (iii) Types of hydraulic motors-gear, vane & piston. (iv) Methods of control of acceleration, deceleration. (v) Calculation of piston velocity, thrust under static and dynamic applications, considering friction, inertia loads (Numerical Treatment).

Industrial circuits: Simple reciprocating, Regenerative, Speed control (Meter in, meter out & bleed off), Sequencing, Synchronization, transverse & feed, automatic reciprocating, fail safe circuit, counter balance circuit, actuator locking, circuit for hydraulic press, unloading circuit, motor breaking circuit.

Unit V **06 Hours**

Pneumatics

Principle of Pneumatics: (i) Laws of compression, types of compressors, selection of compressors. Pneumatic actuators-rotary, reciprocating (ii) Comparison of pneumatics with hydraulic power transmissions. (iii) Types of filters, regulators, lubricators, mufflers, dryers. (iv) Pressure regulating valves, (v) Direction control valves (vi) Speed regulating methods used in Pneumatics.(vii) Basic pneumatic circuits (viii) Introduction to electro-pneumatics. Application of pneumatics in industrial automation.

Introduction to vacuum: Vacuum measurement, vacuum pumps, introduction to vacuum sensors and valves. Industrial applications of vacuum.

Unit VI **06 Hours**

System Design

Design of hydraulic/ pneumatic circuit for practical application, Selection of different components such as reservoir, various valves, actuators, filters, pumps based on design. (Students are advised to refer manufacturer's catalogues.)

Assignments

Assignments will be based on above syllabus

1. Theory questions based on hydraulic fluids, seal, strainer, conductor and filters.
2. At least five numerical/theory questions on sources of power.
3. Theory questions based on selection of pressure control, flow control and directional control valve for specific application.
4. Develop at least five hydraulic circuits using simulation software like Automation Studio.
5. Develop at least five pneumatic circuits for low cost industrial automation using simulation software like Automation Studio, FluidSIM®.
6. Design of at least five hydraulic/pneumatic systems which includes components such as reservoir, various valves, actuators, filters, pumps based on design.
7. Theory questions based on sources of contamination, and its control.
8. Theory questions based on fluid power control.
9. Theory questions based on pneumatics and its applications
10. Identify at least five fluid power applications and enlist the fluid power components used in each of these applications.
11. Design of hydraulic/pneumatic circuit for practical application and selection of fluid power components.

Text Books

1. Anthony Esposito, Fluid Power with Applications, Pearson.
2. S.R. Majumdar, Oil Hydraulic systems- Principle and maintenance,Tata McGraw Hill.
3. S.R.Majumdar,Pneumatics Systems Principles and Maintenance,Tata McGraw Hill.
4. H. L. Stewart, Hydraulics and Pneumatics, Taraporewala Publication.
5. Jagadeesha T. and Tahammaiah Gowda, Fluid Power, Generation, Transmission and Control Wiley Publication.

Reference Books

1. J. J. Pipenger "Industrial Hydraulics", McGraw Hill
2. Pinches "Industrial Fluid Power", Prentice hall.
3. D.A. Pease "Basic Fluid Power"', Prentice hall.
4. B. Lall "Oil Hydraulics", International Literature Association.
5. Yeaple "Fluid Power Design Handbook".
6. ISO - 1219, Fluid Systems and components, Graphic Symbols
7. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science and Technology Books
8. Product Manuals and books from Vickers/ Eaton, FESTO, SMC pneumatics
9. Dr. R K Bansal, Fluid Mechanics, Laxmi Publications(P) Ltd.

Syllabus for Unit Tests:

Unit Test-I Unit-I,II, III

Unit Test-II Unit-IV, V, VI

Elective-II COMPUTATIONAL FLUID DYNAMICS (Course No.C405)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Prerequisites:-

Student should have Basic Knowledge of

1. Mathematics & Science
2. Fluid mechanics
3. heat transfer

Course Objectives:

1. To study Governing Equations of vicious fluid flows
2. To analyze numerical modeling and its role in the field of fluid flow and heat transfer
3. To enable the students to understand the various discretization methods

Course Outcomes: Students will be able to:

1. Understand fundamental concepts of fluid dynamics.
2. Understand the concept of meshing
3. analyze heat transfer and fluid flow problems using different discretization techniques.
4. analyze steady and unsteady heat conduction problems using CFD techniques.
5. analyze convection-diffusion problems using CFD techniques
6. apply knowledge of CFD techniques to solve practical problems.

Unit I **06 Hours**

Introduction to fluid Dynamics

Concepts of Fluid Flow, Pressure distribution in fluids, Reynolds transport theorem, Integral form of conservation equations, Differential form of conservation equations, Different Types of Flows, Euler and Navier Stokes equations, Properties of supersonic and subsonic flows, Flow characteristics over various bodies.

Unit II **06 Hours**

Mesh Generation

Surface mesh generation Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms, grid clustering and quality checks for volume mesh. Adaptive, Moving and Hybrid Grids, Need for adaptive and, moving grids, Tet, pyramid, prism, and hex grids, using various elements in combination

Unit III **06 Hours**

Basic Discretization Techniques

Need to discretization the domain and governing equations, Finite difference approximation using Taylor series, for first order (Forward Difference Approximation, Backward Difference Approximation, Central difference Approximation) and second order (based on 3 node, 4 node and 5 node points),explicit and Implicit approaches applied to 1D transient conduction equation, Couette flow equation using FTCS and Crank Nicholson‘s Method, Stability Criteria concept and physical interpretation, Thomas Tri-diagonal matrix solver.

Unit IV **06 Hours**

Two Dimensional Steady and unsteady heat conduction

Solution of two dimensional steady and unsteady heat conduction equation with Dirichlet, Neumann, robbins and mixed boundary condition – solution by Explicit and Alternating Direction Implicit method (ADI Method), Approach for irregular boundary for 2D heat conduction problems

Unit V **06 Hours**

Application of Numerical Methods to Convection – Diffusion System

Convection: first order wave equation solution with upwind, Lax–Wendroff, Mac Cormack scheme, Stability Criteria concept and physical interpretation Convection –Diffusion: 1D and 2D steady Convection Diffusion system – Central difference approach, Peclet Number, stability criteria, upwind difference approach, 1 D transient convection-diffusion system

Unit VI **06 Hours**

CFD as Practical Approach

Introduction to any CFD tool, steps in pre-processing, geometry creation, mesh generation, selection of physics and material properties, specifying boundary condition, Physical Boundary condition types such as no slip, free slip, rotating wall, symmetry and periodic, wall roughness, initialising and solution control for the solver, Residuals, analysing the plots of various parameters (Scalar and Vector contours such as streamlines, velocity vector plots and animation). Introduction to turbulence models. Reynolds Averaged Navier-Stokes equations (RANS), k- , k- . Simple problems like flow inside a 2-D square lid driven cavity flow through the nozzle

<u>Assignments:</u>

Assignments will be based on above syllabus:

1. Reynolds transport theorem, Integral form of conservation equations
2. Differential form of conservation equations, Different Types of Flows, Euler and Navier Stokes equations
3. Surface mesh generation Surface mesh repair, Volume grid generation, Volume mesh improvement, mesh smoothing algorithms
4. Grid clustering and quality checks for volume mesh. Adaptive, Moving and Hybrid Grids
5. Finite difference approximation using Taylor series, for first order
6. Explicit and Implicit approaches applied to 1D transient conduction equation, Couette flow equation using FTCS and Crank Nicholson's Method
7. Solution of two dimensional steady and unsteady heat conduction equation with Dirichlet, Neumann,

8. Robbins and mixed boundary condition – solution by Explicit and Alternating Direction Implicit method (ADI Method), Approach for irregular boundary for 2D heat conduction problems
9. Convection: first order wave equation solution with upwind, Lax–Wendroff, Mac Cormack scheme, Stability Criteria concept
10. Selection of physics and material properties, specifying boundary condition, Physical Boundary condition types such as no slip, free slip, rotating wall, symmetry and periodic, wall roughness

Text Books

1. Versteeg, H.K., and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The finite volume Method, Longman, 1998.
2. Ghoshdastidar , P.S., computer Simulation of flow and heat transfer, Tata McGraw Hill Publishing Company Ltd., 1998.
3. Fundamentals Patankar, S.V. Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004
4. Muralidhar, K., and Sundararajan, T., computations Fluid Flow and Heat Transfer, Narosa Publishing House, NewDelhi, 1995.
4. Prodip Niyogi, Chakrabarty .S.K., Laha .M.K. Introduction to Computational Fluid Dynamics, Pearson Education, 2005
5. Introduction to Computational Fluid Dynamics Anil W. Date Cambridge University Press, 2005.

Syllabus for Unit Test:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Elective-II INDUSTRIAL ENGINEERING & MANAGEMENT (Course No.C406)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. Fundamentals of Mechanical Engineering
2. Manufacturing Process 3. Advanced Manufacturing Processes

Course Objectives:

1. To study The fundamentals of management
2. To study Types of business organization and its structure
3. To study fundamentals of main four departments of an organization i.e. finance, production, marketing and personnel
4. To study details of method study tool of industrial engineering
5. To study details of work measurement tool of industrial engineering
6. To study details of ergonomics and industrial safety tool of industrial engineering

Course Outcomes: Students will be able to:

1. Understand fundamentals of management
2. Understand and select different types of business organizations and it's structure

3. Evaluate fundamentals of main four departments of an organization i.e. finance, production, marketing and personnel
4. Understand and Analyze the details of method study tool used in industrial engineering
5. Understand and Analyze the details of work measurement tool used in industrial engineering
6. Understand and Analyze the details of ergonomics and industrial safety tool used in industrial engineering

Unit I **6 Hours**

Management-An Introduction

Management- Meaning and Definitions, Management, Administration, and Organization concepts, Management as an Art and Science and a profession, contribution of various thinkers to management thought, Types and Functions of Management. Different approaches to management – scientific, operational, human and system approach.

Unit II **6 Hours**

Organization

Different forms of business Organization –Individual proprietorship, Partnership, Joint stock company, Co-Operative enterprise, Public Sector, Undertakings, organizational structures in Industries, Line, Functional ,Line and functional , Project, Matrix Organization and Committees

Unit III **6 Hours**

Financial, Marketing and Personnel Management

Personnel Management-Definitions Recruitment, Selection and training of the employees, Job valuation and Merit rating, wage administration different methods of wage payments, incentives.

Marketing Management-Definitions, Marketing and Selling concept, market segmentation, distribution channels, Market Research, Advertising and sales promotion and Sales forecasting.

Financial Management-Capital structure, Fixed capital, working capital, sources of finance, cost analysis, Break even analysis, Depreciation and Financial statement.

Unit IV **6 Hours**

Method Study:

Steps in method study, tools and techniques used, process chart symbols, flow diagrams, two handed chart, multiple activity chart, use of motion pictures and its analysis. SIMO charts, chorno & cycle graph, developing, presentation, installation and maintenance of improved methods.

Unit V **6 Hours**

Work Measurement

Time Study: Aim and objectives , terminology and tools, use of stop watch procedure in making a time study, elements, selection of operations time study forms, handling of foreign elements. Performance rating. Allowances: Personal, Fatigue and other allowances. Analysis and calculation of Standard Time. Determination of number of cycles time study for indirect functions such as Maintenance , Marketing etc., MOST Technique. Works Sampling: Definition, Objectives, theory of Work Sampling. Other applications of work sampling, errors in work sampling study.

Synthetic and Standard data Methods: Concepts, introduction to PMTS, MTM-1, WF, Basic motion time, MTM-2, and other second – generation methods timing of group operations.

Unit VI **6 Hours**

Ergonomics and Industrial Safety:

Definitions, importance in industry, basic anatomy of human body, anthropometrics, measurement of physical work and its techniques, work and rest cycles, bio mechanical factors environment effects.

Importance of safety, planning, training, safety precautions, safety Equipments, Government regulations on safety.

Assignments:

Theory questions on following topics:

1. Management: Types, Functions, Principles
2. Study of organization Structure

3. Study of Business organizations
4. Study of Financial, Marketing and Management
5. Study of Personnel Management
6. Study of Method Study methods and procedure
7. Study of Method Study charts
8. Study of Work Measurement methods and procedure
9. Study of Time study procedure and problems
10. Study of Work sampling and problems
11. Study of Ergonomics
12. Study of Industrial Safety

Text Books/ Reference Books

1. O. P. Khanna, Industrial Engineering & Management, Dhanapat Rai & Sons.
2. M. C. Shukla, Business Organization and Management, S. Chand & Co. Ltd, New Delhi.
3. Harold Koontz & Heinz Enrich, Essentials of Management, McGraw Hill International.
4. M. N. Mishra, Organizational Behavior, Vikas publishing New Delhi. Dale Yoder, Personnel Management.Work Study, ILO.
5. S. S. Patil, Industrial Engineering & Management, Electro tech Publication.
6. Mansoor Ali & Dalela, Industrial Engineering & Management System, Standard Publisher distributions.
7. R. M. Currie, Work Study, ELBS.
8. Management by James A. F. Stoner, R. Edward Freeman, PHI
9. Management Today: Principles and Practice by Gene Burton and Manab Thakur, TMH
10. Organizational Behavior by Keith Davis, TMH
11. Management (Tasks, responsibilities and Practices) by Peter Drucker, Harper Business
12. Production Management by Lockyer, ELBS
13. Modern Production Management by E. S. Buffa (John Wiley)
14. Financial Management by Vanhorne, PHI
15. Financial Management (Theory and Practice) by Prasanna Chandra, TMH

16. Marketing Management by Philip Kotler, Pearson Edition
17. Marketing Management by Rajan Saxena, TMH
18. Personnel Management by Edward Flippo, TMH
19. Industrial Engineering and PPC" by A.K Bewwor and V.A.Kulkarni.

Syllabus for Unit Test:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Elective-II NANOTECHNOLOGY
(Course No.C407)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. Material Science 2. Engineering Physics 3. Engineering Chemistry

Course Objectives:

1. To study the basics of nano-science, nanotechnology and properties of nano-materials
2. To study different synthesis methods and various characterization techniques for nano-materials
3. To create an awareness about multidisciplinary applications and safety in nanotechnology

Course Outcomes: Students will be able to

1. Understand the basics of nano science and nanotechnology
2. Analyze various properties of nonmaterial
3. Understand the different synthesis methods for formulation of nonmaterial
4. Understand the different characterization techniques for nonmaterial
5. Understand applications of nano science and nanotechnology in multidisciplinary fields
6. Analyze safety parameters while using nonmaterial

Unit I **06 Hours**

Basics of Nanoscience

Introduction, length scale of different structures, definition of nanoscience and nanotechnology, fullerenes, CNTs, graphenes and inorganic nanostructures, the evolution of Nanoscience, quantum dots and electronic structure of various nanophase materials.

Unit II **06 Hours**

Properties of Nano materials

Mechanical, Thermal, Electrical, Optical, Magnetic and Structural properties. Carbon nanostructures -Fabrication, structure, electrical properties and mechanical properties

Unit III **06 Hours**

Synthesis of Nonmaterial

Bottom up-Ball Milling, Melt mixing, Physical vapour deposition, Ionized cluster beam deposition, Laser pyrolysis, Sputter deposition, Electric arc deposition, Gas evaporation.

Chemical methods: Hydrothermal combustion, bath deposition with capping techniques and top down, Chemical vapour deposition, Synthesis of metal & semiconductor nanoparticles by colloidal route, Microemulsions, Sol-gel method, Combustion method, Wet chemical method.

Unit IV **06 Hours**

Nano-materials characterization

Nanomaterials characterization XRD, UV-VIS spectroscopy, X-ray fluorence, X-ray photon emission spectroscopy, Scanning electon microscopy, Transmision electron microscophy, Scanning tunneling microscopy, Atomic force microscopy, Nuclear magnetic resonance spectroscopy, Electron spin resonance spectroscopy, Raman spectroscopy.

Unit V **06 Hours**

Applications of Nanotechnology

Industrial applications of nanomaterials, in the areas of electronics, photonics, biology, nano biomaterials, health and environment, medicine, defence, chemicals, catalysts, textiles, etc. Application of nanotechnology in remediation of pollution, photocatalysis and other nanocatalysts, greenhouse gases, global warming. Monitoring nanoparticles at work place and sensors used for this.

Unit VI **06 Hours**

Nanotechnology and Safety

Assessment of human health risks associated with the use of nanotechnologies and nanomaterials in the food and agriculture sectors, safety, current risk assessment approaches used by FAO/WHO, environmental, ethical, policy and regulatory issues. Toxicity of nanoparticles, exposure to nanoparticles and CNTs and influence on respiratory systems

Assignments:

Theory questions on following topics:

1. Study of nano science and nanotechnology structures
2. Properties :Mechanical, Thermal, Electrical, Optical, Magnetic and Structural
3. Properties: Carbon nanostructures
4. Synthesis of Non-materials: Bottom up
5. Synthesis of Non-materials: Chemical methods
6. Surface electon microscopy, Transmision electron microscophy, Scanning tunneling microscopy
7. UV-VIS spectroscopy, X-ray fluorence, Atomic force Microscope, Raman spectroscopy
8. Applications in electronics, photonics, biology, health and environment, medicine, defence, chemicals, catalysts, textiles
9. Application of nanotechnology in remediation of pollution, photocatalysis and other nanocatalysts, greenhouse gases, global warming
10. Nanotechnology and Safety

Text Books/ Reference Books

1. Edward L. Wolf (2nd Ed.), Nanophysics & Nanotechnology: An Introduction to Modern Concepts in Nanoscience, WILEYVCH, 2006
2. H.S.Nalwa, Hand book of Nanostructure materials and nanotechnology; (Vol.1-Acad. Press, Boston, 2000
3. C.P.Poole Jr., F.J.Owens; Introduction to Nanotechnology, John Wiley and sons, 2003
4. C. Furetta, Hand book of thermoluminescence; World Scientific Publ.
5. T.J.Deming, Nanotechnology; Springer Verrlag, Berlin, 1999
6. C. Delerue, M.Lannoo; Nanostructures theory and Modelling

7. Fausto, Fiorillo, Measurement and Characterization of Magnetic materials
8. Janos H, Fendler; Nanoparticles and Nanostructured Films
9. Liu, Hand Book of Advanced Magnetic Materials (4 Vol.)
10. Banwong, Anurag Mittal; Nano CMOS Circuit and Physical Design
11. S. Sakka,Sol-gel science and technology processing, characterization and applications; Kluwer Acad. Publ.
12. Goser et al, “Nanoelectronics & Nanosystems: From Transistor to Molecular & Quantum Devices”
13. A. Balandin and K. L. Wang, “Handbook of Semiconductor Nanostructures & Nanodevices”
14. Cao Guozhong, “Nanostructures &Nanomaterials -Synthesis, Properties & Application

Unit Tests-

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Elective-II PRODUCTION PLANING AND CONTROL (Course No.C408)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. Mathematics , Statistics and Manufactring process
2. Operation research
3. skills of scope, objective, application of production planning and control in manufacturing Industries.

Course Objectives:

1 The student should acquire skills of scope, objective, application of production planning and control in manufacturing Industries.

2. To acquire skills apply the techniques specified for production planning and control used in manufacturing Industries

3. To get the knowledge of material management and computer aided process planning

Course Outcomes: Students will be able to

1. Understand the various stages in production planning and control and apply it to product life cycle.
2. Understand the different forecasting techniques and evaluate trends by forecasting.
3. Understand the methods of production planning, scheduling and evaluate minimum production time.

4. Understand different the concept of MRP1 and MRP 2 and apply it for capacity planning.
5. Understand the different models used in material management and inventory control.
6. Understand the computer aided process planning and apply it for MRP and machine capacity planning.

Unit I **06 Hours**

Introduction to PPC

Role and stages of PPC, PPC as an integrated function, Product Life Cycle Analysis, Types of Production systems.

Unit II **06 Hours**

Forecasting Techniques

Use and types of forecasting, Methods of forecasting and comparison, Verification and control.(Numerical Treatment)

Unit III **06 Hours**

Techniques And Production Control

Process sheet, Routing, Scheduling- Gantt Chart, Machine Loading Chart, Line of Balance, Line Balancing, Dispatching rules, Sequencing - Johnson's rule, Loading, Follow- up, Evaluation, PERT, CPM. .(Numerical Treatment)

Unit IV **06 Hours**

Materials Planning And Purchasing:

Scope and requirement of MRP, MRP I and MRP II, Master Production Schedule, Bill of Materials, Capacity Requirement Planning, Introduction to ERP, Purchasing - Documentation, Make or Buy decisions, Vendor Development.

Unit V **06 Hours**

Inventory Control & Stores Management

Types of Inventory Cost of Inventory, EOQ, Selective Inventory Control, Replenishment Systems.Types of stores, Storage layout and storage systems, Stores Documentations, Stores Control and Control of Wastage and surplus, JIT, KANBAN, KAIZEN, Value Stream Mapping

Unit VI **06 Hours**

Computer aided production planning and control applied to :

a) Machine capacity planning and utilization. b) Productivity measurement. c) Material Requirement Planning. d) Scheduling Techniques. Hands on experience of Computer aided Production Planning and Control. Case studies from Industries.

Assignments:

Theory questions on following topics:

1. Introduction of PPC
2. Techniques of Forecasting used in PPC
3. Different Techniques used in PPC to improve the production and to reduce the cost of production
4. Use and application applications of material planning and purchasing
5. Use of inventory control
6. Computer aided production planning and control (CAPP)

Text Books/ Reference Books

1. J.L. Riggs, "Production Systems - Planning Analysis and Control ", JhonWiley & Sons.
2. J.B. Dilworth, "Operations Management - Design, Planning & Control for Manufacturing and Services ", McGraw Hill.
3. S N Charry, "Production and Operation Management" Tata McGraw- Hill
4. Samuel Elion, Elements of PPC ", Universal Book Company.
5. Martand Telsang, "Industrial Engineering and Production Management" S. Chand and Co. Ltd.
6. Moore, "Production Control ".
7. Mager and Boodman," Production Planning And Inventory Control"
8. Martin Star, “Production Management ".
9. Erry Johnson, “Process Engineering ".
10. E. EL. Buffa, “Production Management ".
11. A.K. Bewoor and V.A. Kulkarni “Production planning and Control”

Syllabus for Unit Tests:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Elective-II Experimental Methods in Mechanical Engineering (Course No.C409)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. All core courses in Mechanical Engineering
2. Basic concepts in Engineering Mathematics
3. Mechanical Measurement & Metrology

Course Objectives:

1. To acquire the concept of probability, statistics and to apply curve fitting methods for engineering applications.
2. To acquire the knowledge of pilot experimentation using different methods.
3. To acquire skills of reducing uncertainty by using advanced measurement techniques.
4. To acquire knowledge of data acquisition system for different experimentations.

Course Outcomes: Students will be able to

1. Understand the different characteristics of mechanical measurement systems and evaluate response of the systems.
2. Understand the different curve fitting techniques and apply it for engineering applications.
3. Understand the different experimental methods and apply it for experimental investigation.

4. Understand the concept of uncertainty in measurement and evaluate uncertainty using various statistical tools.
5. Understand the different advanced measurement techniques for multidisciplinary applications.
6. Understand the different characteristics of data acquisition systems and apply it for selection of DAS for different experimentation.

Unit I **06 Hours**

Introduction to Probability and Statistics & measurement systems

Statistical Measurement Theory, Mean Value and Uncertainty, Probability-Density Function, Histogram-Frequency distribution, Mean value and Variance, Infinite Statistics, Normal-Gaussian distribution, Normal-Gaussian distribution

Characteristics of measurement systems: Dynamic characteristics of first order (liquid in glass thermometer) and second order instruments (U tube manometer). Response of first order and second order systems.

Unit II **06 Hours**

Curve Fitting

Engineering application of curve fitting. Least squares approach, Polynomial curve fitting, Overfit and underfit. Multivariable regression analysis. Correlation coefficient. Power law and exponential curve fitting. Numericals based on practical engineering problems.

Unit III **06 Hours**

Planning of Experiments

Planning of experiments, various stages in experimental investigations; preliminary, intermediate and final, steady state and transient techniques, Need for design of experiments (DOE). Guidelines for performing DOE. Factorial design: Full factorial design and Fractional factorial design. 2K factorial design. Taguchi method. Response surface methodology

Unit IV **06 Hours**

Uncertainty in Measurements

Errors in instruments, Analysis of experimental data and determination of overall uncertainties in experimental investigation, uncertainties in measurement of parameters like pressure, temperature, flow etc. under various conditions. Estimation of uncertainty by Partial Differentiation Method (PDM), Combining uncertainty components. Student's t-test method.

Unit V **06 Hours**

Advanced Measurement Techniques

Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Telemetry in measurement, Orsat apparatus, Gas Analyzers, Smoke meters, gas chromatography, spectrometry, FFT analyzer

Unit VI **06 Hours**

Data Acquisition System (DAS)

Data Acquisition Systems: Basic and automated versions of DAS. Characteristics of DAS:

analogous input, sample speed, accuracy, linearity and resolution. A/D and D/A converters, Signal conditioning equipments. Case studies on selection of DAS for different experimentations. Introduction to data acquisition software's.

Assignment

Theory questions on following topics:

1. Problems on uncertainty analysis
2. Theory questions on introduction to experimental methods
3. Problems on practical engineering based on curve fitting
4. Theory questions on curve fitting
5. Theory questions on design of experiments
6. Practical engineering problems based on design of experiments
7. Questions based on transducers, sensors and actuators
8. Questions based on static and dynamic characteristics of instruments

9. Questions based on data acquisition system
10. Two practical oriented problems using any coding language.

Text Books/ Reference Books

1. Coleman H. W. and Steele W. G., Experimentation, Validation, and Uncertainty Analysis for Engineers, 3rd ed.: John Wiley & Sons Inc., New Jersey, 2009.
2. Grewal, B. S. Higher engineering mathematics. Khanna Publisher, New Delhi, 1996.
3. Montgomery, Douglas C. Design and analysis of experiments. Vol. 6. New York: Wiley, 2002.
4. Kumar D. S., Mechanical Measurement & Control, Metropolitan Book Co. Pvt. Ltd. New Delhi, 2007.
5. Beckwith T. G., Marangoni R. D., Lienhard J. H., Mechanical Engineering Measurements, Pearson Prentice Hall, 2007

Syllabus for Unit Tests:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

IN PLANT TRAINING FOR 45 DAYS (Course No.C410)

Teaching Scheme	Examination Scheme		Credit Scheme
Theory:- -- Hours/ Week	End Semester Examination	Marks	Theory : --
			Pr/Oral : 04
Practical : -- Hours/ Week	Unit Test -- Marks		
	Assignments -- Marks		
	Internal Evaluation -- Marks		
	Term Work/ Oral: 50 Marks		
	Total 50 Marks		04

Course Pre-requisites: Student should have Basic Knowledge of

1. All courses up to B.Tech Semester VI.

Course Objectives:

Provide help to the students,

1. To expose technical student to the industrial environment.
2. To provide possible opportunities to learn, understand, and sharpen the real time technical, managerial skills required at the job
3. To familiarize with various materials, processes, products and their applications along with relevant aspects of quality control.
4. To acquaint the social, economic and administratative considerations that influence the working environment of industrial organization

Course Outcomes: Students will be able to:

1. Understand the latest changes in technological world and Apply fundamental principles of science and engineering
2. Create ability to identify, formulate and model problems and apply it to find engineering solutions based on a system approach.
3. Understand importance of sustainability and cost-effectiveness in design and development of engineering solution.
4. Create ability to be multi skilled engineer with a good technical knowledge, management, leadership, entrepreneurship skills.

5. Create awareness of social, cultural, global and environmental responsibility as an engineer.
6. Create ability to communicate efficiently.
   equipment's.

Unit I **06 Hours**

Basic Concepts of Vibration

In plant training for 45 days: Before the VII semester, students are required go through in-plant training for 45 days in a manufacturing company. The students will show their interest of training to the faculty coordinator who will arrange their training. In case a student wishes to undergo training in a specific company, he will indicate the same to the training coordinator who after ensuring the suitability of the company will take suitable action. During the training period student will be required to strictly follow the company rules and regulations about timings and other matters will work on the assigned project. During training period the students are required to go the company daily. Their attendance record verified by the factory training in charge of the factory will be part of their project report.

Report: On completion of training, students are required to write a technical report about their training. In general the report should not exceed 50 pages of typed material. The report should cover following: Introduction-organization, its short history, products manufactured, competitors and organization's position in the market and its growth potential, production planning & control, material management, delivery of orders, off loading of work to third party cost saving or energy saving proposals, qualitative feedback from expert, study of tool room .

PROJECT STAGE -I
(Course No.C411)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- -- Hours/ Week	End Semester Examination -- Marks	Theory : --
		Pr/Oral : 04
Practical : 02 Hours/ Week	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation -- Marks	
	Term Work/ Oral: 100 Marks	
	Total 100 Marks	04

Course Pre-requisites:

Student should have Basic Knowledge of

1. All courses up to B.Tech Semester VI.

Course Objectives:

Provide help to the students ,

1. in generating a new idea or modify existing system for solving societal, industrial and/or institutional problem.
2. in review of literature that aligns with new idea and/or existing systems and clearly defining the problem
3. in developing a workflow process/methodology for the desired system.
4. in designing various components of the system assembly
5. in developing a CAD model of the desired system.
6. in writing the technical report based on the work completed

Course Outcomes: Students will be able to

1. Understand real life societal, industrial and/or institutional problems.
2. Create new idea or plan for modification of an existing system.
3. Understand concepts in existing literature and apply them for clearly defining the problem.

4. Create a workflow process/methodology for desired system.
5. Design various components, select standard components and create CAD model of desired system
6. Write technical report and present it to the supervisors.

Course Contents

1. The formation of a project team with members having similar interest.
2. Discuss the ideas within the team members and choosing a faculty member interested in similar activity with the consent of the HOD.
3. The projects can be on new equipment development, on industry sponsored problems or on research oriented subjects.
4. Discuss the project with the Faculty with the idea that projects selected are suitable for design and fabrication with the available resources.
5. First stage presentation with

- Project Aim
- Feasible design and alternatives considered
- Estimation of approximate cost of the project
- Activities bar chart
- Internal Lab resources required
- External resources required and their availability.

6. Second presentation with

- Collection of reference material and
- Design of the equipment with working drawings
- Stage of work completed through activities bar chart.

7. Third presentation of complete work with suggested modifications.

POWER PLANT ENGINEERING
(Course No.C412)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 04 Hours/ Week	End Semester Examination 60 Marks	Theory : 04
Practical : 02 Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: 50 Marks	
	Total 150 Marks	5

Course Pre-requisites:

Student should have Basic Knowledge of

1. Engineering Thermodynamics
2. Turbo-machinery

Course Objectives:

To provide the knowledge of

1. To study different types of power plants and their components.
2. To analyze thermodynamics and economics analysis of power plants.
3. To energy storage technologies, power plants safety and maintenance.

Course Outcomes: Students will be able to:

1. Understand operation of different types of power plants and power distribution system of India.
2. Understand the concepts of non renewable power systems; and analyze steam, diesel and gas power cycles.
3. Understand the concepts of steam condensers, nozzles and cooling towers and analyze them.
4. Understand the concepts of renewable and hybrid power systems and analyze them.
5. Understand the concept of economics of power plants and analyze power plant.
6. Understand the concepts of energy storage technologies, plant safety and maintenance.

Unit I **08 Hours**

Introduction to Power Engineering

Different types of power plants–Thermal, Hydro, IC Engine, Gas Turbine, Nuclear and their characteristics, Combined Cycle, Pumped storage, Compressed air storage power plants and their characteristics. Comparison of Power plants with respect to various parameters.Issues in Power plants. Resources and development of power in India, NTPC, NHPC and their role in Power development in India. Power generation in Private sector, Power distribution, National Grid, Indian Electricity Grid Code. Regulation Structure of IEGC, Operating Policies and Procedures, Present Power position in India.

Unit II **08 Hours**

Non-Renewable Power Systems

High pressure and Super Critical Boilers – Fluidised bed boilers.

Steam power cycles- Rankin cycle with reheat, regeneration. Numerical based on different combinations.

Performance of boilers.

Fuel and ash handling, Combustion equipment for burning coal, Mechanical Stokers. Pulveriser, Electrostatic Precipitator, Draught- Different types

Gas Turbine Power Plants: Fuels, Gas turbine material, open and closed cycles, reheating, Regeneration and intercooling, combined cycle. Turbojet, Ramjet, Turboprop, Rocket engine.

Diesel Power Plants: Types of diesel plants, components, Selection of Engine type, applications.

Nuclear Power Plants: Nuclear reactors-PWR, BWR, CANDU, Sodium graphite, fast breeder, homogeneous; gas cooled. Advantages and limitations, nuclear power station, waste disposal.

Unit III **08 Hours**

Condensers, Cooling Towers and Steam Nozzles

Steam Condensers: Function of condenser in thermal power plant, Classification of condensers: Jet, Surface and Evaporative. Air leakage in condenser: sources and its effects. Condenser vacuum, Estimation of quantity of cooling water, Dalton’s law of partial pressure, Vacuum efficiency, Condenser efficiency.

Cooling Towers: Cooling water system, types of cooling towers. Performance assessment of cooling towers, Energy saving opportunities.

Steam nozzles: General forms of nozzles, Flow through steam nozzles, Velocity of steam leaving nozzle. Mass of steam discharged, Critical pressure ratio, Areas of throat and exit for maximum discharge, Length of nozzle. Efficiency of a nozzle. Effect of friction in a nozzle.

Unit IV **08 Hours**

Renewable and Hybrid Power Systems

Solar Power System: Types of Solar Collectors, Collection efficiency, Testing of Solar collectors – IS code, Applications of solar energy. Solar Pond, Solar Energy storage and types. Photovoltaic and fuel cells.

Wind power: Power from wind, Site selection, Wind energy conversion systems and their classification, construction and working of typical wind mill, Design considerations for wind mills, present status.

Biomass power: Energy plantation, Combustion and fermentation, Anaerobic digester, Biomass gasification, Pyrolysis, various applications of Biomass energy, Bio-fuel – Relevance, types, and applications.

Hybrid Power Systems: Need for Hybrid systems, Range and type of hybrid systems, Case studies of Diesel-PV, Wind-PV, Micro-hydel-PV, Biomass-Diesel systems, hybrid electric vehicles, etc.

Unit V **08 Hours**

Analysis of Power Plants

Load Curves, Load duration curves, Performance and operational characteristics of power plants, Peak load, Intermediate load and Base load plants and their characteristics, Input output characteristics of power plants, Economic division of between Base load plant and peak load plants. Cost of energy generation, Tariff methods. Economics of load sharing, comparison of various power plants. Numericals based on the syllabus contents.

Unit VI **08 Hours**

Energy Storage Technologies, Plant Safety and Maintenance

Energy Storage Technologies: Pumped Hydroelectric Storage, Compressed Air Energy Storage,

Battery Technologies - Traditional and Advanced, Flow Batteries, Flywheels, Superconducting Magnetic Energy Storage, Super-capacitors/Ultra-capacitors, Energy Storage Technology Comparisons, Functional Comparison, Cost Comparison.

Plant Safety and Maintenance: Operation and Maintenance procedures of power plants, Operator training, Safety during selection of power plant equipment –safety in commissioning of thermal power plant equipments, hydrostatic and air leakage test, acid and alkali cleaning, safety in auxiliary plants. Cooling water system, Safety in maintenance of power plants.

Term Work/Practical's: (Any 8)

1. Study of National & International Grid, Indian Electricity Grid Code
2. Study of combined cycle gas based and coal based Power plant.
3. To perform analysis of a thermal power plant.
4. To perform analysis of gas turbine/ diesel/ solar power system.
5. To perform analysis of wind/ biomass power system.
6. Study of Power plant Instrumentation.
7. Visit to a thermal power plant.
8. Study of Heat Exchangers used in Power Plant
9. To study different energy storage technologies.
10. To study different types of hybrid power plants.

Assignment

Problems and/or theory questions on following topics:

1. Theory questions on different types of power plants.
2. Problems on performance of steam power plant based on Rankin cycle
3. Theory questions on components of steam power plant.
4. Theory questions on gas turbine, diesel and solar power systems.
5. Theory questions on wind, biomass and hybrid power systems.
6. Practical engineering problems based on analysis of power plants.
7. Questions based on various terms related to economics of power generation.
8. Questions based on energy storage technologies.
9. Case study on electricity terrify calculation both for industry as well as household purpose.
10. Questions based on plant safety and maintenance.

Text Books/ Reference Books

1. Modern Power Station Practice, Vol.6, Instrumentation, Controls and Testing, Pergamon Press, Oxford, 1971.
2. John V Grimaldi and Rollin H Simonds, Safety Management
3. M. M. El Wakil, Power Plant Technology –Mc Graw Hill. Int.Edition.
4. Domkundwar and Arora, Power Plant Engineering, Dhanpatrai and Sons.
5. Grainger John J, and Stevenson Jr. W.D. Power System Analysis, McGraw Hill 1994
6. L.K.Kirchmeyer, Economic Operation of Power Systems, John Wiley and Sons, 1993.
7. C.A.Gross, Power System Analysis, John Wiley and Sons, Inc.1986.
8. John Weisman & L.E. Eckart, Modern Power Engineering, Prentice Hall, 1985
9. A course on Power Plant Engineering Ramlingam SCITECH Publication
10. S.P.Sukhatme, Solar Energy, Tata McGraw Hill, 3rdEdition 1996.
11. G. D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 2011
12. P. K. Nag, Power plant Engineering, TMH, 3rd Edition 2002

Syllabus for Unit Test:

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Elective-III INDUSTRIAL AUTOMATION AND ROBOTICS (Course No.C415)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. Engineering Mathematics-II
2. Mechanisms and Machines
3. Industrial Fluid Power
4. Mechanical Measurement and Metrology
5. Automatic control system

Course Objectives:

1. To inculcate the basic concepts of robotics and automation, parts of robots and Automation types.
2. To make the students familiar with the various drive system, sensors and their application and programming languages of robots.
3. To inculcate fundamentals of robot kinematics, dynamics and provide knowledge of robot programming methods.

Course Outcomes: Student will be able to

1. Understand the basic concept of robotics and industrial automation.

2. Understand high volume manufacturing system and apply it for line balancing system.
3. Understand fundamentals of robot technology, robot anatomy, robot motions, robot specifications, robot control method, robot drive technology and apply it to select a robot for industrial applications .
4. Understand the different types of robot sensors, end effectors and select it for various industrial automation applications.
5. Understand the fundamentals of robot kinematics, dynamics and apply these to analyze robot joint movements
6. Understand the robot programming language and apply it for industrial automation applications.

Unit I **06 Hours**

Introduction to Industrial Automation

Automation and Robotics, Historical Development, Basic concept of automation, Building Blocks of Automation Systems- Sensors, Analyzers, Actuators, Drives. Types of automation: fixed, flexible and programmable and their comparative study. Concept of Mechanization of Parts Handling.

Unit II **06 Hours**

High Volume Manufacturing System

Transfer Lines, Detroit type automation-Design and fabrication considerations. Analysis of automated flow lines- technology, analysis of transfer lines without storage, partial automation and automated flow lines with storage buffers, computer simulation of automated flow lines. Assembly system and line balancing- computerized line balancing methods.

Unit III **06 Hours**

Fundamentals of Robot Technology

Robot Definitions, Laws of Robotics, Basic Structure of Robots, links and Joints, types of Joints, types of links, types of end effectors, Wrist configuration: concept of: yaw, pitch and roll. Robot Anatomy, work volume, work envelope, robot manipulator. Specifications of robot: degrees of freedom (DOF), accuracy, repeatability, spatial resolution, compliance, loads carrying capacity, speed of response. Classification of Robots- 1) Co-ordinate system: Cartesian, cylindrical, spherical, SCARA, articulated 2) Control Method: Servo controlled and non-servo controlled, their comparative study 3) Form of motion: P-T-P (point to point), C-P (continuous path), pick and place etc. and their comparative study 4) Drive Technology: Hydraulic, Pneumatic, Electric (stepper motor, D.C. servo motor) in detail with selection criteria. Motion conversion: Rotary to rotary, rotary to linear and vice versa.

Unit IV **06 Hours**

Sensors and End-Effectors in Robotics

Uses of Sensors in Robotics, type of sensors in robot systems, non-optical and optical position sensors, Touch Sensors-Tactile sensor, Pressure sensors, colour sensor, gas sensor and flexible force sensor, Torque sensors, Light sensors, Voice Communication. Classification of End Effectors, Drive system for end effectors, Mechanical Grippers, Magnetic Grippers, Vacuum Grippers, adhesive Grippers, Hooks, Scoops, Tools as end effectors. Gripper force analysis and gripper design- Simple problems, Active and Passive Grippers

Unit V **06 Hours**

Robot Kinematics and Dynamics

Introduction to manipulator kinematics, position representation, forward and reverse transformation of two degree of freedom robot arm, four degree of freedom manipulator in three dimensions. Robot Dynamics, D Alembert's Equations of Motion.

Unit VI **06 Hours**

Robot Programming Languages and Industrial Applications

Concept of on-line and off line programming, concept of teach pendant. Methods of robot programming- Lead through methods, Textual robot languages and their Features. Robot applications based on survilllance system, machining, material handling, house hold and service sector. Applications of Telechiric robots.

Assignments:

Assignments will be based on above syllabus:

1. At least five theory questions based on identifying the industrial applications of robotics & automation.

2. At least five theory questions on identifying the industrial applications of automation with building blocks.
3. At least five theory questions on identifying the fixed, flexible and programmable automation.
4. At least five theory questions on high volume manufacturing system.
5. At least five theory questions on study of line balancing of an automation system.
6. At least five PLC programs based on pick and place robot.
7. At least five theory questions based on fundamentals of robotics.
8. At least five theory questions based on selection of sensors.
9. At least five theory /numerical questions based on selection of end effectors of robot.
10. At least five theory /numerical questions based on robot kinematics and dynamics.
11. At least five theory questions based on robot programming language and robot applications.
12. At least five theory questions on identifying the industrial applications of robots.

Text Books/ Reference Books

1. "Industrial Robotics", Groover, Weiss, Nagel, McGraw Hill International
2. Automation, Production Systems and Computer Integrated Manufacturing M.P.Groover, Pearson Education.5th edition, 2009
3. Introduction to Robotics- John J. Craig, Addison Wesley Publishing, 3rd edition, 2010
4. Robotics Technology and Flexible Automation, Second Edition, 2010 McGraw Hill Education (India) Private Limited
5. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata McGraw Hill Publishing company Ltd., 1995.
6. Stuart A Boyer: SCADA supervisory control and data acquisition, International Society of Automation, 2010.
7. A Robot Engineering Textbook "– Mohsen Shahinpoor – Harper & Row publishers, New York
8. "Anatomy of Automation"- Amber G.H & P. S. Amber, Prentice Hall. Principles of CIM by Vajpayee, PHI.
9. R. K. Mittal, I. J. Nagrath, "Robotics and Control", Tata McGraw Hill Publishing Company Ltd., New Delhi.

10. Robert J. Schilling, "Fundamentals of Robotics: Analysis and Control", Prentice Hall of India, New Delhi
11. Arthur J. Critchlow, "Introduction to Robotics", Macmillan Publishers Limited, 1985
12. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, "Industrial Robotics: Technology, Programming and Applications", McGraw Hill Book Company.

Unit Tests-

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Elective-III CRYOGENICS
(Course No.C416)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. heat transfer.
2. refrigeration and air conditioning

Course Objectives:

To provide the knowledge of

1. fundamentals of cryogenics, materials, cry coolers and their applications
2. gas liquification, separation and purification systems
3. fluid storage and transfer systems.

Course Outcomes: Student will be able to

1. Understand fundamental concepts of cryogenics and properties of materials
2. Understand and analyze gas liquification systems.
3. Understand the concepts of cry cooler and its applications
4. Understand gas separation and purification system
5. Understand the concepts of fluid storage and transfer systems
6. apply the concepts of cryogenics to real life systems

Unit I **06 Hours**

Introduction to Cryogenic and properties of materials

History and development its importance, cryogenic temperature scale.

Low temperature properties of materials, Mechanical properties Thermal properties, electric and magnetic properties, Properties of cryogenics& fluids.

Unit II **06 Hours**

Gas Liquification Systems

Introduction- production of low temperature , Liquefaction systems for N2, Neon, Hydrogen, He etc.(Numerical Treatment)

Unit III **06 Hours**

Cryocoolers

Regenerative systems – Overview of regenerative coolers, Introduction to Pulse Tube Coolers, Stirling Coolers, G-M Coolers, J-T Coolers, Cryocooler applications.

Unit IV **06 Hours**

Gas Separation And Purification Systems

Thermodynamically ideal separation systems- properties of mixtures , principles of gas separation Rectification column- Linde single and double column system of air separation

Unit V **06 Hours**

Fluid Storage And Transfer Systems

Dewar vessel, insulation types and importance. Components of transfer system with importance. Importance of vacuum and it's measurement

Unit VI **06 Hours**

Application Of Cryogenic Systems

Applications in mechanical, electrical, food preservation, biological and medical, space technology etc.

Assignments:

Assignments will be based on above syllabus:

1. History and development it's importance, cryogenic temperature scale.
2. Low temperature properties of materials, Mechanical properties Thermal properties, electric and magnetic properties
3. Introduction- production of low temperature , Liquefaction systems for N2
4. Liquefaction systems for Neon, Hydrogen, He
5. Regenerative systems – Overview of regenerative coolers, Introduction to Pulse Tube.
6. Stirling Coolers, G-M Coolers, J-T Coolers, Cryocooler applications.
7. Thermodynamically ideal separation systems- properties of mixtures , principles of gas separation Rectification column- Linde single
8. Dewar vessel, insulation types and importance.
9. Components of transfer system with importance. Importance of vacuum and it's measurement
10. Applications in mechanical, electrical, food preservation, biological.

Text Books/ Reference Books

1. Cryogenics systems – Randall Barron – Mc Graw Hill Book Co
2. Cryogenic Engineering – R.B.Scott – Van Nosfrand Co.
3. Cryogenic Engineering –J.H.Bell – Prentice Hall
4. Cryogenic Engineering – R.W.Vance – John Welley
5. Cryocoolers - Walkers – Prentice Hill Publication

Unit Tests-

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Elective-III PROJECT MANAGEMENT & ETHICS (Course No.C417)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. Mathematics & Statistics.
2. Industrial Engineering & Management
3. soft skills and professional skills

Course Objectives:

1. To create awareness about the concepts of project management and its components
2. To apply the techniques specified by project management body of knowledge for effective project management.
3. To create awareness of social and professional responsibility among stakeholders

Course Outcomes: Student will be able to

1. Understand concepts of project management and apply it to various phases in project life cycle.
2. Understand economic models, evaluate project profitability and analyze risk management
3. Understand different cost estimating & forecasting methods to apply in project budgeting.
4. Understand the methods of project planning, scheduling and apply it to reduce project duration

5. Understand the project excecution, monitoring, control process and evaluate the performance of the project
6. Understand professional ethics of project management and apply it for organizational benefits.

Unit I **06 Hours**

Introduction to Project Management

Project, Project Management, Management by projects, Project Management Associations, Benefits of Project Management, Project management Process, Role of Project Manager. Project Lifecycle

Unit II **06 Hours**

Project Management Techniques and Risk Management

Feasibility Studies, Numerical Models (Payback Period, Return on Investment, Net Present Value, Internal rate of Return), Scoring Models, Break Even Analysis

Project Risk Management: Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks.

Use of excel and MS project for feasibility studies and risk management.

Unit III **06 Hours**

Project Cost Estimating

Estimating terminology, Project Costs, Estimating Methods (Jobbing, Factoring, Inflation, Economies of Sales, Unit Rates, Day Work), Analogous Estimating, Parametric Estimating, Bottom-Up Estimating, Three-Point Estimates, Monte Carlo Simulation, Project Budgeting, Resource Allocation, Cost Forecasts Use of excel and MS project for project cost estimating

Unit IV **06 Hours**

Project Planning and Scheduling

Project Planning: Introduction, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS) Scheduling: Introduction, Development of Project

Network, Time Estimation, Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System Use of MS project Planning and Scheduling

Unit V **06 Hours**

Project Monitoring and Control

Project Execution and Control: Introduction, Project Execution, Project Control Process, Purpose of Project Execution and Control Project Management Information System: Introduction, Project Management Information System (PMIS), Planning of PMIS, Design of PMIS Project Performance Measurement and Evaluation: Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects

Unit VI **06 Hours**

Professional Responsibility (Ethics)

Ensuring Integrity and Professionalism, Project Management Knowledge Base, Enhancing Individual Competence, Balancing Stakeholder Interests, Interactions with Team Members and Stakeholders, Templates, Tools and Techniques.

Assignments:

Assignments will be based on above syllabus:

1. At least five questions based on the introduction to project management
2. Case study involving various aspects of project.
3. Case study involving various techniques used for project selection.
4. At least five Numerical on various techniques used for project selection.
5. Case study of project cost estimation
6. At least five Numerical on project cost estimation
7. Case study of project scheduling
8. At least five Numerical on project scheduling
9. Case study based on project scheduling
10. At least five questions based on project monitoring
11. At least five questions based on ethics

Text Books/ Reference Books

1. Project Management Institute; "A Guide to the Project Management Body of Knowledge (PMBOK Guide)"; 5th Revised edition (1 January 2013)
2. Harold Kerzner; "Project Management: A Systems Approach to Planning, Scheduling and Controlling Paperback"; Wiley; tenth edition (20 November 2012)
3. Erik Larson, Clifford Gray; "Project Management: The Managerial Process"; McGraw Hill Education; Sixth edition (1 July 2014)
4. Panneerselvam R; "Project Management"; Prentice Hall India Learning Private Limited; 1 Edition (2009)
5. Samuel J. Mantel, Jack R. Meredith; "Project Management: A Managerial Approach"; Wiley; Eighth edition (6 August 2012)
6. Gupta R; "Project Management"; Prentice Hall India Learning Private Limited; Second edition (2014)

Unit Tests-

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Elective-III TOTAL QUALITY MANAGEMENT (Course No.C418)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. Basics of Statistics
2. Mechanical Measurement and Metrology
3. Industrial Engineering and Management

Course Objectives:

1. To inculcate the concepts, various tools and Principles of Management
2. To make the students familiar with the Toyota Production system and lean manufacturing system
3. To create awareness about Quality systems and advanced techniques of Total Quality Management.

Course Outcomes: Students will be able to

1. Understand the concepts of Quality, Quality Management and apply it to improve the Quality
2. Understand the Quality assurance tools and apply it to improve Customers Satisfaction
3. Understand the total quality management tools and apply in Quality Management
4. Understand the various techniques of Lean Manufacturing and apply it in industries

5. Understand various Quality standards and apply it in industries to achieve ISO standards.
6. Understand the advanced techniques of total quality management and apply it for industry and research

Unit I **6 Hours**

Quality & Total Quality Management

Quality, Definitions of Quality, New philosophy of quality, Product quality, & its prospects.

Overview of TQM : Concept & definition, Fundamentals, Principles of TQM, Elements of TQM,Approaches of TQM, Models of TQM, Zero defect concept, Benefits of TQM. Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits,

Unit II **6 Hours**

Quality Assurance

Basic concepts, Quality assurance input – process – output. Significance of feedback for Quality assurance, Process capability analysis, Concept of Six Sigma.

Internal customer approach, Customer – Satisfaction, data collection & complaint, Redressal mechanism

Unit III **6 Hours**

TQM TOOLS

Continuous Process Improvement - Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership - Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure,Just – in- Time, Quality Function Deployment (QFD) - House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) - Concept, Improvement Needs, FMEA - Stages of FMEA., FMEA, TPM.

Unit IV **6 Hours**

TOYOTA Production System and Lean Manufacturing

History of TPS. History, Scope lean production, Introduction, background, and lean thinking. Lean production preparation – System assessment, process and value-stream mapping – Sources of waste.

Lean production processes, approaches and techniques.Importance of focusing upon flow. Tools include: a. Workplace organization – 5S. b. Stability. c. Just-In-Time – One piece flow – Pull. d. Cellular systems. e. Quick change and set-up reduction methods. f. Total productive maintenance. g. Poka-Yoke – mistake proofing, quality improvement. h. Standards. i. Leveling. j. Visual management.

Employee involvement – Teams – Training – Supporting and encouraging involvement – Involving people in the change process -- communication -- Importance of culture

Unit V **6 Hours**

Quality Systems

Policy & objectives, Quality standards, Concept of quality system standards, Relevance & origin of ISO 9000–2000 standard & certification, Benefits. Elements of ISO 9001, 9002, 9003 series–Clauses, contents, interpretations & implementation.TS - 16949, QS-9000, ISO 14000, OHSAS

Unit VI **6 Hours**

Advanced Techniques of Total Quality Management

Design of experiments, Failure mode effect analysis, Taguchi methodTaguchi's quality engineering –Loss function, orthogonal arrays, Signal to noise ratio, parameter design & tolerance design.Total Quality in service sector.S. S. Technique, Kanban (Little's Law for KANBAN system)

<u>Assignments:</u>

Assignments will be based on above syllabus:

1. At least five theory questions based on TQM
2. At least five theory questions on Six sigma concept

3. At least five theory questions on TQM principles
4. At least five theory questions on TQM tools.
5. At least five theory questions on study Quality Systems
6. At least five theory questions based on Advanced Techniques of Total Quality Management.

Text Books/ Reference Books

1. Sundar Raju, “Total Quality Management”, Tata McGraw Hills.
2. M. Zairi, “Total Quality Management for Engineers”, Aditya Books.
3. ISO 9000 Quality System”, Dalela& Saurabh, Standard Publishers.
4. R.C. Gupta, “Statistical Quality Control”.
5. Grant E. L. & R. Leavenworth, “Statistical Quality Control”, Tata McGraw Hills
6. TapanBagchi, “Taguchi Methods Management”, Pearson Education.
7. Feigenban, “Total Quality Control”, Tata McGraw Hills.
8. Total Quality Management Handbook, J. K. Hradeskym, Tata McGraw Hills

Unit Tests

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

Elective-III FINITE ELEMENT ANALYSIS (Course No.C419)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- 3 Hours/ Week	End Semester Examination 60 Marks	Theory : 03
Practical : -- Hours/ Week	Unit Test 20 Marks	
	Assignments 10 Marks	
	Internal Evaluation 10 Marks	
	Term Work/ Oral: -- Marks	
	Total 100 Marks	3

Course Pre-requisites:

Student should have Basic Knowledge of

1. Engineering Mathematics-I,
2. Strength of Machine Elements
3. Numerical Methods
4. Machine Design I & II
5. Heat Transfer

Course Objectives:

1. To develop the finite element formulation for a model one-dimensional problem like axially loaded bar for the case of simplest approximation (i.e., linear approximation)
2. Develop the Shape Functions for Various Elements
3. To discuss the possible refinements of the simplest approximation.
4. To develop the frame work of a finite element code to solve the one dimensional problem.5. To extend the finite element formulation to other one-dimensional problems like the beam problem.
5. To develop the two-dimensional finite element formulation for a model 2-D problem like 2-D steady-state heat conduction problem.

Programme: B. Tech. Mechanical

Course Outcomes: Students will be able to

1. Understand the Formulation of Finite Element Method
2. solve 1 D Problems
3. solve 2 D Structural and Thermal Problems
4. analyze Mechanical Engineering real life problems
5. Mechanical Engineering Problems subjected to Heat Transfer..
6. solve Mechanical Engineering Problems subjected to Mechanical Vibration.

Unit I **6 Hours**

Introduction

Basic Steps in FEM Formulation, Error Analysis P & h formulation; Stress Equilibrium equation; Strain displacement equation; Stress-Strain equation; Introduction to Solvers; Variational Approach, Ritz Method. Derivation of Elemental Equations, Assembly, Imposition of Boundary Conditions, Solution of the Equations. Computer implementation: Pre-processor, Processor, Post-processor.

Unit II **6 Hours**

One Dimensional Problem

1 -D Elements, Relationship between Global and Natural coordinate system; Formulation of Element Stiffness Matrix and Load Vector by Potential Energy approach; Shape Functions using LAGRANGE Polyomials for Two noded Bar Element, Rectangular Element, hexahedron Brick Element; Convergence Criteria, Temperature effect.

Unit III **6 Hours**

Two Dimensional Problem

Plain Stress , Plain Strain; Types of 2 D Element, Formulation of Element Stiffness matrix and Load Vector for Constant Strain Triangles, Formulation of Element Stiffness matrix and Load Vector for 2D Trusses; Introduction to Higher Order Elements.

Unit IV **6 Hours**

Axisymmetric Formulation

Stress calculation and Temperature effect on Flywheel using Galerkin Approach; Isoparametric Elements; Element Quality Criterion; Full and Reduced integration; Sub Modelling and Sub Structuring.

Unit V **6 Hours**

1D Steady State Heat Transfer

Governing Differential Equation; Steady State Heat transfer Formulation of 1 D Element for Conduction and Convection; Boundary Conditions and Solving for Temperature Distribution; 1D Heat Transfer Steps involved in Processing Steps

Unit VI **6 Hours**

Dynamic Analysis

Lumped mass and Consistent Mass Matrices; Free Vibration Problems, Formulation of Eigen Value and Eigen Vector Problem by Power Method, Step wise solution of Problems on Vibration in Bar Element; FEM Formulation. Time dependent Problems

Assignments:

Assignments will be based on above syllabus:

1. Introduction to Finite Element method..
2. Derivations and Numerical on Variational Approach and Ritz Method.
3. Derivations and Numerical on Potential Energy Approach.
4. Determination of Shape Functions for Various Elements.
5. Derivations and Numerical on CST Elements.
6. Derivations and Numerical on Trusses
7. Stress calculation and Temperature effect on Flywheel using Galerkin Approach.
8. Isoparametric Elements: Full and Reduced integration methods Numerical

9. Derivation and Numerical on Steady State Heat transfer Formulation of 1 D element for Conduction and Convection by Differential Equation.
10. Analysis of any one Mechanical Component subjected to Heat transfer.
11. Determination of Eigen value and Eigen vector for any Mechanical component.
12. Analysis of Time Dependent problem.

Text Books/ Reference Books

1. S. S. Rao, The Finite Element Methods in Engineering, Pergomon Press Oxford, 2nd edition, 1989
2. Sagarlind L. J, Applied Finite Element Analysis, John Wiley, 1984.
3. Chandrupatla & Belegundu, Introduction to Finite Elements in Engineering, Prentice
4. Reddy. J.N, An Introduction to Finite Element Methods, Tata McGraw Hill, 1997
5. Cook, Robert, Davis Etal, Concept & Applications of Finite Element Analysis, John Wiley & Sons, 1999

Unit Tests

Unit Test-I Unit-I,II,III

Unit Test-II Unit-IV,V,VI

PROJECT STAGE -II
(Course No.C420)

Teaching Scheme	Examination Scheme	Credit Scheme
Theory:- -- Hours/ Week	End Semester Examination -- Marks	Theory : --
		Pr/Oral : 08
Practical : 04 Hours/ Week	Unit Test -- Marks	
	Assignments -- Marks	
	Internal Evaluation -- Marks	
	Term Work/ Oral: 200 Marks	
	Total 200 Marks	08

Course Pre-requisites:

Student should have Basic Knowledge of

1. Project Stage I

Course Objectives:

Provide help to the students,

1. in fabrication of the experimental setup/new system and/or purchase of standard components.
2. in pilot run and/or validation of new system for its performance
3. in modifying the system if required to improve its performance.
4. in detailed parametric studies of the modified system and analyzing the results
5. in writing the technical report, research article and/or filing a patent.

Course Outcomes: Students will be able to

1. create/Fabricate an experimental setup/new system
2. evaluate preliminary performance of a new system/experimental setup through its pilot run.
3. evaluate the system performance through detailed parametric studies.

4. analyze the results and draw conclusions
5. create technical report and present it to the supervisors.
6. publish the project outcomes in the form of journal or conference article / patents and/or in project competitions

Course Contents

The project taken in the First semester will be continued as far as possible. In case after the training, the students wish to change their project, the same may be allowed after discussion with the faculty. The new project should be based on the training taken and should utilize the training experience.

In Semester II concentration will be on

1. Hard ware fabrication
2. Testing of equipment
3. Preparing a project report

   The work will be evaluated through three presentations with aim of watching the progress and suggesting modifications for completing the project.

Rules regarding ATKT, Continuous Assessment and award of Class A. T. K. T.

- A candidate who is granted term for B. Tech. Semester-I will be allowed to keep term for his/her B. Tech. Semester-II examination even if he/she appears and fails or does not appear at B. Tech. Semester-I examination.
- A candidate who is granted term for B. Tech. Semester - III will be allowed to keep term for his/her B. Tech. Semester-IV examination even if he/she appears and fails or does not appear at B. Tech. Semester-III examination.
- A candidate who is granted term for B. Tech. Semester-V will be allowed to keep term for his/her B. Tech. Semester-VI examination if he/she appear and fails or does not appear at B. Tech. Semester-V examination.
- A candidate who is granted term for B. Tech. Semester-VII will be allowed to keep term for his/her B. Tech. Semester-VIII examination if he/she appears and fails or does not appear at B. Tech. Semester-VII examination.
- A candidate shall be allowed to keep term for the B. Tech. Semester-III course if he/she has a backlog of not more than 3 Heads of passing out of total number of Heads of passing in theory examination at B. Tech. Semester-I & II taken together.
- A candidate shall be allowed to keep term for the B. Tech. Semester-V of respective course if he/she has no backlog of B. Tech Semester-I & II and he/she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 heads of passing in term work and practical examination or term work and oral examination.
- A candidate shall be allowed to keep term for the B. Tech. Semester-VII course if he/she has no backlog of B. Tech. Semester-III & IV and he/she has a backlog of not more than 3 Heads of passing in theory examination and not more than 3 Heads of passing in term work and practical examination or term work and oral examination.

CONTINUOUS ASSESSMENT

- In respect of Term work at B. Tech. Semester-I & II, B. Tech. Semester-III & IV and B. Tech. Semester-V & VI, target date shall be fixed for the completion of each job, project experiment or assignment as prescribed in the syllabus and the same shall be collected on the target date and assessed immediately at an affiliated college by at least one pair of the concerned teachers for the subject and the marks shall be submitted at the end of each term to the Principal of the college.
- Termwork and performance of Practical/Oral examination shall be assessed on the basis of the depth of understanding of the principles involved, correctness of results

and not on ornamental or colorful presentation.

- For B. Tech. Semester-VII & VIII, term work assessment will be done by external and internal examiners jointly during the examination schedule declared by the university. The record of continuous assessment shall be made available to the examiners during Term work and practical and Term work and oral examinations. Examiner shall use this record for overall assessment of the performance of the student. Every practical/term work assignment shall be assessed on the scale of 25 marks and weightage of 25 marks shall be distributed as follows:

Sr. No.	Activity	Marks
1	Timely Submission	07
2	Presentation	06
3	Understanding	12

- Marks obtained out of 25 for all assignments together will be converted on scale of marks assigned to term work of respective subject in the structure of the course.

CLASS

The class should be awarded to the student on the basis of aggregate marks obtained together in both the semesters of the respective year by him. The award of class shall be as follows.

A	Aggregate 66% or more marks	First Class with Distinction
B	Aggregate 60% or more marks but less than 66%	First Class
C	Aggregate 55% or more marks but less than 60%	Higher Second Class
D	Aggregate 50% or more marks but less than 55%	Second Class
E	Aggregate 40% or more marks but less than 50%	Pass Class