REGULATIONS, COURSE STRUCTURE AND SYLLABUS

(Aligned with AICTE Model Curriculum & APSCHE Curriculum)

SITE 21 REGULATIONS

For

B.Tech.

Mechanical Engineering

With effective from the Academic Year

2021-2022

B.Tech. Regulations

1.1 Short title and Commencement

The regulations listed under this head are common for all degree level under graduate programs (B.Tech.) offered by the college with effect from the academic year 2021-22 and they are called as "SITE21" regulations.

The regulations here under are subject to amendments as may be made by the Academic Council of the college from time to time, keeping the recommendations of the Board of Studies in view. Any or all such amendments will be effective from such date and to such batches of candidates including those already undergoing the program, as may be decided by the Academic Council.

1.2. Definitions

a. "Commission" means University Grants Commission(UGC)
b. "Council" means All India Council for Technical Education(AICTE)
c. "University" Means Jawaharlal Nehru Technological University Kakinada(JNTUK)
d. "College" means Sasi Institute of Technology & Engineering, Tadepalligudem.
e. "Program" Means any combination of courses and /or requirements leading to award of a degree
f. "Course" Means a subject either theory or practical identified by its course title and code number and which is normally studied in asemester.
g. For example, (ELECTRONC DEVICES) is a course offered at third semester of B.Tech (ECT) and its code is (21ETETT3030)
h. "Degree" means an academic degree conferred by the university upon those who complete the undergraduate curriculum
i. "Regular Student" means student enrolled into the four year programme in the firstyear
j. "Lateral entry Students" Means student enrolled into the four year programme in the secondyear

1.3. Academic Programs

1.3.1. Nomenclature of Programs

The nomenclature and its abbreviation given below shall continue to be used for the degree programs under the University, as required by the Council and Commission. The name of specialization shall be indicated in brackets after the abbreviation. For e.g. UG engineering degree in Mechanical Engineering program is abbreviated as B.Tech. (ME). Bachelor of Technology (B.Tech.) degree program offered in:

1. Artificial Intelligence & Machine Learning(AIM)
2. Civil Engineering(CE)
3. Computer Science and Engineering(Artificial Intelligence and Machine learning)-CSM
4. Computer Science and Engineering (IoT and Cyber Security including Block Chain Technology) (CIS)
5. Computer Science and Engineering(Data Science)-CSD
6. Computer Science and Engineering(CSE)
7. Computer Science and Technology(CST)
8. Electronics and Communication Engineering(ECE)
9. Electronics and Communication Technology(ECT)
10. Electrical and Electronics Engineering(EEE)
11. Information Technology(IT)
12. Mechanical Engineering(ME)

– Curriculum framework is important in setting the right direction for a Degree program

as it takes into account the type and quantum of knowledge necessary to be acquired by a student to qualify for a award in his/her chosen branch or specialization.

- Besides, this also helps in assigning the credits for each course, sequencing the courses semester-wise and finally arriving at the total number of courses to be studied and the total number of credits to be earned by a student to fulfill the requirements for conferment of degree.
- Each theory course shall consist of five units.

1.3.2. Curriculum Structure

The curriculum structure is designed in such a way that it facilitates the courses required to attain the expected knowledge, skills and attitude by the time of their graduation as per the needs of the stakeholders. The curriculum structure consists of various course categories (as described in 1.6.3 to 1.6.9) to cover the depth and breadth required for the program and for the attainment of program outcomes of the corresponding program. Each Programme of study will be designed to have 40-45 theory courses and 16-18 laboratory courses. The distribution and types of courses offered from the above is indicated in the following table 3.

1.3.3. Induction Program

The Induction Program for two weeks is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing competition and making them work for excellence, promote bonding within them, build relations between teachers and students and building of character. Induction program covers

Physical activity
Creative arts
Universal human values
Literary and Proficiency modules
Lectures by Eminent peoples

1.4Admission Criteria

The eligibility criteria for admission into UG engineering programs are as per the norms approved by government of Andhra Pradesh from time to time. The sanctioned seats in each program in the college are classified into CATEGORY-A and CATEGORY-B at first year level and Lateral Entry at second year level.

- **CATEGORY – A Seats:** These seats will be filled as per the norms approved by the Government of Andhra Pradesh.
- **CATEGORY – B Seats:** These seats will be filled by the College as per the norms approved by the Government of Andhra Pradesh.
- **CATEGORY – Lateral Entry Seats** : Lateralentry candidates shall be admitted into the Third semester directly as per the norms approved by government of Andhra Pradesh. The percentages of Category-A, Category-B and Lateral Entry Seats are decided time to time by the Government of Andhra Pradesh.

2. Award of B. Tech. Degree

a) A student will be declared eligible for the award of B. Tech. Degree if he fulfills the following academic regulations:
   i. A student shall be declared eligible for the award of B. Tech Degree, if he pursues a course of study in not less than four and not more than eight academic years. After eight academic years from the year of their admission, he/she shall forfeit their seat in B.Tech course and their admission stands cancelled.
   ii. The candidate shall register for 160 credits and secure all the 160 credits.

b) The medium of instruction for the entire under graduate programmer in Engineering &Technology will be in **English** only.

3. Programme Pattern:

a) Total duration of the of B. Tech (Regular) Programme is four academic years
b) Each Academic year of study is divided into Two Semesters.
c) Minimum number of instruction days in each semester is 90.
d) Grade points, based on percentage of marks awarded for each course will form the basis for calculation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average).
e) The total credits for the Programme is 160.
f) Three week induction program is mandatory for all first year UG students and shall be conducted as per AICTE/UGC/APSCHE guidelines.
g) Student is introduced to "Choice Based Credit System (CBCS)".
h) A pool of interdisciplinary and job-oriented mandatory skill courses which are relevant to the industry are integrated into the curriculum of concerned branch of engineering (total five skill courses: two basic level skill courses, one on soft skills and other two on advanced level skill courses)
i) A student has to register for all courses in a semester.
j) All the registered credits will be considered for the calculation of final CGPA.
k) Each semester has - 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)'.Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as indicated by UGC and course structure as suggested by AICTE are followed.
l) A 10 months industry/field mandatory internship, both industry and social, during the summer vacation and also in the final semester to acquire the skills required for job and make engineering graduates to connect with the needs of the industry and society at large.
m) All the students shall be mandatorily registered for NCC, NSS activities and Community Service Project as per the Government and University norms.
n) Each college shall assign a faculty advisor/mentor after admission to each student or group of students from same department to provide guidance in courses registration / career growth/placements/opportunities for higher studies/ GATE / other competitive exams etc.

4. Registration for Courses:

a) In each semester a student shall mandatorily register courses which he/she wishes to pursue within a week from the starting of the class work with the advice of Head of the Department and mentor of the student of the concerned department of the college.
b) If any student wishes to withdraw the registration of the course, he/she shall submit a letter to the Principal of the college through the Head of the Department and mentor within fifteen days.
c) The concerned college shall thoroughly verify and upload the data/courses registered by each student in the university examination center within 20 days. The Principal of the concerned college shall ensure that there no wrong registration courses by the student. The university registration portal will be closed after 20 days.

5. (a) Award of B. Tech. Degree: A student will be declared eligible for the award of B. Tech. Degree if he fulfills the following academic regulations:

i. A student shall be declared eligible for award of the B. Tech Degree, if he pursues a course of study in not less than four and not more than eight academic years. After eight academic years from the year of their admission, he/she shall **forfeit** their seat in B. Tech course and their admission stands cancelled.
ii. The student shall register for 160 credits and must secure all the 160 credits.
iii. All students shall mandatorily register for the courses like Environmental Sciences,

Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge etc., shall be included in the curriculum as non-credit mandatory courses. Environmental Sciences is to be offered compulsorily as mandatory course for all branches. A student has to secure at least 40% of the marks allotted in the internal evaluation for passing the course and shall maintain 75% of attendance in the subject.

iv. All students shall mandatorily register for NCC/NSS activities and will be required to participate in an activity specified by NSS officer during second and third semesters. Grade shall be awarded as Satisfactory or Unsatisfactory in the mark sheet on the basis of participation, attendance, performance and behavior. If a student gets an unsatisfactory Grade, he/she shall repeat the above activity in the subsequent years, in order to complete the degree requirements.

v. Credits are defined as per AICTE norms.

(b) Award of B. Tech. (Honor):

- Students of a Department/Discipline are eligible to opt for Honors Programme offered by the same Department/Discipline
- A student shall be permitted to register for Honors program at the beginning of 4 th semester provided that the student must have acquired a minimum of 8.0 SGPA upto the end of 2 nd semester without any backlogs. In case of the declaration of the 3rd semester results after the commencement of the 4th semester and if a student fails to score the required minimum of 8 SGPA, his/her registration for Honors Programme stands cancelled and he/she shall continue with the regular Programme.
- Students can select the additional and advanced courses from their respective branch in which they are pursuing the degree and get an honors degree in the same. e.g. If a Mechanical Engineering student completes the selected advanced courses from same branch under this scheme, he/she will be awarded B.Tech. (Honors) in Mechanical Engineering.
- In addition to fulfilling all the requisites of a Regular B.Tech Programme, a student shall earn 20 additional credits to be eligible for the award of B. Tech (Honors) degree. This is in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline (i.e. 160 credits).
- Of the 20 additional Credits to be acquired, 16 credits shall be earned by undergoing specified courses listed as pools, with four courses, each carrying 4 credits. The remaining 4 credits must be acquired through two MOOCs, which shall be domain specific, each with 2 credits and with a minimum duration of 8/12weeks as recommended by the Board of studies.
- It is the responsibility of the student to acquire/complete prerequisite before taking the respective course. The courses offered in each pool shall be domain specific courses and advanced courses
- The concerned BoS shall decide on the minimum enrolments for offering Honors program by the department. If minimum enrolments criteria are not met then the students shall be permitted to register for the equivalent MOOC courses as approved by the concerned Head of the department in consultation with BoS.
- Each pool can have theory as well as laboratory courses. If a course comes with a lab component, that component has to be cleared separately. The concerned BoS shall 16 explore the possibility of introducing virtual labs for such courses with lab component.
- MOOC courses must be of minimum 8 weeks in duration. Attendance will not be monitored for MOOC courses. Students have to acquire a certificate from the agencies approved by the BOS with grading or marks or pass/fail in order to earn 4 credits. If the MOOC course is a pass/fail course without any grades, the grade to be assigned will be as decided by the university/academic council.

- The concerned BoS shall also consider courses listed under professional electives of the respective B. Tech programs for the requirements of B. Tech (Honors). However, a student shall be permitted to choose only those courses that he/she has not studied in any form during the Programme.
- If a student drops or is terminated from the Honors program, the additional credits so far earned cannot be converted into free or core electives; they will remain extra. These additional courses will find mention in the transcript (but not in the degree certificate). In such cases, the student may choose between the actual grade or a "pass (P)" grade and also choose to omit the mention of the course as for the following: All the courses done under the dropped Minors will be shown in the transcript. None of the courses done under the dropped Minor will be shown in the transcript.
- In case a student fails to meet the CGPA requirement for Degree with Honors at any point after registration, he/she will be dropped from the list of students eligible for Degree with Honors and they will receive regular B.Tech degree only. However, such students will receive a separate grade sheet mentioning the additional courses completed by them.
- Honors must be completed simultaneously with a major degree program. A student cannot earn Honors after he/she has already earned bachelor's degree.

(c) **Award of B. Tech. (Minors):**

- a)Students who are desirous of pursuing their special interest areas other than the chosen discipline of Engineering may opt for additional courses in minor specialization groups offered by a department other than their parent department. For example, If Mechanical Engineering student selects subjects from Civil Engineering under this scheme, he/she will get Major degree of Mechanical Engineering with minor degree of Civil Engineering b) Student can also opt for Industry relevant tracks of any branch to obtain the Minor Degree, for example, a B.Tech Mechanical student can opt for the industry relevant tracks like Data Mining track, IOT track, Machine learning track etc.
- The BOS concerned shall identify as many tracks as possible in the areas of emerging technologies and industrial relevance / demand. For example, the minor tracks can be the fundamental courses in CSE, ECE, EEE,CE,ME etc or industry tracks such as Artificial Intelligence (AI), Machine Learning (ML), Data Science (DS), Robotics, Electric vehicles, Robotics, VLSI etc.
- The list of disciplines/branches eligible to opt for a particular industry relevant minor specialization shall be clearly mentioned by the respective BoS.
- There shall be no limit on the number of programs offered under Minor. The University/Institution can offer minor programs in emerging technologies based on expertise in the respective departments or can explore the possibility of collaborating with the relevant industries/agencies in offering the program.
- The concerned BoS shall decide on the minimum enrolments for offering Minor program by the department. If a minimum enrolments criterion is not met, then the students may be permitted to register for the equivalent MOOC courses as approved by the concerned Head of the department in consultation with BoS.
- A student shall be permitted to register for Minors program at the beginning of 4th semester subject to a maximum of two additional courses per semester, provided that the student must have acquired 8 SGPA (Semester Grade point average) upto the end of 2nd semester without any history of backlogs. It is expected that the 3rd semester results may be announced after the commencement of the 4th semester. If a student fails to acquire 8 SGPA upto 3rd semester or failed in any of the courses, his registration for Minors program shall stand cancelled. An SGPA of 8 has to be maintained in the subsequent semesters without any backlog in order to keep the Minors registration active.

- A student shall earn additional 20 credits in the specified area to be eligible for the award of B. Tech degree with Minor. This is in addition to the credits essential for obtaining the Under Graduate Degree in Major Discipline (i.e. 160 credits).
- Out of the 20 Credits, 16 credits shall be earned by undergoing specified courses listed by the concerned BoS along with prerequisites. It is the responsibility of the student to acquire/complete prerequisite before taking the respective course. If a course comes with a lab component, that component has to be cleared separately. A student shall be permitted to choose only those courses that he/she has not studied in any form during the Programme.
- In addition to the 16 credits, students must pursue at least 2 courses through MOOCs. The courses must be of minimum 8 weeks in duration. Attendance will not be monitored for MOOC courses. Student has to acquire a certificate from the agencies approved by the BOS with grading or marks or pass/fail in order to earn 4 credits. If the MOOC course is a pass/fail course without any grades, the grade to be assigned as decided by the university/academic council.
- Student can opt for the Industry relevant minor specialization as approved by the concerned departmental BoS. Student can opt the courses from Skill Development Corporation (APSSDC) or can opt the courses from an external agency recommended and approved by concerned BOS and should produce course completion certificate. The Board of studies of the concerned discipline of Engineering shall review such courses being offered by eligible external agencies and prepare a fresh list every year incorporating latest skills based on industrial demand.
- A committee should be formed at the level of College/Universities/department to evaluate the grades/marks given by external agencies to a student which are approved by concerned BoS. Upon completion of courses the departmental committee should convert the obtained grades/marks to the maximum marks assigned to that course. The controller of examinations can take a decision on such conversions and may give appropriate grades.
- If a student drops (or terminated) from the Minor program, they cannot convert the earned credits into free or core electives; they will remain extra. These additional courses will find mention in the transcript (but not in the degree certificate). In such cases, the student may choose between the actual grade or a "pass (P)" grade and also choose to omit the mention of the course as for the following: All the courses done under the dropped Minors will be shown in the transcript. None of the courses done under the dropped Minor will be shown in the transcript.
- In case a student fails to meet the CGPA requirement for B.Tech degree with Minor at any point after registration, he/she will be dropped from the list of students eligible for degree with Minors and they will receive B. Tech degree only. However, such students will receive a separate grade sheet mentioning the additional courses completed by them.
- Minor must be completed simultaneously with a major degree program. A student cannot earn the Minor after he/she has already earned bachelor's degree.

6. Attendance Requirements

a) A student is eligible to write the University examinations if he acquires a minimum of 40% in each subject and 75% of attendance in aggregate of all the subjects.
b) Condonation of shortage of attendance in aggregate up to 10% (65% and above, and below 75%) may be granted by the College Academic Committee. However, this condonation concession is applicable only to any two semesters during the entire programme.
c) Shortage of Attendance below 65% in aggregate shall not be condoned.
d) A student who is short of attendance in a semester may seek re-admission into that

semester when offered within 4 weeks from the date of commencement of class work.

e) Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class.
f) A stipulated fee of Rs. 1000/- in the concerned semester shall be payable towards condonation of shortage of attendance. Students availing condonation on medical ground shall produce a medical certificate issued by the competitive authority.
g) A student will be promoted to the next semester if he satisfies the (i) attendance requirement of the present semester and (ii) minimum required credits.
h) If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.
i) For induction programme attendance shall be maintained as per AICTE norms.
j) For non-credit mandatory courses the students shall maintain the attendance similar to credit courses

7. Evaluation-Distribution and Weightage of marks

i. Paper setting and evaluation of the answer scripts shall be done as per the procedures laid down by the University Examination section from time to time.
ii. To maintain the quality, external examiners and question paper setters shall be selected from reputed institutes like IISc, IITs, IIITs, IISERs, NITs and Universities.
iii. For non-credit mandatory courses, like Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge, the student has to secure 40% of the marks allotted in the internal evaluation for passing the course. No marks or letter grade shall be allotted for all mandatory non-credit courses.
iv. A student is deemed to have satisfied the minimum academic requirements if he has earned the credits allotted to each theory/practical design/drawing subject/ project etc by securing not less than 35% of marks in the end semester exam and minimum 40% of marks in the sum total of the internal marks and end semester examination marks together.

v. **Distribution and Weightage of marks:**The assessment of the student's performance in each course will be as per the details given:

S. No.	Components	Internal	External	Total
1	Theory	30	70	100
2	Engineering Graphics/Design/Drawing	30	70	100
3	Practical	15	35	50
4	Mini Project/Internship/Industrial Training/ Skill Development programs/Research Project	-	50	50
5	Project Work	60	140	200

vi. Continuous Internal Theory Evaluation:

a) For theory subjects, during a semester, there shall be two mid-term examinations. Each mid-term examination consists of (i) one online objective examination (20 multiple choice questions) for 10 marks for a duration of 20 minutes (ii) one descriptive examination (3 full questions for 5 marks each) for 15 marks for a duration of 90 minutes and (iii) one assignment for 05 marks. All the internal exams shall be conducted as per university norms from first 50% of the syllabi.
b) In the similar lines, the second online, descriptive examinations assignment shall be conducted on the rest of the 50% syllabus.
c) The total marks secured by the student in each mid-term examination are evaluated for 30 marks. The first mid marks (Mid-1) consisting of marks of online objective examination, descriptive examination and assignment shall be submitted to the University examination

section within one week after completion of first mid examination.

d) The mid marks submitted to the University examination section shall be displayed in the concerned college notice boards for the benefit of the students.

e) If any discrepancy found in the submitted Mid-1 marks, it shall be brought to the notice of university examination section within one week from the submission.

f) Second mid marks (Mid-2) consisting of marks of online objective examination, descriptive examination and assignment shall also be submitted to University examination section within one week after completion of second mid examination and it shall be displayed in the notice boards. If any discrepancy found in the submitted mid-2 marks, it shall be brought to the notice of university examination section within one week from the submission.

g) Internal marks can be calculated with 80% weightage for better of the two mids and 20% Weightage for other mid exam.
   a. Example: **Mid-1 marks** = Marks secured in
   b. (Online examination-1 + descriptive examination-1 +one assignment-1)
   c. **Mid-2 marks** = Marks secured in
   d. (Online examination-2+descriptive examination-2+one assignment-2)
   e. **Final internal Marks** = (Best of (Mid-1/Mid-2) marks x 0.8 + Least of (Mid-1/Mid-2) marks x 0.2)

h) With the above criteria, university examination section will send mid marks of all subjects in consolidated form to all the concerned colleges and same shall be displayed in the concerned college notice boards. If any discrepancy found, it shall be brought to the notice of university examination section through proper channel within one week with all proofs. Discrepancies brought after the given deadline will not be entertained under any circumstances.

vii. Semester End Theory Examinations Evaluation:

a) The semester end examinations will be conducted university examination section for 70 marks consists of five questions carrying 14 marks each. Each of these questions is from one unit and may contain sub-questions. For each question there will be an "either" "or" choice, which means that there will be two questions from each unit and the student should answer either of the two questions.

b) For practical subjects there shall be continuous evaluation during the semester for 15 internal marks and 35 end examination marks. The internal 15 marks shall be awarded as follows: day to day work - 5 marks, Record-5 marks and the remaining 5 marks to be awarded by conducting an internal laboratory test. The end examination shall be conducted by the teacher concerned and external examiner appointed.

c) For the subject having design and / or drawing, (such as Engineering Graphics, Engineering Drawing, Machine Drawing) and estimation, the distribution shall be 30 marks for internal evaluation (15 marks for continuous Assessment (day–to–day work) and 15 marks for internal tests) and 70 marks for end examination. There shall be two internal tests in a Semester for 15 marks each and final marks can be calculated with 80% weightage for better of the two tests and 20% weightage for other test and these are to be added to the marks obtained in day to day work.

Evaluation of the summer internships:

- Two summer internships each with a minimum of six weeks duration, done at the end of second and third years, respectively are mandatory. The internship can be done by the students at local industries, Govt. Organizations, construction agencies, Industries, Hydel and thermal power projects and also in software MNCs.
- Evaluation of the summer internships shall be through the departmental committee. A student will be required to submit a summer internship report to the concerned

department and appear for an oral presentation before the departmental committee. The report and the oral presentation shall carry 40% and 60% weightages respectively.

- In the final semester, the student should mandatorily undergo internship and parallelly he/she should work on a project with well-defined objectives. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship. The project report shall be evaluated with an external examiner
- The College shall facilitate and monitor the student internship programs. Completion of internships is mandatory, if any student fails to complete internship, he/she will not be eligible for the award of degree. In such cases, the student shall repeat and complete the internship.
- It shall be evaluated for 50 external marks at the end of the semester. There shall be no internal marks for Summer Internship. A student shall secure minimum 40% of marks for successful completion.

d) Curricular Framework for Skill oriented:

- The job oriented skill courses may be registered at the college or at any accredited external agency. A student shall submit a record/report on the on the list skills learned. If the student completes job oriented skill course at external agency, a certificate from the agency shall be included in the report. The course will be evaluated at the end of the semester for 50 marks (record: 15 marks and viva-voce: 35 marks) along with laboratory end examinations in the presence of external and internal examiner (course instructor or mentor). There are no internal marks for the job oriented skill courses.
- For skill oriented/skill advanced course, one theory and 2 practical hours or two theory hours may be allotted as per the decision of concerned BOS.
- Out of the five skill courses two shall be skill-oriented courses from the same domain and shall be completed in second year. Of the remaining 3 skill courses, one shall be necessarily be a soft skill course and the remaining 2 shall be skill-advanced courses either from the same domain or Job oriented skill courses, which can be of inter disciplinary nature.
- A pool of interdisciplinary job-oriented skill courses shall be designed by a common Board of studies by the participating departments/disciplines and the syllabus along with the pre requisites shall be prepared for each of the laboratory infrastructure requirements. The list of such courses shall be included in the curriculum structure of each branch of Engineering, so as to enable the student to choose from the list
- The student shall be given an option to choose either the skill courses being offered by the college or to choose a certificate course being offered by industries/Professional bodies/APSSDC or any other accredited bodies as approved by the concerned BoS
- The Board of studies of the concerned discipline of Engineering shall review the skill advanced courses being offered by eligible external agencies and prepare a fresh list every year incorporating latest courses based on industrial demand
- If a student chooses to take a Certificate Course offered by industries/Professional bodies/APSSDC or any other accredited bodies, in lieu of the skill advanced course offered by the Department, the credits shall be awarded to the student upon producing the Course Completion Certificate from the agency/professional bodies as approved by the Board of studies.
- If a student prefers to take a certificate course offered by external agency, the department shall mark attendance of the student for the remaining courses in that semester excluding the skill course in all the calculations of mandatory attendance requirements upon producing a valid certificate as approved by the concerned Board of Studies, the student is deemed to have fulfilled the attendance requirement of the course

and acquire the credits assigned to the course.

- A committee shall be formed at the level of the college to evaluate the grades/marks given for a course by external agencies and convert to the equivalent marks/grades. The recommended conversions and appropriate grades/marks are to be approved by the University/Academic Council.

e) Mandatory Course (M.C): Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge etc non-credit (zero credits) mandatory courses. Environmental Sciences shall be offered compulsorily as mandatory course for all branches. A minimum of 75% attendance is mandatory in these subjects. There shall be an external examination for 70 marks and it shall be conducted by the college internally. Two internal examinations shall be conducted for 30 marks and a student has to secure at least 40% of the marks for passing the course. There is no online internal exam for mandatory courses. No marks or letter grade shall be printed in the transcripts for all mandatory non-credit courses, but only Completed (Y)/Not-completed (N) will be specified.

f) **Procedure for Conduct and Evaluation of MOOC:** There shall be a Discipline Centric Elective Course through Massive Open Online Course (MOOC) as Program Elective course. The student shall register for the course (Minimum of 12 weeks) offered by SWAYAM/NPTEL through online with the approval of Head of the Department. The Head of the Department shall appoint one mentor for each of the MOOC subjects offered. The student needs to register the course in the SWAYAM/NPTEL portal. During the course, the mentor monitors the student's assignment submissions given by SWAYAM/NPTEL. The student needs to submit all the assignments given and needs to take final exam at the proctor center. The student needs to earn a certificate by passing the exam. The student will be awarded the credits given in curriculum only by submission of the certificate. In case if student does not pass subjects registered through SWAYAM/NPTEL, the same or alternative equivalent subject may be registered again through SWAYAM/NPTEL in the next semester with the recommendation of HOD and shall be pass.

g) ***Major Project (*****Project - Project work, seminar and internship in industry):**

In the final semester, the student should mandatorily register and undergo internship and in parallel he/she should work on a project with well-defined objectives. At the end of the semester the candidate shall submit an internship completion certificate and a project report. A student shall also be permitted to submit project report on the work carried out during the internship. The project report shall be evaluated with an external examiner.

Evaluation*:* The total marks for project work 200 marks and distribution shall be 60 marks for internal and 140 marks for external evaluation. The supervisor assesses the student for 30 marks (Report: 15 marks, Seminar: 15 marks). At the end of the semester, all projects shall be showcased at the department for the benefit of all students and staff and the same is to be evaluated by the departmental Project Review Committee consisting of supervisor, a senior faculty and HOD for 30 marks. The external evaluation of Project Work is a Viva-Voce Examination conducted in the presence of internal examiner and external examiner and is evaluated for 140 marks.

8 Results Declaration:

i. Before results declaration, an academic council meeting shall be conducted and results shall be placed before the academic council for approval.
ii. With the approval of academic council, the results shall be submitted to the University to get the Approval from Honorable Vice-Chancellor.
iii. The University may normalize the result, if required, before declaration of the result (Guidelines for normalization will be provided separately)

iv. A copy of approved results in a CD shall be submitted to the University examination Center.

9. **Academic Audit:** Academic audit in each semester will be conducted as per norms.
10. **Recounting or Re-evaluation of Marks in the End Semester Examination:** A student can request for recounting of revaluation of his/her answer book on payment of a prescribed fee as per norms.
11. **Supplementary Examinations:** A student who has failed to secure the required credits can appear for a supplementary examination, as per the schedule announced by the University.
12. **Malpractices in Examinations:** Disciplinary action shall be taken in case of malpractices during Mid/End examinations as per the rules framed by the University.
13. **Promotion Rules:** The following academic requirements have to be satisfied in addition to the attendance requirements mentioned in item no.5 for promotion to higher classes
    a) A student shall be promoted from first year to second year if he fulfills the minimum attendance requirement as per University norm.
    b) A student will be promoted from II year to III year if he fulfills the academic requirement of 40% of credits up to either II year I-Semester or II year II-Semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in II year II semester.
    c) A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.
14. **Course Pattern**
    a) The entire course of study is for four academic years; all years are on semester pattern.
    b) A student eligible to appear for the end semester examination in a subject, but absent from it or has failed in the end semester examination, may write the exam in that subject when conducted next.
    c) When a student is detained for lack of credits / shortage of attendance, he may be re-admitted into the same semester/year in which he has been detained. However, the academic regulations under which he was first admitted shall continue to be applicable to him.
15. **Earning of Credit**:

A student shall be considered to have completed a course successfully and earned the credits if he/she secures an acceptable letter grade in the range A+ to E as given below. Letter grade 'F' in any course implies failure of the student in that course and no credits earned. Absent is also treated as no credits earned. For project same % percentages will be followed for grading.

Marks Range Max:100	Marks range Max:50	Level	Letter Grade	Grade point
≥ 90	≥ 45	Outstanding	A+	10
≥80 to <89	≥40 to <44	Excellent	A	9
≥70 to <79	≥35 to <39	Very Good	B	8
≥60 to <69	≥30 to <34	Good	C	7
≥50 to <59	≥25 to <29	Fair	D	6
≥40 to <49	≥20 to <24	Satisfactory	E	5
<40	<20	Fail	F	0
-		Absent	AB	0

16. Award of Class:

After a student has satisfied the requirements prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	Remarks
First Class with Distinction	≥7.75 (Without any supplementary appearance)	From the CGPA secured from 160 Credits
First Class	≥ 6.75	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 5.00 to < 5.75	

17. Minimum Instruction Days:

The minimum instruction days for each semester shall be 90 working days. There shall be no branch transfers after the completion of the admission process. There shall be no transfer from one college/stream to another within the Constituent Colleges and Units of Jawaharlal Nehru Technological University Kakinada.

18. Withholding of Results:

If the student is involved in indiscipline/malpractices/court cases, the result of the student will be withheld.

19. Transitory Regulations

a) Discontinued or detained candidates are eligible for re-admission as and when next offered.
b) The re-admitted candidate will be governed by the rules & regulations under which the candidate has been admitted.
c) In case of transferred students from other Universities, credits shall be transferred to JNTUK as per the academic regulations and course structure of JNTUK.
d) The students seeking transfer to colleges affiliated to JNTUK from various other Universities / Institutions haveto obtain the credits of any equivalent subjects as prescribed by JNTUK. In addition, the transferred candidates have to pass the failed subjects at the earlier Institute with already obtained internal/sessional marks to be conducted by JNTUK.

20. Gap – Year:

Gap Year concept of Student Entrepreneur in Residence shall be introduced and outstanding students who wish to pursue entrepreneurship are allowed to take a break of one year at any time after I/II/III year to pursue entrepreneurship full time. This period shall be counted for the maximum time for graduation. An evaluation committee at university level shall be constituted to evaluate the proposal submitted by the student and the committee shall decide on permitting the student for availing the Gap Year.

21. General:

a) Wherever the words “he”, “him”, “his”, occur in the regulations, they include “she”, “her”, “hers”.
b) The academic regulation should be read as a whole for the purpose of any interpretation.
c) In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Vice-Chancellor is final.
d) The University may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the University.

ACADEMIC REGULATIONS (SITE21) FOR B.Tech (LATERAL ENTRY SCHEME)

Applicable for the students admitted into II year B. Tech. from the Academic Year 2022-23 onwards

1. Award of B. Tech. Degree

A student will be declared eligible for the award of B. Tech. Degree if he fulfills the following academic regulations:

a) A student shall be declared eligible for the award of the B. Tech Degree, if he pursues a course of study in not less than three academic years and not more than six academic years. After six academic years from the year of their admission, he/she shall forfeit their seat in B. Tech course and their admission stands cancelled.

b) The candidate shall register for 121 credits and secure all the 122 credits.

2. The attendance regulations of B. Tech. (Regular) shall be applicable to B.Tech (lateral entry)

3. **Promotion Rules:** A student shall be promoted from second year to third year if he fulfills the minimum attendance requirement.

A student shall be promoted from III year to IV year if he fulfills the academic requirements of 40% of the credits up to either III year I semester or III year II semester from all the examinations, whether or not the candidate takes the examinations and secures prescribed minimum attendance in III year II semester.

4. **Award of Class**

After a student has satisfied the requirement prescribed for the completion of the program and is eligible for the award of B. Tech. Degree, he shall be placed in one of the following four classes:

Class Awarded	CGPA to be secured	Remarks
First Class with Distinction	≥ 7.75 (Without any supplementary appearance)	From the CGPA secured from 121 Credits from II Year to IV Year
First Class	≥ 6.75	
Second Class	≥ 5.75 to < 6.75	
Pass Class	≥ 5.00 to < 5.75	

The Grades secured, Grade points and Credits obtained will be shown separately in the memorandum of marks.

5. All the other regulations as applicable to **B. Tech. 4-year degree course (Regular) will hold good for B. Tech. (Lateral Entry Scheme**

COMMUNITY SERVICE PROJECT

Introduction

1. Community Service Project is an experiential learning strategy that integrates meaningful community service with instruction, participation, learning and community development
2. Community Service Project involves students in community development and service activities and applies the experience to personal and academic development.
3. Community Service Project is meant to link the community with the college for mutual benefit. The community will be benefited with the focused contribution of the college students for the village/ local development. The college finds an opportunity to develop social sensibility and responsibility among students and also emerge as a socially responsible institution.

Objective

Community Service Project should be an integral part of the curriculum, as an alternative to the 2 months of Summer Internships / Apprenticeships / On the Job Training, whenever there is an exigency when students cannot pursue their summer internships. The specific objectives are;

1. To sensitize the students to the living conditions of the people who are around them,
2. To help students to realize the stark realities of the society.
3. To bring about an attitudinal change in the students and help them to develop societal consciousness, sensibility, responsibility and accountability
4. To make students aware of their inner strength and help them to find new /out of box solutions to the social problems.
5. To make students socially responsible citizens who are sensitive to the needs of the disadvantaged sections.
6. To help students to initiate developmental activities in the community in coordination with public and government authorities.
7. To develop a holistic life perspective among the students by making them study culture, traditions, habits, lifestyles, resource utilization, wastages and its management, social problems, public administration system and the roles and responsibilities of different persons across different social systems.

Implementation of Community Service Project

1. Every student should put in a minimum of **180 hours** for the Community Service Project during the summer vacation
2. Each class/section should be assigned with a mentor.
3. Specific Departments could concentrate on their major areas of concern. For example, Dept. of Computer Science can take up activities related to Computer Literacy to different sections of people like - youth, women, house-wives, etc.
4. A log book has to be maintained by each of the student, where the activities undertaken/involved to be recorded. The log book has to be countersigned by the concerned mentor/faculty in charge.
5. Evaluation to be done based on the active participation of the student and grade could be awarded by the mentor/faculty member.
6. The final evaluation to be reflected in the grade memo of the student.
7. The Community Service Project should be different from the regular programs of NSS/NCC/Green Corps/Red Ribbon Club, etc.
8. Minor project report should be submitted by each student. An internal Viva shall also be conducted by a committee constituted by the principal of the college.
9. Award of marks shall be made as per the guidelines of Internship/apprentice/ on the job training

Procedure

1. A group of students or even a single student could be assigned for a particular habitation or village or municipal ward, as far as possible, in the near vicinity of their place of stay, so as to enable them to commute from their residence and return back by evening or so.
2. The Community Service Project is a twofold one –
   a) First, the student/s could conduct a survey of the habitation, if necessary, in terms of their own domain or subject area. Or it can even be a general survey, incorporating all the different areas. A common survey format could be designed. This should not be viewed as a duplication of work by the Village or Ward volunteers, rather, it could be another primary source of data.
   b) Secondly, the student/s could take up a social activity, concerning their domain or

subject area. The different areas, could be like –

- Agriculture
- Health
- Marketing and Cooperation
- Animal Husbandry
- Horticulture
- Fisheries
- Sericulture
- Revenue and Survey
- Natural Disaster Management
- Irrigation
- Law & Order
- Excise and Prohibition
- Mines and Geology
- Energy
- Internet
- Free Electricity
- Drinking Water

EXPECTED OUTCOMES **BENEFITS OF COMMUNITY SERVICE PROJECT TO STUDENTS**

Learning Outcomes

1. Positive impact on students' academic learning.
2. Improves students' ability to apply what they have learned in "the real world".
3. Positive impact on academic outcomes such as demonstrated complexity of understanding, problem analysis, problem-solving, critical thinking, and cognitive development.
4. Improved ability to understand complexity and ambiguity.

Personal Outcomes

1. Greater sense of personal efficacy, personal identity, spiritual growth, and moral development.
2. Greater interpersonal development, particularly the ability to work well with others, and build leadership and communication skills

Social Outcomes

1. Reduced stereotypes and greater inter-cultural understanding
2. Improved social responsibility and citizenship skills
3. Greater involvement in community service after graduation

Career Development

1. Connections with professionals and community members for learning and career opportunities
2. Greater academic learning, leadership skills, and personal efficacy can lead to greater opportunity

Relationship with the Institution

1. Stronger relationships with faculty
2. Greater satisfaction with college
3. Improved graduation rates

BENEFITS OF COMMUNITY SERVICE PROJECT TO FACULTY MEMBERS

1. Satisfaction with the quality of student learning
2. New avenues for research and publication via new relationships between faculty and community
3. Providing networking opportunities with engaged faculty in other disciplines or institutions
4. A stronger commitment to one's research

BENEFITS OF COMMUNITY SERVICE PROJECT TO COLLEGES AND UNIVERSITIES

1. Improved institutional commitment
2. Improved student retention
3. Enhanced community relations

BENEFITS OF COMMUNITY SERVICE PROJECT TO COMMUNITY

1. Satisfaction with student participation
2. Valuable human resources needed to achieve community goals
3. New energy, enthusiasm and perspectives applied to community work
4. Enhanced community-university relations.

SUGGESTIVE LIST OF PROGRAMMES UNDER COMMUNITY SERVICE PROJECT

The following the recommended list of projects for engineering students. The lists are not exhaustive and open for additions, deletions and modifications. Colleges are expected to focus on specific local issues for this kind of projects. The students are expected to carry out these projects with involvement, commitment, responsibility and accountability. The mentors of a group of students should take the responsibility of motivating, facilitating, and guiding the students. They have to interact with local leadership and people and appraise the objectives and benefits of this kind of projects. The project reports shall be placed in the college website for reference. Systematic, Factual, methodical and honest reporting shall be ensured.

For Engineering Students

1. Water facilities and drinking water availability
2. Health and hygiene
3. Stress levels and coping mechanisms
4. Health intervention programs
5. Horticulture
6. Herbal plants
7. Botanical survey
8. Zoological survey
9. Marine products
10. Aqua culture
11. Inland fisheries
12. Animals and species
13. Nutrition
14. Traditional health care methods
15. Food habits
16. Air pollution
17. Water pollution
18. Plantation
19. Soil protection
20. Renewable energy
21. Plant diseases
22. Yoga awareness and practice
23. Health care awareness programs and their impact
24. Use of chemicals on fruits and vegetables
25. Organic farming
26. Crop rotation
27. Floury culture
28. Access to safe drinking water
29. Geographical survey
30. Geological survey
31. Sericulture
32. Study of species

33. Food adulteration
34. Incidence of Diabetes and other chronic diseases
35. Human genetics
36. Blood groups and blood levels
37. Internet Usage in Villages
38. Android Phone usage by different people
39. Utilization of free electricity to farmers and related issues
40. Gender ration in schooling level- observation.

Complementing the community service project, the students may be involved to take up some awareness campaigns on social issues/special groups. The suggested list of programs are;

Programs for School Children:

1. Reading Skill Programme (Reading Competition)
2. Preparation of Study Materials for the next class.
3. Personality / Leadership Development
4. Career Guidance for X class students
5. Screening Documentary and other educational films
6. Awareness Programme on Good Touch and Bad Touch (Sexual abuse)
7. Awareness Programme on Socially relevant themes.

Programs for Women Empowerment

1. Government Guidelines and Policy Guidelines
2. Women's' Rights
3. Domestic Violence
4. Prevention and Control of Cancer
5. Promotion of Social Entrepreneurship

General Camps

1. General Medical camps
2. Eye Camps
3. Dental Camps
4. Importance of protected drinking water
5. ODF awareness camp
6. Swatch Bharat
7. AIDS awareness camp
8. Anti-Plastic Awareness
9. Programs on Environment
10. Health and Hygiene
11. Hand wash programs
12. memoration and Celebration of important days

Programs for Youth Empowerment

1. Leadership
2. Anti-alcoholism and Drug addiction
3. Anti-tobacco
4. Awareness on Competitive Examinations
5. Personality Development

Common Programs

1. Awareness on RTI
2. Health intervention programs
3. Yoga
4. Tree plantation
5. Programs in consonance with the Govt. Departments like –
    i. Agriculture

ii. Health
iii. Marketing and Cooperation
iv. Animal Husbandry
v. Horticulture
vi. Fisheries
vii. Sericulture
viii. Revenue and Survey
ix. Natural Disaster Management
x. Irrigation
xi. Law & Order
xii. Excise and Prohibition
xiii. Mines and Geology
xiv. Energy

Role of Students:

1. Students may not have the expertise to conduct all the programmes on their own. The students thencan play a facilitator role.
2. For conducting special camps like Health related, they will be coordinating with the Governmental agencies.
3. As and when required the College faculty themselves act as Resource Persons.
4. Students can work in close association with Non-Governmental Organizations like Lions Club, Rotary Club, etc or with any NGO actively working in that habitation.
5. And also, with the Governmental Departments. If the programme is rolled out, the District Administration could be roped in for the successful deployment of the programme.
6. An in-house training and induction programme could be arranged for the faculty and participating students, to expose them to the methodology of Service Learning.

Timeline for the Community Service Project Activity

Duration: 8 weeks

1. Preliminary Survey (One Week)

a) A preliminary survey including the socio-economic conditions of the allotted habitation to be conducted.
b) A survey form based on the type of habitation to be prepared before visiting the habitation with the help of social sciences faculty. (However, a template could be designed for different habitations, rural/urban.
c) The Governmental agencies, like revenue administration, corporation and municipal authorities and village secretariats could be aligned for the survey.

2. Community Awareness Campaigns (Two Weeks)

Based on the survey and the specific requirements of the habitation, different awareness campaigns and programmes to be conducted, spread over two weeks of time. The list of activities suggested could be taken into consideration.

3. Community Immersion Programme (Four Weeks)

Along with the Community Awareness Programmes, the student batch can also work with any one of the below listed governmental agencies and work in tandem with them. This community involvement programme will involve the students in exposing themselves to the experiential learning about the community and its dynamics. Programmes could be in consonance with the Govt. Departments.

4. Community Exit Report (One Week)

During the last week of the Community Service Project, a detailed report of the outcome of the 8 weeks works to be drafted and a copy shall be submitted to the local administration. This report will be a basis for the next batch of students visiting that particular habitation.

The same report submitted to the teacher-mentor will be evaluated by the mentor and suitable marks are awarded for onward submission to the University.

Throughout the Community Service Project, a daily log-book need to be maintained by the students batch, which should be countersigned by the governmental agency representative and the teacher-mentor, who is required to periodically visit the students and guide them.

Course Numbering Scheme

The Course number code consists of 11alphabets. A typical course number code is illustrated in the followingFigure-1.

Mechanical Engineering (ME)

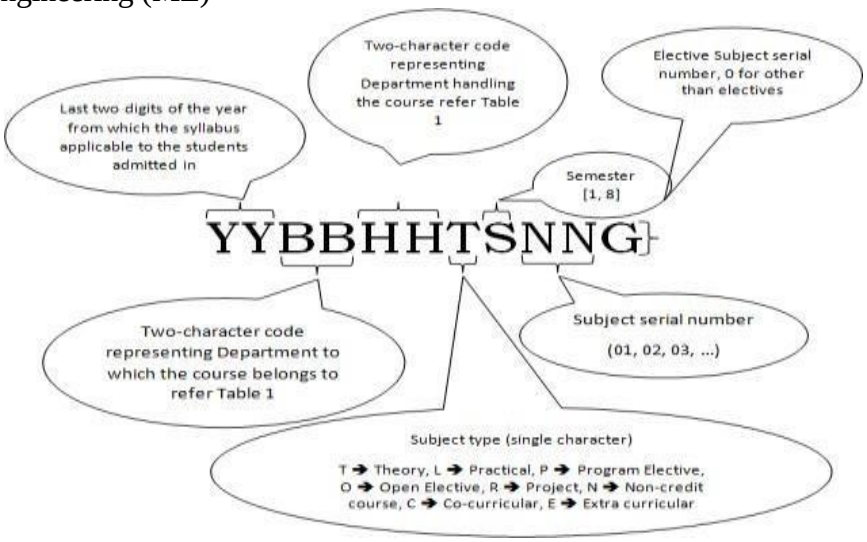


Figure 1: Course Numbering Scheme

The department codes are in given in following table 1.

Table 1: Department Codes

Department	Two-character code
Artificial Intelligence and Machine Learning	AM
Civil Engineering	CE
Electrical & Electronics Engineering	EE
Mechanical Engineering	ME
Electronics & Communications Engineering	EC
Electronics & Communications Technology	ET
Computer Science and Engineering (Artificial Intelligence and Machine Learning)	CA
Computer Science and Engineering (IoT and Cyber Security including Block Chain Technology)	CI
Computer Science and Engineering (Data Science)	CD
Computer Science and Engineering	CS
Computer Science and Technology	CT
Information Technology	IT
Management Science	MS
Mathematics	MA
Physics	PH
Chemistry	CH
English	EG
Biology	BI
Common to All Branches	CM

Example: ED in 3rd semester for ECT with S. No. 3
Course Code: 21ETETT3030

Table-2: Comparison of Suggested breakup of Credits AICTE, APSCHE and SITE Curriculum

S. No.	Category	No of Credits		
		Suggested by AICTE	Suggested by APSCHE	Approved SITE-21
1	Humanities and Social Sciences	12	10.5	10.5
2	Basic Science Courses	25	21	21
3	Engineering Science Courses	24	24	24
4	Professional Core Courses	48	51	51
5	Professional Elective Courses	18	15	15
6	Open Elective Courses	18	12	12
7	Project Work, Seminar and Internship	15	16.5	16.5
8	Skill oriented Courses	-	10	10
9	Mandatory Courses	-	-	-
Total Credits		160	160	160

Malpractice

DISCIPLINARY ACTION FOR MALPRACTICES/IMPROPER CONDUCT IN EXAMS

S. No.	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
1. (b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including

	which the candidate is appearing.	practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year.The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and

		all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

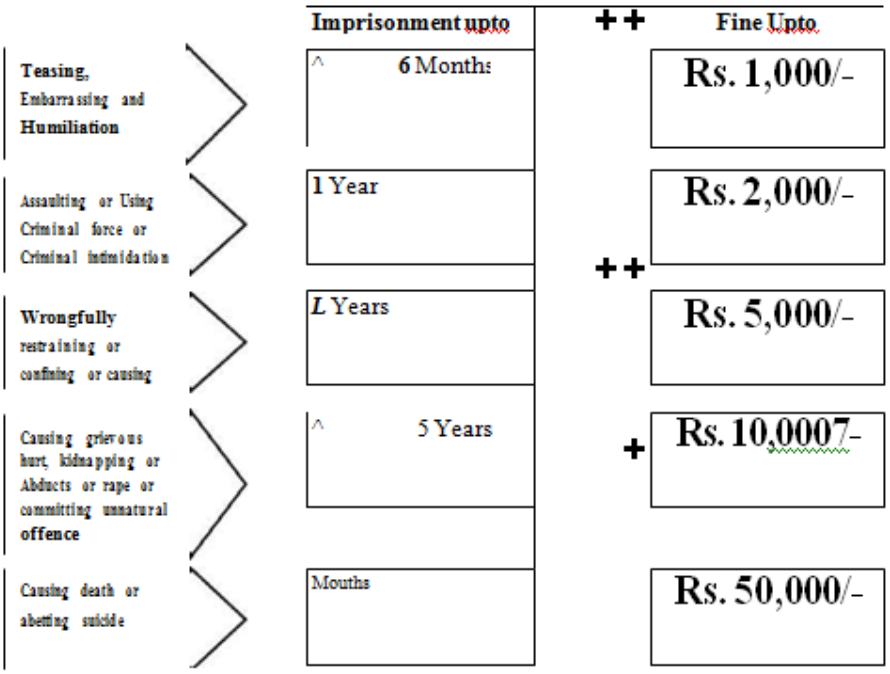
MALPRACTICES

- The Principal shall refer the cases of malpractices in Continuous Evaluation and Semester-End Examinations, to Malpractice Enquiry Committee, constituted by him/her for the purpose. Such committee shall follow the approved scales of punishment. The Principal shall take necessary action, against the erring students based on the recommendations of the committee.
- Any action on the part of student at an examination trying to get undue advantage in the performance or trying to help another, or derive the same through unfair means is punishable according to the provisions contained hereunder. The involvement of the Staff, who are in charge of conducting examinations, valuing examination papers and preparing/keeping records of documents relating to the examinations in such acts (inclusive of providing incorrect or misleading information) that infringe upon the course of natural justice to one and all concerned at the examination shall be viewed seriously and recommended for award of appropriate punishment after thorough enquiry.

Ragging

Prohibition of ragging in educational institutions Act 26 of 1997 Salient Features

- Ragging within or outside any educational institution is prohibited.
- Ragging means doing an act which causes or is likely to cause Insult or Annoyance of Fear or Apprehension or Threat or Intimidation or outrage of modesty or Injury to a student.



LET US MAKE SITE RAGGING FREE INSTITUTE

Program Outcomes for an Engineering Graduates:

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.

COURSE STRUCTURE

SITE-21 REGULATIONS

For

Mechanical Engineering

With effective from the
Academic Year
2021-22

I B. Tech. I Semester Proposed Course Structure for the Regulation SITE 21

S. No.	CC	Course code	Course Title	L	T	P	C
1	BSC	21CMMAT1010	Engineering Mathematics – I (Calculus and Differential Equations)	3	0	0	3
2	BSC	21EEPHT1020	Engineering Physics	3	0	0	3
3	BSC	21CMCHT1030	Engineering Chemistry	3	0	0	3
4	ESC	21CMCST1040	Programming for Problem Solving	3	0	0	3
5	ESC	21CMMEL1050	Engineering Graphics	2	0	2	3
6	BSC	21EEPHL1060	Engineering Physics Lab	0	0	3	1.5
7	BSC	21CMCHL1070	Engineering Chemistry Lab	0	0	3	1.5
8	ESC	21CMCSL1080	Programming for Problem Solving Lab	0	0	3	1.5
9	MC	21CMMSN1090	Constitution of India, Professional Ethics & Human Rights	2	0	0	0
TOTAL				**16**	**0**	**11**	**19.5**

I B. Tech. II Semester Proposed Course Structure for the Regulation SITE 21

S. No.	CC	Course code	Course Title	L	T	P	C
1	HSC	21CMEGT2010	Technical English	3	0	0	3
2	BSC	21CMMAT2020	Engineering Mathematics – II (Linear algebra, Laplace Transforms and Numerical Methods)	3	0	0	3
3	ESC	21CMEET2030	Basic Electrical Engineering	3	0	0	3
4	ESC	21CMCST2040	Python Programming	1	0	4	3
5	ESC	21EEMET2050	Engineering Mechanics	3	0	0	3
6	HSC	21CMEGL2060	English Communication Skills Lab	0	0	3	1.5
7	ESC	21CMEEL2070	Basic Electrical Engineering Lab	0	0	3	1.5
8	ESC	21CMMEL2080	Engineering Workshop Lab	0	0	3	1.5
9	MC	21CMCHN2090	Environmental Science	2	0	0	0
			TOTAL	**15**	**0**	**13**	**19.5**

II B. Tech. III Semester Proposed Course Structure for the Regulation SITE 21

S. No.	CC	Course Code	Course Title	L	T	P	C
1	BSC	21CMMAT3010	Engineering Mathematics -III (Vector Calculus and Complex Analysis)	3	0	0	3
2	ESC	21MEMET3020	Materials Engineering	3	0	0	3
3	PCC	21MEMET3030	Mechanics of Solids	3	0	3	3
4	PCC	21MEMET3040	Thermodynamics	3	0	0	3
5	PCC	21MEMET3050	Fluid Mechanics and Fluid Machines	3	0	3	3
6	ESC	21MEMEL3060	Mechanics of Solids &Materials Lab	0	0	3	1.5
7	PCC	21MEMEL3070	Fluid Mechanics and Fluid Machine s Lab	0	0	3	1.5
8	SOC	21MEMES3080	Computer Aided Engineering Drawing and Drafting (CAEDP)	1	0	2	2
9	MC	21MEECN3090	Basic Electronics Engineering	3	0	0	0
			Total	**19**	**0**	**14**	**20**

II B. Tech. IV Semester Proposed Course Structure for the Regulation SITE 21

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1.	BSC	21 CMMAT 4010	Engineering Mathematics –IV (Fourier series, Applications of PDE and Probability &	3	0	0	3
2.	PCC	21MEMET4020	Applied Thermodynamics	3	0	0	3
3.	PCC	21MEMET4030	Design of Machine Elements - I	3	0	0	3
4.	PCC	21MEMET4040	Production Technology	3	0	0	3
5.	PCC	21MEMET4050	Kinematics of Machinery	3	0	0	3
6.	HSC	21MEMST4060	Engineering Economics and Financial Management	3	0	0	3
7.	PCC	21MEMEL4070	Thermal Engineering Lab	0	0	3	1.5
8.	PCC	21MEMEL4080	Production Technology Lab	0	0	3	1.5
9.	SOC	21MEMES4090	Computer Aided Three-Dimensional Interactive Application (CATIA)	1	0	2	2
10.			**Total**	**19**	**0**	**8**	**23**
H/M			Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)	4	0	0	4

III B. Tech. V Semester Course Structure for the Regulation SITE 21

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PCC	21MEMET5010	Machine Tools and Metrology	3	0	0	3
2	PCC	21MEMET5020	Dynamics of Machinery	3	0	0	3
3	PCC	21MEMET5030	Design of Machine Elements-II	3	0	0	3
4	PEC	21MEMEP504X	Professional Elective-I	3	0	0	3
5	OEC	21MEXXO505X	Open Elective Course-I	3	0	0	3
6	PCC	21MEMEL5060	Machine Tools and Metrology Lab	0	0	3	1.5
7	PCC	21MEMEL5070	Theory of Machines Lab	0	0	3	1.5
8	SOC	21CMAHS5080	Soft Skills & Aptitude Builder - 1	1	0	2	2
9	MC	21MEMEN5090	Machine Drawing Practice Lab	0	0	3	0
10	SI	21MEMER5100	Summer Internship (2 months) after II year to be evaluated during V semester	0	0	0	1.5
			Total	**16**	**0**	**11**	**21.5**
11	H/M		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)	4	0	0	4

Professional Elective Course -I

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP504A	Conventional and Non-Conventional Power Stations	3	0	0	3
2		21MEMEP504B	Nano Technology	3	0	0	3
3		21MEMEP504C	Industrial Robotics with Artificial Intelligence	3	0	0	3
4		21MEMEP504D	Advanced Materials	3	0	0	3
5		21MEMEP504E	Industrial Management	3	0	0	3
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

III B. Tech. VI Semester Course Structure for the Regulation SITE 21

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PCC	21MEMET6010	CAD/CAM/CIM	3	0	0	3
2	PCC	21MEMET6020	Finite Element Methods	3	0	0	3
3	PCC	21MEMET6030	Heat Transfer	3	0	0	3
4	PEC	21MEMEP604X	Professional Elective-II	3	0	0	3
5	OEC	21MEXXO605X	Open Elective Course-II	3	0	0	3
6	PCCL	21MEMEL6060	CAD/CAM Lab	0	0	3	1.5
7	PCCL	21MEMEL6070	Heat Transfer Lab	0	0	3	1.5
8	PCCL	21MEMEL6080	Instrumentation and Mechatronics Lab	0	0	3	1.5
9	SOC	21CMAHS6090	Soft Skills & Aptitude Builder - 2	1	0	2	2
10	MC	21CMBIN6100	Biology for Engineers	2	0	0	0
11	I/RI	Research Internship - 2 Months (Mandatory) after Third year (to be evaluated during VII semester					
			Total	**18**	**0**	**11**	**21.5**
12	H/M		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)	4	0	0	4

Professional Elective-II

S. No.	CC	Subject Code	Name of the subject	L	T	P	Cr
1	PEC	21MEMEP604A	Gas Dynamics and Jet Propulsion	3	0	0	3*
2		21MEMEP604B	Mechanical Vibrations	3	0	0	3*
3		21MEMEP604C	Instrumentation and Mechatronics	3	0	0	3*
4		21MEMEP604D	Unconventional Machining Processes	3	0	0	3*
5		21MEMEP604E	Energy Management	3	0	0	3*
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

IV B. Tech. VII Semester Course Structure for the Regulation SITE 21

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP701X	Professional Elective-III	3	0	0	3
2	PEC	21MEMEP702X	Professional Elective-IV	3	0	0	3
3	PEC	21MEMEP703X	Professional Elective-V	3	0	0	3
4	OEC	21MEXXO704X	Open Elective Course-III	3	0	0	3
5	OEC	21MEXXO705X	Open Elective Course-IV	3	0	0	3
6	HSC	21MEMET7060	Operation Research	3	0	0	3
7	SOC	21MEMES7070	Modelling and Analysis (FEA)	1	0	2	2
8	I/RI	21MEMER7080	Research Internship - 2 Months (Mandatory) after Third year (to be evaluated during VII semester	0	0	6	3
			Total	**19**	**0**	**8**	**23**
9	H/M		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)	4	0	0	4

Professional Elective Course -III

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP701A	Prime Movers for Automobiles	3	0	0	3
2		21MEMEP701B	Mechanics of Composites	3	0	0	3
3		21MEMEP701C	Non – Destructive Evaluation	3	0	0	3
4		21MEMEP701D	Micro Electro Mechanical Systems	3	0	0	3
5		21MEMEP701E	Product Design and Development	3	0	0	3
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

Professional Elective Course -IV

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP702A	Refrigeration & Air Conditioning	3	0	0	3
2		21MEMEP702B	Synthesis and Characterization of Materials	3	0	0	3
3		21MEMEP702C	Smart Manufacturing and IIOT	3	0	0	3
4		21MEMEP702D	Tribology	3	0	0	3
5		21MEMEP702E	Hydrogen & Fuel Cells	3	0	0	3
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

Professional Elective Course -V

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP703A	Solar Energy Engineering and Applications	3	0	0	3
2		21MEMEP703B	Additive Manufacturing	3	0	0	3
3		21MEMEP703C	Production Planning and Control	3	0	0	3
4		21MEMEP703D	Machine Tool Design	3	0	0	3
5		21MEMEP703E	Computational Fluid Dynamics	3	0	0	3
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

IV B. Tech. II Semester Course Structure for the Regulation SITE 21

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	Project	21MEMER8010	Project, Seminar and Internship in Industry (6 months)	0	0	0	12
			Total	**0**	**0**	**0**	**12**

Comparison of suggested breakup of AICTE, APSCHE and SITE21Curriculum Credit Distribution for B.Tech. Mechanical Engineering Program

S.No.	Category	No. of Credits		
		Suggested by AICTE	APSCHE	Proposed SITE-21
1	Humanities and Social Sciences	9	10.5	10.5
2	Basic Science Courses	30	21	18
3	Engineering Science Courses	27	24	24
4	Professional Core Courses	50.5	51	54
5	Professional Elective Courses	18	15	15
6	Open Elective Courses	9	12	12
7	Project Work , Seminar and Internship	15	16.5	16.5
8	Skill oriented Courses	-	10	10
9	Mandatory Courses	-	-	-
Total Credits		160	160	160

Semester Wise Number of Credits of AICTE, APSCHE and SITE21Curriculum

SEMESTER	CREDITS			
	AICTE	APSCHE	JNTUK R20	SITE-21
I	17.5	19.5	19.5	19.5
II	20.5	19.5	19.5	19.5
III	23	21.5	21.5	20
IV	19	21.5	21.5	23
V	20.5	21.5	21.5	21.5
VI	21.5	21.5	21.5	21.5
VII	18.5	23	23	23
VIII	18	12	12	12
TOTAL	**160**	**160**	**160**	**160**

COURSE STRUCTUREAND SYLLABUS

SITE-21 REGULATIONS

For

I B.Tech. I Semester

Mechanical Engineering

I B. Tech. I Semester Proposed Course Structure for the Regulation SITE 21

S. No.	CC	Course code	Course Title	L	T	P	C
1	BSC	21CMMAT1010	Engineering Mathematics – I (Calculus and Differential Equations)	3	0	0	3
2	BSC	21EEPHT1020	Engineering Physics	3	0	0	3
3	BSC	21CMCHT1030	Engineering Chemistry	3	0	0	3
4	ESC	21CMCST1040	Programming for Problem Solving	3	0	0	3
5	ESC	21CMMEL1050	Engineering Graphics	2	0	2	3
6	BSC	21EEPHL1060	Engineering Physics Lab	0	0	3	1.5
7	BSC	21CMCHL1070	Engineering Chemistry Lab	0	0	3	1.5
8	ESC	21CMCSL1080	Programming for Problem Solving Lab	0	0	3	1.5
9	MC	21CMMSN1090	Constitution of India, Professional Ethics & Human Rights	2	0	0	0
TOTAL				**16**	**0**	**11**	**19.5**

ENGINEERING MATHEMATICS-I
(Calculus & Differential Equations)
(Syllabus for the academic year 2021 -2022)
Common to all the branches
SEMESTER - I/I

Subject Code	21CMMAT1010/20	IA Marks	30
Number of Lecture Hours/Week	3	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03

Credits – 03

Course Objectives:

1. To solve the differential equations related to various engineering fields
2. To enlighten the learners in the concept of differential equations.
3. To familiarize with functions of several variables which is useful in optimization
4. To solve the partial partial differential equations of first order
5. To apply double integration techniques in evaluating areas bounded by region.

Unit -1	
Differential Equations of first order and first degree: Linear differential equations - Bernoulli's equations – Exact equations and Equations reducible to exact form. Applications: Newton's law of cooling - Law of natural growth and decay - Orthogonal trajectories.	**Hours – 10**
Unit -2	
Linear differential equations of higher order: Homogeneous and Non-homogeneous differential equations of higher order with constant coefficients – with non-homogeneous term of the type e^{ax}, sin ax, cos ax, polynomials in x^n, e^{ax} V(x) and x^n V(x) – Method of Variation of parameters. Applications: LCR circuit.	**Hours – 10**
Unit – 3	
Partial differentiation: Introduction – Homogeneous function – Euler's theorem– Total derivative– Chain rule– Jacobian – Functional dependence –Taylor's and MacLaurin's series expansion of functions of two variables. Applications: Maxima and Minima of functions of two variables without constraints and Lagrange's method.	**Hours – 10**
Unit – 4	
PDE of first order: Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solutions of first order linear (Lagrange) equation and nonlinear (standard types) equations.	**Hours – 08**
Unit – 5	
Multiple integrals: Double and Triple integrals – Change of order of	**Hours –**

integration in double integrals – Change of variables to polar, cylindrical and spherical coordinates. Applications: Finding Areas and Volumes.	**12**

Course outcomes:

On completion of this course, students are able to

1. Solve the differential equations related to various engineering fields (L3)
2. Solve the differential equations of higher C order related to various engineering fields (L3)
3. familiarize with functions of several variables which is useful in optimization (L3)
4. Solve the partial partial differential equations of first order (L3)
5. Apply double integration techniques in evaluating areas bounded by region (L3).

Question paper pattern:

1. Question paper consists of 10 questions.
2. Each full question carrying 14 marks.
3. Each full question will have sub question covering all topics under a unit.
4. The student will have to answer 5 full questions selecting one full question from each unit.

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. Joel Hass, Christopher Heil and Maurice D. Weir, Thomas calculus, 14thEdition, Pearson.
3. Lawrence Turyn, Advanced Engineering Mathematics, CRC Press, 2013.
4. Srimantha Pal, S C Bhunia, Engineering Mathematics, Oxford University Press.

ENGINEERING PHYSICS (Introduction to Mechanics) (Common for ME & CE in I-Semester)			
Subject Code	21CEPHT1020 21MEPHT1020	IA Marks	30
Number of Lecture Hours/Week	03	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 03			

COURSE OBJECTIVES:

The objectives of this course, help the students

- **To explore** the knowledge of fundamental vibrations.
- **To impart** the concept of Newton's law of motion in central force field.
- **To enable** the students to understand the Rigid body dynamics.
- **To study** the structure- property relationship exhibited by solid materials with in the elastic limits.

Unit -1	
One Dimensional motion: Newton's Equation of motion in one dimension-examples of particle falling under a gravity, Simple harmonic motion (Mechanical oscillator) and its characteristics, damped harmonic motion (Mechanical oscillator) and damping conditions (over-damped, critically damped and under damped conditions), Forced oscillations (Mechanical oscillator) - un damped and damped conditions, Resonance.	**Hours – 11**
Unit -2	
Two dimensional motions: Two-Dimensional motion in the Cartesian coordinate system – Example of Projectile motion without air drag; Two-Dimensional motion in Radial polar coordinate system- Example of planetary motion, Kepler's laws and their deduction, Newton equations for variable mass system (rocket), Calculations of Centre of mass and its characteristics.	**Hours – 11**
Unit -3	
Conservative & Non-Conservative motion: Invariance of Newton's equations-Under shift of coordinate system - Galileo transformation - Accelerating frames of reference, Reference frame rotating with a constant angular velocity, Centrifugal Force-Apparent gravitational acceleration, Coriolis force -Effect of Coriolis force on a freely falling body. Conservative and Non-Conservative forces.	**Hours – 9**
Unit – 4	

Rigid body dynamics: Angular momentum of a single particle and system of particle, conservation of angular momentum; Equation of motion of a rigid body; Kinetic energy of a rigid rotating body; Moment of Inertia, Calculations of moment of inertia-rectangular lamina and Uniform cylinder (rod, circular disc); Parallel axis theorem and perpendicular axis theorem and their applications; Euler's equation describing rigid body motion.	**Hours – 10**
Unit – 5	
Elasticity: Stress, Strain, Hook's law, stress strain curve, generalized Hook's law with and without thermal strains for isotropic materials, Factors affecting the elastic behavior, energy stored per unit volume in stretched wire, different types of moduli and their relations, bending of beams, Bending moment of a beam, Depression of cantilever.	**Hours –9**

COURSE OUTCOMES:

On completion of the course student will able to

1. **Distinguish** the various harmonic motions and resonance.
2. **Apply** Newton's law of motion to understand the motions of mechanical systems.
3. **Verify** the invariance of Newton's equation of motion.
4. **Understand** the concept of conservative and non-conservative motions.
5. **Formulate** the rigid body dynamics.
6. **Study** the structure- elastic property correlation under load within the elastic limits.

QUESTION PAPER PATTERN:

1. It will have 5 questions with internal choice.
2. Each question carries 14 marks.
3. Each full question comprises sub questions covering all topics under a unit.

TEXT BOOKS:

1. Introduction to Mechanics — MK Verma.
2. A Text Book of Engineering Physics- M.N.Avadhanulu, 11e , S.CHAND,

REFERENCE BOOKS:

1. S.L Gupta& D.L. Gupta, Unified physics
2. An Introduction to Mechanics — D Kleppner & R Kolenkow
3. Principles of Mechanics — JL Synge & BA Griffiths.
4. Engineering Physics- Ch. Srinivas, Ch. Sesubabu Cengage learning.

WEB SOURCES:

W1: http://www.physics.org/news.asp
W2: http://www.phys.lsu.edu/newwebsite/lecturedemo/
W3: http://www.nptl.ac.in
W4: American Association of Physics Teachers [http://www.aapt.org/]

ENGINEERING CHEMISTRY SEMESTER - I/I			
Subject Code	21CMCHT1030/ 2030	IA Marks	30
Number of Lecture Hours/Week	3	Exam Marks	70
Total Number of Lecture Hours	48	Exam Hours	03
Credits – 03			

COURSE OBJECTIVES:

The objectives of this course, help the students to

1. Explain the mechanism of corrosion
2. Interpret various boiler troubles and importance of water quality standards.
3. Learn preparation of semiconducting materials, nanomaterials and liquid crystals – their applications
4. Acquire knowledge on nonconventional energy resources and different types of batteries
5. Know various spectroscopic techniques.
6. Acquire knowledge on volumetric analysis.

Module-1	
ELECTROCHEMISTRY AND CORROSION **Electro chemistry:** Introduction, electrode potential, standard electrodes – Hydrogen and Calomel electrodes, Nernst equation and applications. **Corrosion:** Introduction, Mechanism of Wet chemical corrosion, control methods – proper designing, cathodic protection- Sacrificial anodic and impressed current cathodic protection.	**Hours –9**
Module -2	
WATER CHEMISTRY AND SURFACE PROPERTIES **Water chemistry:** Surface and subsurface water quality parameters – turbidity, pH, total dissolved salts, chloride content, Hardness of water, Temporary and Permanent hardness, Units, determination of hardness by complexometric method. Boiler troubles, Caustic Embrittlement, Priming and foaming, Boiler corrosion. Break point chlorination. **Surface properties:** Determination of surface tension and viscosity of liquids.	**Hours –9**
Module -3	

MATERIAL CHEMISTRY **Non-elemental semiconducting materials:** Stoichiometric, controlled valency and chalcogen photo/semiconductors and preparation of semiconductors (distillation, zone refining, Czochralski crystal pulling, epitaxy, diffusion and ion implantation). **Liquid crystals:** Introduction, types and applications. **Nanoparticles**: Introduction, preparation methods – Sol-gel method, Chemical reduction method – Preparation of carbon nanotubes (Arc discharge, chemical vapour deposition and laser ablation methods) properties and applications.	**Hours – 10**
Module – 4	
ENERGY SOURCES: **Non-conventional energy sources,** Design, working, schematic diagram, advantages and disadvantages of photovoltaic cell,hydropower, geothermal power, tidal and wave power, ocean thermal energy conversion. **Batteries and fuel cells:** Primary and secondary batteries - Dry cell, Lead Acid Cell, Lithium-ion battery and Zinc air cells and fuel cells - H_2-O_2, CH_3OH-O_2, Phosphoric acid and molten carbonate.	**Hours – 10**
Module – 5	
SPECTROSCOPY AND CHROMATOGRAPHY TECHNIQUES Regions of electromagnetic spectrum - Principles of vibrational and rotational spectroscopy. Vibrational and rotational spectroscopy of diatomic molecules: Rigid diatomic molecules - selection rule - simple Harmonic Oscillator - diatomic vibrating rotator. Nuclear magnetic resonance – Principle and Instrumentation. Principles of chromatography – Thin Layer & Paper Chromatography.	**Hours – 10**
COURSE OUTCOMES: On completion of the course student will be able to 1. Interpret the mechanism of corrosion 2. Summarize the problems faced in industries due to boiler troubles. 3. Recall the properties and applications of advanced materials. 4. Summarize the advantages of non-conventional energy resources and batteries. 5. Able to gain knowledge on spectroscopic techniques and the ranges of the electromagnetic spectrum used for exciting different molecular energy levels. 6. Determine the strength of acid, base and some elements by volumetric	

and instrumental analysis.

QUESTION PAPER PATTERN:

1. It will have 5 questions with internal choice.
2. Each question carries 14 marks.
3. Each full question comprises sub questions covering all topics under a unit.

TEXT BOOKS:

1. P.C. Jain and M. Jain "**Engineering Chemistry**", 15/e, Dhanpat Rai & Sons,Delhi,
2. Shikha Agarwal, "**Engineering Chemistry**", Cambridge University Press, (2019)
3. S.S. Dara, "**A Textbook of Engineering Chemistry**", S.Chand & Co, (2010).
4. Shashi Chawla, "Engineering Chemistry", Dhanpat Rai Publicating Co. (Latest edition).
5. Fundamentals of Molecular Spectroscopy, by C. N. Banwell.

REFERENCE BOOKS:

1. K. Sesha Maheshwaramma and Mridula Chugh, "**Engineering Chemistry**", Pearson India Edn.
2. O.G. Palana, "**Engineering Chemistry**", Tata McGraw Hill Education Private Limited, (2009).
3. CNR Rao and JM Honig (Eds) "**Preparation and characterization of materials**" Academic press, New York (latest edition)

PROGRAMMING FOR PROBLEM SOLVING SEMESTER - I/I			
Subject Code	21CMCST1040	IA Marks	30
Number of Lecture Hours/Week	03	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 03			

COURSE OBJECTIVES:

The Objectives of Programming for problem solving are:

- To learn about C programming language syntax, semantics, and the runtime environment.
- To be familiarized with general computer programming concepts like data types, conditional statements, loops and functions.
- To be familiarized with general coding techniques and procedure-oriented programming.

Unit -1	
History& Hardware: (TB 1: 1-22) Computer Hardware, Components, Types ofSoftware, Memory Units. **Introduction to Problem solving:(TB1:33-50)** Algorithm, Characteristics of Algorithms, Basic Operations of Algorithms, Pseudo Code, Flowchart, Types of Languages, Relation between Data, Information, Input and Output. **Basics of C: (TB1:58-67)** History and Features of C, Importance of C, Procedural Language, Compiler versus Interpreter, Structure of C Program, Program Development Steps, Programming Errors.	**Hours – 11**
Unit -2	
Overview of C:(TB:68-125) Character Set, C-Tokens, Data Types, Variables, Constants, Operators, Operator Precedence and Associativity, Converting Mathematical Expressionsto C-expressions, Evaluation of C-Expressions, Input/Output Functions. **Conditional Branching:(TB1:143-152)** if statement, if…else statement, Nested if…else statement, if…else…if ladder, switch statement. **Unconditional Branching:(TB1:174-175)** goto. Control flow Statements: break, continue. **Looping Constructs:(TB1:156-170)** do-while statement, while statement, for statement.	**Hours – 11**

Unit -3	
Arrays:(TB1:188-222) Introduction, 1-D Arrays, Character arrays and string representation, 2-D Arrays (Matrix), Multi-Dimensional Arrays. **Strings:** Working with Strings, String Handling Functions (both library and user defined). **Functions:(TB1:230-260)** Basics, Necessity and Advantages, Types of Functions, Parameter Passing Mechanisms, Recursion, Storage Classes, Command Line Arguments, Conversion from Recursion to Iteration and Vice-Versa.	**Hours – 9**
Unit – 4	
Pointers:(TB1:288-347) Understanding Pointers, Pointer Expressions, Pointer and Arrays, Pointers and Strings, Pointers to Functions. Dynamic Memory Allocation: Introduction to Dynamic Memory Allocation- malloc (), calloc (), realloc (), free (). **Structures and Unions:(TB1:370-394)** Defining a Structure, typedef, Advantage of Structure, Nested Structures, Arrays of Structures, Structures and Arrays, Structures and Functions, Structures and Pointers, Defining Unions, Union with in Union, Structure within Union, Unionwithin Structure, Self-Referential Structures, Bitfields, Enumerations.	**Hours – 10**
Unit – 5	
Preprocessing Directives:(TB2:325-333) Macro Substitution, File Inclusion, Conditional Compilation and Other Directives **File Management In C:(TB1:408-422)** Introduction to File Management, Modes and Operations on Files, Types of Files, Error Handling during I/O Operations.	**Hours –9**
COURSE OUTCOMES: On completion of the course student can able to 1. Demonstrate computer components, algorithms, translate them into pro 2. Choose the suitable control structures for the problem to be solved. 3. Make use of arrays, pointers, structures, and unions effectively. 4. Organize reusable code in a program into functions. 5. Demonstration of file operations.	
QUESTION PAPER PATTERN: 1. It will have 5 questions with internal choice. 2. Each question carries 14 marks. 3. Each full question comprises sub questions covering all topics under a unit.	

TEXT BOOKS:

1. Programming in C ,Pradip Dey ,Manas Ghosh, OXFORD
2. Programming in ,C Reema Thareja,Second Edition, OXFORD
3. Programming for Problem Solving, Behrouz A. Forouzan, Richard F.Gilberg, CENGAGE.

REFERENCE BOOKS:

1. Computer Fundamentals and Programming, Sumithabha Das, Mc Graw Hill.
2. Programming in C, Ashok N. Kamthane, Amit Kamthane, Pearson.

ENGINEERING GRAPHICS SEMESTER - I/I			
Subject Code	21CMMEL1050	IA Marks	30
Number of Lecture Hours/Week	2(L)+02(P)	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 03			

COURSE OBJECTIVES:

Upon successful completion of the course, **s**tudents should be able to

1. construct polygons, scales, engineering curves (parabola, ellipse, hyperbola, cycloids, involutes)
2. draw orthographic projections of points, lines and planes.
3. draw the orthographic projections of simple solids
4. draw sectional views of solids
5. convert given isometric view into orthographic view and vice versa using AutoCAD software.

Unit -1	
Introduction to Engineering Drawing covering Principles of Engineering Graphics and their significance, usage of drawing instruments, lettering, Conic sections – Ellipse, Parabola, Hyperbola (Eccentricity method only); plain Cycloid, and Involutes; Scales – Plain and Vernier scales only.	**Hours – 10**
Unit -2	
Projections of Points, Projections of straight lines and the line inclined to both planes; Projections of planes (inclined to one reference plane only).	**Hours – 8**
Unit -3	
Projections of regular polyhedrons – tetrahedron, hexahedron, octahedron (axis inclined to one reference plane only). Projections of irregular polyhedrons – Prisms, Pyramids, Cones and Cylinders (axis inclined to one reference plane only).	**Hours – 8**
Unit – 4	
Sectional Views of Right Angular Solids covering Prism, Cylinder, Pyramid and Cone	**Hours – 12**
Unit – 5	
Introduction to AutoCAD - The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension Tools), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and Windows. Isometric Projections, Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.	**Hours –12**

COURSE OUTCOMES:

Upon the successful completion of this course, the students will be able to

1. Construct polygons, scales and engineering curves
2. Draw the orthographic views of points, lines and planes
3. Construct the projections of regular and irregular polyhedrons
4. Draw the sectional views of solids
5. Draw isometric/orthographic views using AutoCAD

QUESTION PAPER PATTERN:

1. It will have 5 questions with internal choice.
2. Each question carries 14 marks.
3. Each full question comprises sub questions covering all topics under a unit.

TEXT/REFERENCE BOOKS:

1. N.D. Bhatt, Engineering Drawing, Charotar Publications
2. R.B.Choudary, Engineering Drawing, Anuradha Publishers
3. Agarwal & Agarwal, Engineering Drawing , Tata McGraw Hill Publishers
4. K.L.Narayana & P.Kannaiah, Engineering Drawing Scitech Publishers
5. K.C. John, Engineering Graphics for Degree, PHI Publishers
6. PI Varghese, Engineering Graphics, McGrawHill Publishers
7. K Venugopal, V. Prabhu Raja, Engineering Drawing + AutoCAD, New Age

ENGINEERING PHYSICS LAB (Common for ME & CE in I-Semester)			
Subject Code	21MEPHL1060 21CEPHL1060	IA Marks	15
Number of Practice Hours/Week	03	Exam Marks	35
Total Number of Practice Hours	36	Exam Hours	03
Credits – 1.5			

COURSE OBJECTIVES:

The objectives of this course, help the students

- **To apply** the theoretical knowledge of Physics through hands on the experimental instruments
- **To improve** the experimental knowledge in the later studies
- **To understand** the basic need of experiments.
- **To know** how to measure the different physical quantities.
- **To acquire** ability to use instrumentation techniques.
- **To train** the students to develop techniques based on the principles related to various devices or components.

List of Experiments

1. Investigation of the Motion of Coupled Oscillators.
2. Determination of the rigidity modulus η of wire-Torsional pendulum.
3. Determination of acceleration due to gravity g and radius of gyration K - Compound pendulum.
4. Determination of the Frequency of an electrically maintained tuning fork by Melde's Experiment.
5. Determination of the velocity of sound in air-Volume resonator.
6. Verification of the laws of transverse vibrations of stretched wire.
7. Determination of the Young's modulus and draw load depression graph in uniform bending.
8. Determination of the Moment of Inertia of a Flywheel.
9. Verification of the parallel axis and perpendicular axis theorems and determine the moment of inertia of a regular rectangular body - Bifilar pendulum.
10. Determination of the frequency of the AC Source using Sonometer.

Demonstration experiments:

1. Determination of Young's Modulus, Modulus of rigidity and Poisson's ratio of the material of a given wire by Searle's dynamical method
2. Study of the variation of moment of inertia of a system with the variation in the distribution of mass and hence to verify the theorem of parallel axes (Maxwell' needle method).

TEXT BOOKS:

1. "*Physics Laboratory Manual*" Prepared by Department of Physics, SITE.

REFERENCE BOOKS:

1. S. Balasubrahmanian, M.N. Srinivasan "A Text book of Practical Physics"- S. Chand Publishers, 2017.
2. Advanced Practical Physics Vol 1& 2 SP Singh & M.S Chauhan Pragati Prakashan, Meerut.

WEB SOURCES:

1. http://vlab.amrita.edu/index.php -Virtual Labs, Amrita University

COURSE OUTCOMES:

On completion of the course student will able to

1. **Compare** the theory and correlated with experiments
2. **Design** experiments
3. **Analyze** the experimental result
4. **Apply** appropriate techniques to perform the experiments
5. **Apply** the knowledge in simple harmonic motions and resonance to understand the rigid body dynamics**.**
6. **Verify** the parallel axis and perpendicular theorems of moment of inertia**.**

ENGINEERING CHEMISTRY LABORATORY SEMESTER - I/I			
Subject Code	21CMCHL1070/ 2070	IA Marks	15
Number of Practice Hours/Week	3	Exam Marks	35
Total Number of Practice Hours	36	Exam Hours	03
Credits – 1.5			

List of Experiments

(Any 10 experiments must be conducted)

1. Determination of HCl using standard Na2CO3 solution
2. Determination of alkalinity of a sample containing Na2CO3 and NaOH
3. Determination of surface tension
4. Determination of viscosity of a liquid by Ostwald viscometer
5. Determination of chloride content of water
6. Determination total hardness of water by EDTA.
7. Determination of Mg^{+2}using standard oxalic acid solution.
8. Determination of Cu^{+2}using standard hypo solution.
9. Determination of the rate constant of first order reaction (Ester hydrolysis)
10. Determination of strength of strong acid using conductometeric titration.
11. Determination of strength of weak acid using conductometeric titration .
12. Determination of Ferrous iron using potentiometer.
13. Chemical oscillations- Iodine clock reaction
14. Estimation of Vitamin C.

Demonstration Experiments

1. Thin Layer Chromatography
2. Determination of $Fe^{+3}$by a colorimetric method.

PROGRAMMING FOR PROBLEM SOLVING LAB SEMESTER - I/I			
Subject Code	21CMCSL1080	IA Marks	15
Number of Practice Hours/Week	03	Exam Marks	35
Total Number of Practice Hours	48	Exam Hours	03
Credits – 1.5			

COURSE OBJECTIVES:

The objectives of this course, help the students

1. To understand the various steps in Program development.
2. To understand the basic concepts in C Programming Language.
3. To learn how to write modular and readable C Programs.
4. To learn to write programs (using structured programming approach) in C to solve problems.
5. To introduce basic data structures such as lists, stacks and queues.

LIST OF EXPERIMENTS

Exercise 1 (Familiarization with programming environment)

a) Familiarization of CODE BLOCKS C++ Editor to edit, compile, execute, test and debugging C programs.
b) Familiarization of RAPTOR Tool to draw flow charts and understand flow of control.
c) Acquaintance with basic LINUX commands.

Exercise 2 (Simple computational problems using arithmetic expressions)

a) Write a C Program to display real number with 2 decimal places.
b) Write a C Program to convert Celsius to Fahrenheit and vice versa.
c) Write a C Program to calculate the area of triangle using the formula area = $\sqrt{}$ (s(s−a)(s−b)(s −c) where s=a+b+c/2.
d) Write a C program to find the largest of three numbers using ternary operator.
e) Write a C Program to swap two numbers without using a temporary variable.

Exercise 3 (Problems involving if-then-else structures)

a) Write a C Program to check whether a given number is even or odd using bitwise operator, shift operator and arithmetic operator.
b) Write a C program to find the roots of a quadratic equation.
c) Write a C Program to display grade based on 6 subject marks using if…else…if ladder.
d) Write a C program, which takes two integer operands and one operator form the user, performs the operation and then prints the result using switch control statement.(Consider the operators +, -,*,/, %)

Exercise 4 (Iterative problems)

a) Write a C Program to count number of 0's and 1's in a binary representation of a given number.
b) Write a C program to generate all the prime numbers between two numbers supplied by the user.
c) Write a C Program to print the multiplication table corresponding to number supplied as input

Exercise 5 (Iterative problems)

a) Write a C Program to Find Whether the Given Number is i)Armstrong Number ii)
Palindrome Number
b) Write a C Program to print sum of digits of a given number

Exercise 6 (Series examples)

a) Write a C Program to calculate sum of following series
b) 1+2+3+…. n b)1+1/2+1/3+……+1/n c)1+x+x2+x3……+xn

Exercise 7 (1D Array manipulation)

a) Write a C program to interchange the largest and smallest numbers in the array.
b) Write a C program to search an element in an array (linear search).
c) Write a C Program to print the following pattern using a character array SA SAS
SASI

Exercise 8 (Matrix problems, String operations)

a) Write a C program to add two matrices.
b) Write a C program to multiply two matrices if they are compatible or print an error message "incompatible matrix sizes" otherwise.
c) Write a C program to check given matrix is symmetric or not.
d) Implement the following string operations with and without library functions. i)copy

ii) concatenate iii) lengthiv) compare

Exercise 9 (Simple functions)

a) Write a C Program demonstrating the following function types
   i. With arguments and with return value.
   ii. With arguments and without return value.
   iii. Without arguments and without return value.
   iv. Without arguments and with return value.
b) Write a C Program illustrating call by reference.

Exercise 10 (Recursive functions)

Write a C Program illustrating the following with Recursion without Recursion

a) Factorial b) GCD c) Power d) Fibonacci

Exercise 11(Pointers and structures)

a) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using malloc ()

function.

b) Write a C program to find sum of n elements entered by user. To perform this program, allocate memory dynamically using calloc () function.

Note: Understand the difference between the above two programs.

c)Write a C Program to read and print student details using structures.

Exercise 12 (File operations)

a) Write a C program to open a file and to print it contents on screen.

b) Write a C program to copy files.

c)Write a C program merges two files onto a new file.

d)Write a C program to delete a file.

COURSE OUTCOMES:

1. Attain knowledge on using CODE BLOCKS and RAPTOR tools in solving problems.
2. Examine and analyze alternative solutions to a problem.
3. Design an algorithmic solution to a problem using problem decomposition and step- wise refinement.
4. Demonstrate conversion of iterative functions to recursive and vice-versa.
5. Implement the concepts of arrays, structures, Unions and files.

Text Books:

1. Computer Programing ANSI C, E Balagurusamy, Mc Graw Hill Education (Private), Limited
2. Programming in C, ReemaThareja, Second Edition, Oxford Higher Education

Reference Books:

1. Computer Basics and C Programming, V Raja Raman, Second Edition, PHI (RB1)

CONSTITUTION OF INDIA, PROFESSIONAL ETHICS & HUMAN RIGHTS SEMESTER - I/I			
Subject Code	21CMMSN1090	IA Marks	30
Number of Lecture Hours/Week	03	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 00			

COURSE OBJECTIVES:

The objectives of this course help the students to

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications.

Unit - I	
Introduction to the Constitution of India, The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations.	**Hours – 10**
Unit - II	
Directive Principles of State Policy & Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India.	**Hours – 10**
Unit – III	
State Executives – Governor, Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th &91st Amendments.	**Hours – 10**
Unit –IV	
Special Provision for SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. Human Rights –Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co - Operative Societies.	**Hours – 10**
Unit – V	
Scope & Aims of Engineering Ethics, Responsibility of Engineers Impediments to Responsibility. Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering.	**Hours – 10**

COURSE OUTCOMES:

On completion of the course student will

1. Have general knowledge and legal literacy and thereby to take up competitive examinations.
2. Understand state and central policies, fundamental duties.
3. Understand Electoral Process, special provisions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies, and
5. Understand Engineering ethics and responsibilities of Engineers
6. Understand Engineering Integrity & Reliability

QUESTION PAPER PATTERN:

1. It will have 5 questions with internal choice.
2. Each question carries 14 marks.
3. Each full question comprises sub questions covering all topics under a unit.

TEXT BOOKS:

1. Durga Das Basu: **"Introduction to the Constitution on India",** (Students Edn.) Prentice –Hall EEE, 19th / 20th Edn., 2001
2. Charles E. Haries, Michael S Pritchard and Michael J. Robins **"Engineering Ethics"** Thompson Asia, 2003-08-05.

REFERENCE BOOKS:

1. M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
2. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, **"Engineering Ethics",** Prentice –Hall of India Pvt. Ltd. New Delhi, 2004
3. Brij Kishore Sharma, **"Introduction to the Constitution of India"**, PHI Learning Pvt. Ltd., New Delhi, 2011.
4. Latest Publications of Indian Institute of Human Rights, New Delhi

COURSE STRUCTUREAND SYLLABUS

SITE-21 REGULATIONS

For

I B.Tech. II Semester

Mechanical Engineering

I B. Tech. II Semester Proposed Course Structure for the Regulation SITE 21

S. No.	CC	Course code	Course Title	L	T	P	C
1	HSC	21CMEGT2010	Technical English	3	0	0	3
2	BSC	21CMMAT2020	Engineering Mathematics – II (Linear algebra, Laplace Transforms and Numerical Methods)	3	0	0	3
3	ESC	21CMEET2030	Basic Electrical Engineering	3	0	0	3
4	ESC	21CMCST2040	Python Programming	1	0	4	3
5	ESC	21EEMET2050	Engineering Mechanics	3	0	0	3
6	HSC	21CMEGL2060	English Communication Skills Lab	0	0	3	1.5
7	ESC	21CMEEL2070	Basic Electrical Engineering Lab	0	0	3	1.5
8	ESC	21CMMEL2080	Engineering Workshop Lab	0	0	3	1.5
9	MC	21CMCHN2090	Environmental Science	2	0	0	0
			TOTAL	**15**	**0**	**13**	**19.5**

TECHNICAL ENGLISH (Approved Syllabus for the Academic Year 2021-22 Semester I/II			
Subject Code	21CMEGT 1010/ 2010	IA Marks	30
Number of Lecture Hours/ Week	03	Exam Marks	70
Total Number of Lecture Hours	50	Exams Hours	03
Credits -03			

Course Objectives:

To enable the students to learn and apply fundamental principles in Technical English & Communication by focusing on:

1. Technical English Vocabulary
2. Writing Skills
3. Common Errors in Writing
4. Nature and Style of Sensible Technical Writing
5. Writing Technical Reports and Letters

Unit I	
Principles of Scientific Vocabulary • Principles of Scientific vocabulary: short and simple words- compact substitutes for wordy phrases- redundant words and expressions-Avoid hackneyed and stilted phrases, verbosity and incorrect use of words • The role of roots in word building, prefixes and suffixes, confusing words and expressions.	10 hours
Unit II	
Writing Skills • Distinguishing between academic and personal styles of writing • Use of clauses in technical phrases and sentences • Techniques of Sentence and paragraph writing • Measuring the clarity of a text through Fog Index or Clarity Index	10 hours
Unit III	
Common Errors in Writing • Subject-verb agreement and concord of nouns, pronouns and possessive adjectives • Common errors in the use of articles, prepositions, adjectives and adverbs • Punctuation • Technical Guidelines for Communication • Avoiding the pitfalls	10 hours
Unit IV	
Nature and Style of Sensible Technical Writing • Academic Writing Process	10 hours

• Describing, processes and products • Defining, Classifying • Effective use of charts, graphs, and tables	
Unit V	
Report writing and Letter writing • Writing Technical Reports • Précis writing • Letter Writing • Essay writing	10 Hours

COURSE OUTCOMES

On Completion of the course student will acquire

1. Ability to understand Scientific vocabulary and use them confidently
2. Familiarity with the basic principles of writing clear sentences and paragraphs
3. Ability to write error free simple technical passages
4. Knowledge of writing different writing styles
5. Confidence to write letters and technical reports clearly and coherently

QUESTION PAPER PATTERN

Section –A

1. 10 questions carrying one mark each
2. Five questions each from Units I and III

Section –B

1. 5 questions carrying 12 marks each (one compulsory question from non-detailed text)
2. Each question will have two or three sub questions covering all the units

TEXT BOOKS

1. Effective Technical Communication by Barun K Mitra, Oxford University Publication

Non-detailed Text

1. Karmayogi: A Biography of E Sreedharan by M S Ashokan

REFERENCE BOOKS

1. Communication Skills by Sanjay Kumar & Pushpa Latha, OUP
2. Study Writing by Liz Hamp-Lyons and Ben Heasly, Cambridge University Press.
3. Remedial English Grammar by F T Wood, Macmillian 2007
4. Practical English Usage by Michael Swan Oxford University Press
5. English Collocations in Use by Michael McCarthy & Felicity O'Dell
6. Effective Technical Communication by Arsahf Rizvi,
7. Essential English Grammar by Raymond Murphy, CUP, 2017

ENGINEERING MATHEMATICS-II (Linear algebra, Laplace transforms & Numerical Methods) SEMESTER - I/II			
Subject Code	21CMMAT2020	IA Marks	30
Number of Lecture Hours/Week	3	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 03			

Course objectives:

To enable students to apply the knowledge of Mathematics in various engineering

fields by making them to learn the following'

1. To develop the use of matrix algebra techniques that is needed by engineers for practical applications and solve system of linear equations
2. To find the inverse and power of a matrix by Cayley-Hamilton theorem and reduce the Quadratic form
3. To solve initial value problems by using Laplace transforms
4. To find the solution of algebraic/ transcendental equations and also interpolate the functions.
5. To apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations.

Unit -1	
Solving systems of linear equations: Rank of a matrix by echelon form and normal form – Solving system of homogeneous and non homogeneous linear equations – Gauss Elimination method- Jacobi and Gauss-Seidel methods for solving system of equations numerically.	**10 Hours**
Unit -2	
Eigen values and Eigen vectors, Cayley–Hamilton theorem and Quadratic forms: Eigen values and Eigen vectors and properties- Cayley-Hamilton theorem (without proof) – Reduction to Diagonal form – Quadratic forms and nature of the quadratic forms – Reduction of quadratic form to canonical forms by orthogonal transformation, Diagonalisation and Lagrange's reduction	**10 Hours**
Unit – 3	
Laplace Transforms: Laplace transforms – Definition and Laplace transforms of some certain functions– Shifting theorems – Transforms of derivatives and integrals – Unit step function – Dirac's delta function Periodic function – Inverse Laplace transforms– Convolution theorem (without proof). Applications: Solving ordinary differential equations (initial value problems) using Laplace transforms.	**10 Hours**

Unit – 4	
Numerical Methods: Introduction - Method of false position - Newton-Raphson method (One Variable) Introduction– Errors in polynomial interpolation – Finite differences– Forward differences– Backward differences –Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula.	**10 Hours**
Unit – 5	
Numerical integration, Solution of ordinary differential equations with initial conditions: Trapezoidal rule - Simpson's 1/3rd and 3/8th rule - Solution of initial value problems by Taylor's series– Picard's method of successive approximations– Euler's method – Runge -Kutta method (second and fourth order).	**10 Hours**
Course outcomes: On completion of this course, students are able to, 1. Develop the use of matrix algebra techniques that is needed by engineers for practical applications and solve system of linear equations (L6) 2. Find the inverse and power of a matrix by Cayley-Hamilton theorem and reduce the Quadratic form (L3) 3. Solve initial value problems by using Laplace transforms (L3) 4. Find the solution of algebraic/ transcendental equations and also interpolate the functions(L3) 5. Apply different algorithms for approximating the solutions of ordinary differential equations with initial conditions to its analytical computations (L3).	
Question paper pattern: 1. Question paper consists of 10 questions. 2. Each full question carrying 14 marks. 3. Each full question will have sub question covering all topics under a unit. 4. The student will have to answer 5 full questions selecting one full question from each unit.	
Text Books: 1. B. S. Grewal," Higher Engineering Mathematics", Khanna publishers, 44th Edition, 2016. 2. Kreyszig, "Advanced Engineering Mathematics " - Wiley, 9th Edition, 2013. 3. B.V.Ramana "Higher Engineering M athematics" Tata Mc Graw-Hill, 2006	
Reference Books: 1. Dr.K.V.Nageswara Reddy and Dr.B.Rama Bhupal Reddy, "Engineering Mathematics, Volume II" Scitech Publications, 2017.	

2. Steven C. Chapra, Applied Numerical Methods with MATLAB for Engineering and Science, Tata McGraw Hill Education, 4th Edition, 2018
3. M. K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publications, 3rd Edition, 2020.
4. Lawrence Turyn, Advanced Engineering Mathematics, CRC Press, 1st Edition 2014.

BASIC ELECTRICAL ENGINEERING SEMESTER I/II Common for ECE, CSE, IT/ CE, EEE, ME, ECT, CST, AI & ML			
Subject Code	21CMEET1030 /2030	IA Marks	30
Number of Lecture Hours/Week	3L + 1T	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits-03			

COURSE OBJECTIVES:

This course will enable student to

1. Understand basic electrical circuit operation.
2. Understand the concept of Alternating Voltage and Current.
3. Understand the operation of DC machines.
4. Understand the working of measuring instruments.
5. Understand the operation of different types of ac machines.
6. Understand the concept of Electrical Safety.

Unit -1	
Basic Electrical Circuits: Basic definitions (Electric Charge, Current, Electro Magnet Force, Potential Difference; Electric Power and Energy) – types of network elements – Ohm's Law – Kirchhoff's Laws –series & parallel circuits - network theorems (Super position, Thevinen's, Norton's, Maximum power transfer theorems)	**Hours – 10**
Unit -2	
AC Fundamentals & Basic Electromagnetic Laws: Study of AC Voltage and Current, RMS and Average Values, Three phase Star-Delta connections, Alternating Voltage applied to Pure Resistance, Inductance, Capacitance and their combinations, Concept of Power and Power Factor in AC Circuit. Concept of Magnetic Field, Magneto Motive Force (MMF), Permeability; Self and Mutual Induction, Basic Electromagnetic laws,	**Hours – 10**
Unit – 3	
DC Machines: DC Machine -Principle of operation & construction – emf equation- torque equation - speed control methods – losses and efficiency – brake test. applications of DC motors.	**Hours – 10**
Unit – 4	
AC Machines: Single Phase Transformers - Construction and Operation-Principles - Classification - Applications-OC & SC test of single phase transformer-regulation & Efficiency. Three Phase Induction Motors: working principle-construction, speed- torque characteristics-losses and	**Hours – 10**

efficiency.	
Unit – 5	
Electrical Safety: Electrical Shock and Precautions against it, Treatment of Electric Shock; Concept of Fuses and Their Classification, Selection and Application; Concept of Earthing.	**Hours – 10**
Course Outcomes: The student should be able to 1. Understand basic electrical circuit operation. 2. Understand the concept of Alternating Voltage and Current. 3. Understand the operation of DC machines. 4. Understand the working of measuring instruments. 5. Understand the operation of different types of ac machines. 6. Understand the concept of Electrical Safety.	
QUESTION PAPER PATTERN: 1. Question paper consists of 10 questions. 2. Each full question carrying 14 marks. 3. Each full question will have sub question covering all topics under a unit. 4. The student will have to answer 5 full questions selecting one full question from each unit.	
Text Books: 1. Electrical Circuit Theory and Technology by John Bird, Routledge Taylor &Francis Group. 2. Principles of Electrical Machines by V.K. Mehta & Rohit Mehta, S.Chand and Company Limited.	
Reference Books: 1. Theory and Performance of Electrical Machines by J.B. Gupta, S.K.Kataria & Sons. 2. A Textbook of Electrical Technology – Volume II: AC & DC Machines by B.L.Theraja & A.K. Theraja, S.Chand and Company Limited. 3. Basic Electrical Engineering by Nagsarkar, Sukhija, Oxford Publications, 2nd edition. 4. Basic Electrical Engineering by M.S.Naidu and S.Kamakshiah, TMH Publications 5. Fundamentals of Electrical Engineering by Rajendra Prasad, PHI Publications, 2nd edition. 6. Electrical Technology by Surinder Pal Bali, Pearson Publications.	

PYTHON PROGRAMMING SEMESTER I/II			
Subject Code	21CMCST2040	IA Marks	30
Number of Lecture Hours/Week	3	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits-03			

COURSE OBJECTIVES:

The Objectives of Python Programming are:

- To learn about Python programming language syntax, semantics, and the runtime environment.
- To be familiarized with general computer programming concepts like data types, conditional statements, loops and functions.
- To be familiarized with general coding techniques and object-oriented programming and Graphical User Interfaces.

Unit -1	
Introduction:(TB1:22-30, TB2:1.1-1.4, TB2:1.21-1.33) Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Variables, Reading Input from the Keyboard, Operators. **Data Types, and Expression: (TB1:41-59)** Strings Assignment, and Comment, Numeric Data Types andCharacter Sets, Type conversions, Expressions, Using functions and Modules. **Decision Structures and Boolean Logic:(TB1:77-85)** if, if-else, if-elif-else Statements, Nested Decision Structures, Comparing Strings, Logical Operators, Boolean Variables.	**Hours – 10**
Unit -2	
Control Statement:(TB1:65-72, TB1:86-91) Definite iteration for Loop Formatting Text for output, Selection if and if else Statement Conditional Iteration, The While Loop, Nested Loops. **Strings and Text Files:(TB1:103-125)** Accessing Character and Substring in Strings, Data Encryption, Strings and Number Systems, String Methods, Text Files.	**Hours – 10**
Unit – 3	
List and Dictionaries:(TB1:135-145, TB1:153-158) Lists, Tuples, Sets, Dictionaries. **Design with Function:(TB1:146-149, TB1:169-190)** Functions as Abstraction Mechanisms, Problem Solving with Top-Down Design, Design with Recursive Functions, Case Study Gathering Information from aFile System. **Modules**: **(TB2:8.1-8.5)** Modules, Standard Modules, Packages.	**Hours – 10**

Unit – 4	
File Operations:(TB1:122-123) Reading config files in python, Writing log files in python, Understanding read functions, read(), readline() and readlines(), Understanding write functions, write() and writelines().**Object Oriented Programming:(TB2:5.1-5.20, TB2:6.1-6.17)** Concept of class, object and instances, Constructor, class attributes and destructors, Inheritance. **Design with Classes:(TB1:294-301, TB1:309-330)** Objects and Classes, Data modeling Examples, Case Study an ATM.	**Hours – 10**
Unit – 5	
Errors and Exceptions:(TB2:7.1-7.8) Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, User-defined Exceptions, Defining Clean-up Actions, Redefined Clean-up Actions. **Graphical User Interfaces:(TB1:245-288)** The Behavior of Terminal Based Programs and GUI -Based,Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources.	**Hours – 10**

COURSE OUTCOMES:

After completion of this course student will able to learn

1. Explain the fundamental concepts in the Python language.
2. Implementation of python iterative statements and strings.
3. Demonstrate python lists, dictionaries, and functions.
4. Understand the concepts of modules and packages in python.
5. Complete coding challenges related to object-oriented programming.
6. Apply variety of error handling and GUI programming techniques.

QUESTION PAPER PATTERN:

1. Question paper consists of 10 questions.
2. Each full question carrying 14 marks.
3. Each full question will have sub question covering all topics under a unit.
4. The student will have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. Fundamentals of Python First Programs, Kenneth. A. Lambert, Cengage.
2. Python Programming: A Modern Approach, Vamsi Kurama, Pearson.

REFERENCE BOOKS:

1. Introduction to Python Programming, Gowrishankar.S, Veena A, CRC Press.
2. Introduction to Programming Using Python, Y. Daniel Liang, Pearson.

E-RESOURCES:

https://www.tutorialspoint.com/python3/python_tutorial.pdf

ENGINEERING MECHANICS SEMESTER I/II			
Subject Code	21CMMET2050	IA Marks	30
Number of Lecture Hours/Week	3(L)	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits - 03			

COURSE OBJECTIVES

On successful completion of the course, the students should be able to

1. understand the effect of forces and moments on the solid rigid bodies
2. analyze static problems using free body diagrams by considering friction.
3. locate centroid and calculate moment of inertia for different cross sections.
4. calculate velocity and acceleration of particles having rectilinear motion and rotation
5. analyze dynamic problems using work energy method and impulse-momentum method.

Unit -1	**Teaching Hours**
Introduction to engineering mechanics: Basic terminologies in mechanics, laws of mechanics, characteristics of force, system of force. **Resultant system of forces**: Resolution of forces, method of composition of forces, resultant of coplanar concurrent force system, moment of a force and couple. **Friction:** Frictional force, laws of Coulomb friction, angle of friction, limiting friction and angle of repose, problems on blocks resting on horizontal and inclined planes.	10 Hours
Unit -2	
Equilibrium of system of forces: Equilibrium of a rigid body subjected to coplanar concurrent forces and coplanar non-concurrent forces, free body diagrams, Lami's theorem, equilibrium of connected bodies.	9 Hours
Unit – 3	
Centroid and centre of gravity: Centre of gravity, centroid, use of axis symmetry determination of centroid of simple figures from first principles, centroid of composite sections. **Moment of inertia**: Moment of inertia, polar moment of inertia, theorems of moment of inertia, moment of inertia of rectangle, triangle, circle, semi circle, quarter circle from first principles, moment of inertia of L, T and I sections only. Mass moment of inertia, radius of gyration, mass moment of inertia of uniform rod, rectangular plate and circular plate only.	12 Hours

Unit-4	
Kinematics: General principles in dynamics, types of motion, rectilinear motion, motion curves, motion with uniform velocity, motion with uniform acceleration, motion with varying acceleration, angular motion, relationship between linear and angular motions. **Kinetics:** Bodies in rectilinear translation, kinetics of bodies rotating about fixed axes, Newton's second law of motion, D-Alembert's principle.	10 Hours
Unit - 5	
Work-Energy Method: Equation of Translation, work energy application to particle motion, connected system - Fixed axis rotation and plane motion, Impulse momentum method.	9 Hours

COURSE OUTCOMES

On completion of this course, students will be able to

1. determine resultant force and moment for different force systems.
2. analyse the rigid bodies associated with frictional forces using conditions of equilibrium
3. locate the centroid / center of gravity and determine the moment of inertia of plane sections/solids.
4. understand the behaviour of moving bodies in rectilinear motion and solve kinematic equations of motion curves.
5. solve the problem using work energy method and impulse momentum method.

QUESTION PAPER PATTERN:

1. Question paper consists of 10 questions.
2. Each full question carrying 14 marks.
3. Each full question will have sub question covering all topics under a unit.
4. The student will have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. S.S. Bhavikatti and K.G. Rajashekarappa, Engineering Mechanics2.
N.H. Dubey, Engineering Mechanics, Mc Graw Hill, 2012

REFERENCE BOOKS:

1 F. L. Singer, Engineering Mechanics, Harper–Collins, 1994
2. B. Bhattacharya, Engineering Mechanics, Oxford University Press, 2008
3. A.K.Tayal, Engineering Mechanics, Umesh Publications, 2012.
4. R.K.Bansal, Engineering Mechanics, Laxmi Publications, 1996.
5. R.K.Rajput, A Text book of Applied Mechanics, Laxmi Publications, 2011.
6. S.Timoshenko and D.H.Young, Engineering Mechanics, 4th Ed. 7. A.Nelson, Engineering Mechanics - Statics and Dynamics, TMG,

WEB REFERENCES

W1. https://nptel.ac.in/courses
W2. http://learnmech.com/

ENGLISH & COMMUNICATION SKILLS LAB Semester I/II			
Subject Code	21CMEGL1050/ 2050	IA Marks	15
Number of Practical Hours/Week	03	Exam Marks	35
Total Number of Practical Hours	36	Exam Hours	03
Credits – 1.5			

COURSE OBJECTIVES:

To enable the students to learn communication skills of Listening, Speaking, Reading and Writing by focusing on:

- Listening Comprehension
- Pronunciation
- Functional English in formal and Informal Situations
- Interpersonal Communication Skills
- Presentations

List of Experiments

UNIT I Listening Comprehension

UNIT II Pronunciation, Stress, Intonation & Rhythm

UNIT III Common Everyday Situations: Conversations & Dialogues; Communication at Workplace: Job Application letter, Email & Resume

UNIT IV Interpersonal Communication Skills-

UNIT V Formal Presentations

COURSE OUTCOMES:

By the end of the course the students will be able to acquire basic Proficiency in English by practicing the following:

1. Listening Comprehension
2. Pronunciation
3. Dialogues
4. Interpersonal Communication Skills
5. Presentations

LEARNING RESOURCES:

1. Interact – English Lab Manual for Undergraduate Students by Orient Black Swan
2. Ted Talks, Interviews with Achievers and select movies
3. Toastmaster's speeches and table topics
4. Book Reviews and movie reviews
5. Exercises in Spoken English Parts: I-III, CIEFL, Hyderabad.

6. Oxford Guide to Effective Writing and Speaking by John Seely
7. https://www.ted.com/talk

BASIC ELECTRICAL ENGINEERING LABORATORY

SEMESTER I/II

Common for ECE, CSE, IT/ CE, EEE, ME, ECT, CST, AI & ML

Subject Code	21CMEEL1070 /2070	IA Marks	15
Number of Lecture Hours/Week	3P	Exam Marks	35
Total Number of Lecture Hours	36	Exam Hours	03

Credits-1.5

COURSE OBJECTIVES:

This course will enable the student to

1. Verify the Kirchoff's laws, network theorems for a given circuit.
2. Analyze the performance of DC shunt generator.
3. Control the speed of DC motor.
4. Predetermine the efficiency DC machine.
5. Analyze performance of three phase induction motor.
6. Determine the regulation of an alternators.

List of Experiments (Any ten experiments must be conducted)

1. Verification of Kirchoff's laws.
2. Verification of Thevenin's Theorem.
3. Verification of Norton's Theorem.
4. Verification of Superposition theorem.
5. Verification of Maximum Power Transfer Theorem.
6. Speed control of D.C. shunt motor.
7. Brake test on DC shunt motor.
8. Calibration of wattmeter.
9. OC & SC tests on single-phase transformer.
10. Brake test on 1-phase Induction motor.
11. Brake test on 3-phase Induction motor.
12. Study experiment on Ear thing.

COURSE OUTCOMES:

On completion of the course student will be able to:

1. Verify the Kirchoff's laws.
2. Verify network theorems for a given circuit.
3. Control the speed of DC motor.
4. Analyze performance of single-phase induction motor
5. Analyze performance of three phase induction motor.
6. Identify different types of earthings

WORKSHOP PRACTISE LABORATORY			
Subject Code	21CMMEL2080	IA Marks	15
Number of Lecture Hours/Week	L (0) +T(0) +P(3)	Exam Marks	35
Total Number of Lecture Hours	36	Exam Hours	3

Credits – 1.5

COURSE OBJECTIVES:

On completion of the course students should be able to

1. Learn basic use of hand tools along with the techniques and methods applicable to the carpentry trade
2. Learn basic use of hand tools along with the techniques and methods applicable to the fitting trade
3. Learn basic use of hand tools along with the techniques and methods applicable to the forging trade
4. Learn basic use of hand tools along with the techniques and methods applicable to the casting trade
5. Learn basic use of hand tools along with the techniques and methods

EXPERIMENTS

1. Preparation of T Lap joint using carpentry.
2. Preparation of Cross Lap joint using carpentry.
3. Preparation of Square fit using mild steel specimen.
4. Preparation of V fit using mild steel specimen.
5. Conversion of round rod to square rod by forging operation.
6. Preparation of *S* hook by forging operation.
7. Preparation of green sand mould for a single piece pattern
8. Preparation of green sand mould for a split piece pattern
9. Preparation of a Butt joint using arc welding
10. Preparation of a Lap joint using arc Welding

ADDITIONAL EXPERIMENTS

1. Preparation of electrical wiring connections using wiring (one lamp controlled by one switch)
2. Preparation of house wiring (stair case wiring)

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

1. perform the joinery work of wooden pieces using carpentry.
2. perform the joinery work of metallic pieces using fitting.
3. produce the required shaped metallic products using black smithy.
4. make the green sand moulds using different patterns
5. fabricate different components using welding.

ENVIRONMENTAL SCIENCE			
Subject Code	21CMCHN1090/2090	IA Marks	30
Number of Lecture Hours/Week	2	Exam Marks	70
Total Number of Lecture Hours	32	Exam Hours	03
Credits – 00			

COURSE OBJECTIVES:

The objectives of this course, help the students to

1. Acquire knowledge on global environmental challenges.
2. Learn different types of natural resources
3. Create awareness on biodiversity and ecology.
4. Gain scientific knowledge on environmental pollution
5. Acquire knowledge on water conservation methods and environmental legislation

Module -1	
MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES **Environment -** Definition, Introduction - Scope and Importance - Global environmental challenges, global warming & climate change - Acid rains, ozone layer depletion - Role of Information Technology in Environment and human health.	**Hours – 6**
Module -2	
NATURAL RESOURCES Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use, deforestation - Timber extraction – Mining, dams and other effects on forest and tribal people Water resources – Floods, drought, , dams – benefits and problems Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. Food resources: Effects of modern agriculture - fertilizer-pesticide problems, water logging, eutrophication, biological magnification and salinity. Energy resources: Renewable and non-renewable energy resources Role of an individual in conservation of natural resources.	**Hours –6**
Module – 3	
ECOSYSTEM AND BIODIVERSITY **Ecosystem** - Concept of an ecosystem. - Structure and function of an ecosystem. - Producers, consumers and decomposers. - Energy flow in the ecosystem - Food chains, food webs and ecological pyramids. - Introduction, types, characteristic features, structure and function of the Forest and grassland ecosystem. **Biodiversity** - Introduction - Definition: genetic, species and ecosystem diversity. – Value of biodiversity: consumptive use, productive use, social, ethical and optional values - Hot-spots of	**Hours –8**

biodiversity - Threats to biodiversity: habitat loss - Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	
Module – 4	
ENVIRONMENTAL POLLUTION Definition, Cause, effects and control measures of : a. Air pollution b. Water pollution c. Soil pollution d. Noise pollution e. Nuclear hazards Solid waste Management: Causes, effects and control measures of urban and industrial wastes - Role of an individual in prevention of pollution.	**Hours –6**
Module – 5	
SOCIAL ISSUES AND THE ENVIRONMENT Urban problems related to energy -Water conservation, rain water harvesting, Resettlement and rehabilitation of people its problems and concerns. Environment Protection Act - Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act -Wildlife Protection Act -Forest Conservation Act .	**Hours –6**

COURSE OUTCOMES:

On completion of the course student will be able to

1. Obtain knowledge on global warming & climate change - Acid rains, ozone layer depletion.
2. Preserve several natural resources
3. Summarize the concept of ecosystem
4. Control different types of pollution
5. Understand social issues and environmental legislation

QUESTION PAPER PATTERN:

1. Question paper consists of 10 questions.
2. Each full question carrying 14 marks.
3. Each full question will have sub question covering all topics under a unit.
4. The student will have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. E. Bharucha (2003), “Environmental Studies”, University Publishing Company, New Delhi.
2. J.G. Henry and G.W. Heinke (2004), “Environmental Science and Engineering”, Second Edition, Prentice Hall of India, New Delhi.
3. G.M. Masters (2004)” Introduction to Environmental Engineering and Science”, Second Edition, Prentice Hall of India, New Delhi

REFERENCE BOOKS:

1. Text Book of Environmental Studies by Deeksha Dave & P. Udaya Bhaskar, Cengage Learning.
2. Environmental Studies by K.V.S.G. Murali Krishna, VGS Publishers, Vijayawada.
3. Environmental Studies, P.N. Palaniswamy, P. Manikandan, A. Geeta and K. Manjula Rani, Pearson Education, Chennai.

COURSE STRUCTURE AND SYLLABUS

SITE-21 REGULATIONS

For

II B.Tech. III Semester

Mechanical Engineering

II B. Tech. III Semester Proposed Course Structure for the Regulation SITE 21

S. No.	CC	Course Code	Course Title	L	T	P	C
1	BSC	21CMMAT3010	Engineering Mathematics -III (Vector Calculus and Complex Analysis)	3	0	0	3
2	ESC	21MEMET3020	Materials Engineering	3	0	0	3
3	PCC	21MEMET3030	Mechanics of Solids	3	0	3	3
4	PCC	21MEMET3040	Thermodynamics	3	0	0	3
5	PCC	21MEMET3050	Fluid Mechanics and Fluid Machines	3	0	3	3
6	ESC	21MEMEL3060	Mechanics of Solids &Materials Lab	0	0	3	1.5
7	PCC	21MEMEL3070	Fluid Mechanics and Fluid Machine s Lab	0	0	3	1.5
8	SOC	21MEMES3080	Computer Aided Engineering Drawing and Drafting (CAEDP)	1	0	2	2
9	MC	21MEECN3090	Basic Electronics Engineering	3	0	0	0
			Total	**19**	**0**	**14**	**20**

ENGINEERING MATHEMATICS-III
(Vector Calculus and Complex analysis)
SEMESTER - III

Subject Code	21CMMAT3010/20	IA Marks	30
Number of Lecture Hours/Week	3	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03

Credits – 03

COURSE OBJECTIVES:

1. To Interpret the physical meaning of different operators such as gradient, curl and divergence.
2. To Estimate the work done against a field, verify integral theorems.
3. To apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic
4. To find the differentiation and integration of complex functions used in engineering problems.
5. To make use of the Cauchy residue theorem to evaluate certain integrals.

Unit -1	
Vector Differentiation: Gradient– Directional derivative – Divergence – Curl - Scalar Potential.	**10**
Unit -2	
Vector Integration: Line integral - Work done – Area - Surface and volume integrals – Vector integral theorems: Greens, Stokes and Gauss Divergence theorems (without proof) and problems on above theorems.	**10**
Unit – 3	
Function of a complex variable Introduction –continuity –differentiability- analyticity – properties – Cauchy –Riemann equations in Cartesian and polar coordinates. Harmonic and conjugate harmonic functions – Milne – Thompson method.	**10**
Unit – 4	
Integration and series expansions Complex integration: Line integral – Cauchy's integral theorem, Cauchy's in integral formula, generalized integral formula (all without proofs) Radius of convergence – expansion in Taylor's series, Maclaurin's series and Laurent series.	**10**
Unit – 5	
Singularities and Residue Theorem Zeros of an analytic function, Singularity, Isolated singularity, Removable singularity, Essential singularity, pole of order m, simple pole, Residues, Residue theorem, Calculation of residues, Residue at a pole of order m**,** Evaluation of real definite integrals: Integration around the unit circle**,** Integration around semi-circle.	**10**

COURSE OUTCOMES:

On completion of this course, students are able to

1. Interpret the physical meaning of different operators such as gradient, curl and divergence(L5)
2. Estimate the work done against a field, and verify integral theorems (L5)
3. apply Cauchy-Riemann equations to complex functions in order to determine whether a given continuous function is analytic (L3)
4. find the differentiation and integration of complex functions used in engineering problems(L3)
5. Make use of the Cauchy residue theorem to evaluate certain integrals (L3)

QUESTION PAPER PATTERN:

Question paper consists of 10 questions.

1. Each full question carrying 14 marks.
2. Each full question will have sub question covering all topics under a unit.
3. The student will have to answer 5 full questions selecting one full question from each unit.

TEXT BOOKS:

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna Publishers.
2. B. V. Ramana, Higher Engineering Mathematics, 2007 Edition, Tata Mc. Graw Hill Education.

REFERENCE BOOKS:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, Wiley-India.
2. Srimantha Pal, S C Bhunia, Engineering Mathematics, Oxford University Press.
3. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 9th edition,
4. N.P.Bali and Manish Goyal, "A text book of Engineering mathematics", Laxmi publications, 7th Edition.
5. H.K. Dass and Er. Rajnish Verma, "Higher Engineering Mathematics", S.Chand publishing, 1st edition, 2011.

MATERIALS ENGINEERING SEMESTER-III			
Subject code	21MEMET3020	Internal marks	30
Number of lecture hours/Week	3(L)	External marks	70
Total No Of lecture hours	50	Exam hours	03
Credits-03			

COURSE OBJECTIVES:

Enable the students to

1. Classify different bonds in solids and understand crystallization of the metals for the formation of the solid solutions and alloy phases.
2. Understand about phase diagrams to identify the number and their variations of phases in Metallographic Structure.
3. Recognize the property requirements of a given application and suggest a suitable ferrous and non-ferrous metal and their alloys.
4. Understand about various heat treatment processes and its microstructure formation.
5. Understand the need for different polymers, ceramics and composites and their uses in the engineering field.

Unit-1	**Hours**
Structure of metals: Bonds in Solids – Metallic bond - crystallization of metals, grain and grain boundaries, effect of grain boundaries on the properties of metal / alloys – determination of grain size. **Constitution of alloys:** Necessity of alloying, types of solid solutions, Hume Rothery's rules, intermediate alloy phases, ductility, resilience, toughness and elastic recovery	**8**
Unit-2	
Phase Diagrams: Methods of construction of equilibrium diagrams, Isomorpous alloy systems, equilibrium cooling and heating of alloys, lever rule, eutectic systems, congruent melting intermediate phases, peritectic reaction Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of important binary phase diagrams of Fe-Fe_3C.	**10**
Unit-3	
Cast Irons: Structure and properties of white cast iron, malleable cast iron, grey cast iron, spheroid graphite cast iron, alloy cast irons. **Non-ferrous metals and alloys:** Classification of steels, structure and properties of plain carbon steels, low alloy steels, Hadfield manganese steels, tool and die steels. Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys	12

Unit-4	
Heat Treatments: Annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface-hardening methods (carburizing, carbo-nitriding, cyaniding, induction hardening and flame hardening), age hardening treatment, and cryogenic treatment of alloys. vacuum and plasma hardening.	**10**
Unit-5	
Ceramics, Polymers and composites: Crystalline ceramics, glasses, cermets, abrasive materials, nano materials –properties and applications. Classification, properties and applications of composites, Reinforced materials, fiber reinforced materials, metal ceramic mixtures, metal matrix composites. Structure, properties, and applications of polymers.	**10**

COURSE OUTCOMES:

1. understand the basic crystal structures and their relationship with the properties
2. Identify the phases, present in different alloy systems by analyzing the phase diagrams
3. understand the structure and properties of cast iron and nonferrous metals and alloys
4. Analyze various heat treatment process to change in physical properties in metals
5. Student is able to Know the structure and properties of different polymers, ceramic and composite materials

QUESTION PAPER PATTERN:

1. Question paper contains 10 questions,2 from each course outcomes,
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal choice)
3. All question carries 14 marks each
4. Each full question will have subquestion covering all topics under a course outcome

TEXT BOOKS:

1. Introduction to Physical Metallurgy, Sidney H. Avener, McGrawHill
2. Essential of Materials Science and Engineering, Donald R. Askeland, Thomson
3. Materials Science and Metallurgy, R.B.Choudary, Khanna Publishers

REFERENCE BOOKS:

1. Material Science and Metallurgy – V.D.Kodgire and S.V.Kodgire, Everest PublishingHouse
2. Materials Science and Engineering - Callister &Baalasubrahmanyam, Willey publications
3. Material Science for Engineering Students, Fischer, Elsevier Publishers

MECHANICS OF SOLIDS SEMESTER - III			
Subject Code	21MEMET3030	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives: Students should be able to

1. Calculate the stress and strain developed in any structural member due to applied external load.
2. Analyze the principal stress and principal strain at a point of a stressed member and draw shear force diagram and bending moment diagram for different types of beams under various loading and support conditions
3. Analyze shear stress distribution in solid members and Determine section modulus for various beam cross-sections
4. Calculate the slope, deflection and torsion at a specified point of a beam and design shafts subjected to different loads.
5. Analyze thin and thick shells under different pressure conditions

Unit -1	**Hours**
Introduction: Stress and strain definitions, types of stresses and strains, elasticity and plasticity. Hooke's law, stress-strain diagrams for engineering materials, modulus of elasticity. Poisson's ratio, relationship between elastic constants, linear and volumetric strains, bars of uniform strength, temperature stresses, compound bars.	**10**
Unit -2	
Compound stresses, principal stresses and strains. Mohr's circle of stresses **Beams:** Shear force and bending moment; relationship between intensity of loading, shear force and bending moment; bending moment and shear force diagrams for cantilever, simply supported beams.	**10**
Unit – 3	
Theory of Bending: Simple theory of bending, moment of resistance, modulus of section. **Shear Stresses in Beams:** Distribution of shear stresses in rectangular, triangular, circular, I and T-sections.	**10**
Unit – 4	
Slopes and Deflections: Slope and deflection measurements of cantilever, simply supported beams with Macaulay's and double integration methods subjected to point loads and uniformly distributed loads. **Torsion:** Derivation of torsion formula for circular section, torsional stresses, angle of twist, power transmission, effect of combined bending and torsion.	**10**

Unit – 5

Cylinders: Stresses in thin and thick cylinders with internal and external pressures. Hoop and longitudinal stresses in cylinders, stresses in compound cylinders.	**10**

Course outcomes:

On completion of this course, students able to

1. **Estimate** the stress and strain developed in any structural member due to applied external load.
2. **Analyze** the principal stress and principal strain at a point of a stressed members and **draw** shear force diagram and bending moment diagram for different types of beams under various loading and support conditions
3. **Analyze** shear stress distribution in solid members and calculate section modulus for various beam cross-sections
4. **Calculate** the slope, deflection and torsion at a specified point of a beam under different loads
5. **Analyze** thin and thick cylinders under different boundary conditions

QUESTION PAPER PATTERN:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carry 14 marks each

Each full question will have sub question covering all topics under a course outcome

TEXT BOOKS

1. S. S. Bhavikatti, Strength of Materials, Second Edition, Vikas Publishing House (P) Ltd., New Delhi, 2002
2. R.K. Rajput, Strength of Materials, Revised Edition, S. Chand & Co., New Delhi, 2007

REFERENCES BOOKS

1. R.K. Bansal, Introduction to Strength of Materials, Laxmi Publications, 2004
2. B.C. Punmia, A. K.Jain, and A. K. Jain, Strength ofMaterials and Theory of Structures, Vols. I & II, XIEdition, Laxmi Publications (P) Ltd, New Delhi, 2002.
3. E. J. Hearn, Strength of Materials, Pergamon Press,Oxford, 1997

THERMODYNAMICS SEMESTER III			
Subject Code	21MEMET3040	**IA Marks**	30
Number of Lecture Hours/Week	3(L)	**Exam Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

COURSE OBJECTIVES: Enable the students to

1. Gain the knowledge on the fundamentals of thermodynamics and temperature scales.
2. Apply First law of thermodynamics to various thermal engineering devices.
3. Understand the direction of second law of thermodynamics and concept of increase in entropy of universe.
4. Develop an idea on properties during various phases of pure substances using steam tables, Mollier chart and psychometric charts.
5. Acquire the knowledge of thermodynamics to air standard cycles, vapour power cycle and the properties of gas mixtures.

Unit -1	**Teaching Hours**
Introduction: Basic Concepts Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; various forms of work. Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers.	**Hours – 10**
Unit -2	
First Law of Thermodynamics: Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy-Demonstration as a property; Various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady, first law applications for system and control volume. Compressibility charts- Properties of two-phase systems.	**Hours – 10**
Unit – 3	
Second law of Thermodynamics: Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale. **Clausius inequality**: Definition of entropy; Demonstration that entropy is a property; Principle of increase of entropy;	**Hours – 12**

Illustration of processes in T-S coordinates; **Irreversibility and Availability**: Availability function for systems and Control volumes undergoing different processes, Second law analysis for a control volume and energy balance equation.	
Unit – 4	
Pure Substance: Definition of Pure substance, - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart. Determination of entropy from steam tables	**Hours – 08**
Unit-5	
Mixtures of Perfect Gases: Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures and Basics of compressible flow. **Thermodynamic Cycles:** Otto, Diesel, Dual Combustion cycles, Sterling Cycle, Atkinson Cycle, Ericcson Cycle, Lenoir Cycle – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles. Brayton and Rankine cycles – Performance Evaluation-improving methods – combined cycles, Bell- Coleman Cycle, Vapour compression cycle-performance Evaluation.	**Hours – 10**
COURSE OUTCOMES: On completion of this course, students should be able to: 1. Identify type of thermodynamic systems in the energy perspective. 2. Solve the practical thermodynamic problems by applying first law and steady flow energy equation. 3. Analyze the problems on heat engines, refrigeration and entropy by applying direction of second law and illustrate the concept of entropy by using second law of thermodynamics. 4. Calculate the thermodynamic properties of the pure substances. 5. Measure the performance of air standard cycles and vapor power cycle and analyze the properties of gas mixtures.	
QUESTION PAPER PATTERN: 1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome 2. CO1- CO5 questions carries 14 marks each. 3. Each full question will have sub question covering all topics under a course outcome.	
TEXT BOOKS: 1. Engineering Thermodynamics, PK Nag 4th Edn, TMH. 2. Fundamentals of Thermodynamics- Sonntag, R. E, Borgnakke, C. and Van	

Wylen, G. J, 2003, 6th Edition, John Wiley and Sons.

REFERENCE BOOKS:

1. Engineering Thermodynamics – Jones & Dugan PHI
2. Thermodynamics – An Engineering Approach with student resources DVD Y.A.Cengel & M.A.Boles , 6thEdn – McGraw Hill
3. Basic Engineering Thermodynamics – A.Venkatesh – Universities press.
4. An Introduction to Thermodynamics – Y.V.C.Rao – Universities press.
5. Engineering Thermodynamics – P.Chattopadhyay – Oxford Higher Edn Publ.
6. Engineering Thermodynamics – D.P.Misra, CengagePubl.

FLUID MECHANICS AND FLUID MACHINES SEMESTER - III			
Subject Code	21MEMET3050	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

1. Understand the fundamental properties of fluid and calculate fluid pressure using the manometer.
2. Apply the differential conservation equations of mass, momentum, and energy to fluid flow problems.
3. Evaluate major and minor losses in pipes and also discuss boundary layer concepts.
4. Solve problems on the turbo machines like turbines using analytical method and velocity triangles.
5. Discuss the Classification and working principles of pumps and evaluate the performance of hydraulic machines.

Unit -1	**Hours**
Fluids: Definition of fluid, Fluid properties, Atmospheric gauge and vacuum pressure – measurement of pressure. Manometers- Piezometer, U-tube, inverted and differential manometers. Pascal's law, hydrostatic law. Buoyancy, forces on submerged bodies, stability of floating bodies.	**10**
Unit -2	
Fluid Kinematics: Introduction, flow types. Equation of continuity for one dimensional flow. Stream line, path line and streak lines and stream tube. Stream function and velocity potential function. **Fluid Dynamics:** surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its applications, force on pipe bend.	**10**
Unit – 3	
Closed Conduit Flow: Reynold's experiment- Darcy Weisbach equation, Minor losses in pipes- pipes in series and pipes in parallel- total energy line hydraulic gradient line. **Basics of Turbo Machinery:** Hydrodynamic force of jets on stationery and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.	**10**
Unit – 4	
Turbines: Hydraulic Turbines: classification of turbines, Working and efficiencies of Pelton wheel, Francis and Kaplan turbines. Importance of Draft Tube. Hydraulic Quantities: Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.	**10**
Unit – 5	
Pumps: Centrifugal Pumps: Classification, working, work done –	**10**

manometric head losses and efficiencies- specific speed- pumps in series and parallel performance characteristic curves, cavitation & NPSH. **Reciprocating Pumps:** Working, Discharge, slip, indicator diagrams.	

Course outcomes:

1. Demonstrate various properties of fluids, pressure measurement devices and their applications.
2. Identify the kinematics and dynamics properties of fluids flowing in different conditions and its effects on the bodies.
3. Estimate the effect of various losses in fluids due to flowing and obstructions understand using the concepts of pipe losses and Boundary layer theory.
4. Analyze the performance of hydraulic turbines, unit and specific quantities based on the design by applying the knowledge of turbo machinery using analytical methods and velocity triangles.
5. Analyze the performance of various hydraulic pumps based on workings and design.

QUESTION PAPER PATTERN:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries 14 marks each
4. Each full question will have sub question covering all topics under a course outcome

TEXT BOOKS

1. Hydraulics, fluid mechanics and Hydraulic machinery Modi and Seth
2. Fluid Mechanics and Hydraulic Machines/ RK Bansal/Laxmi Publications (P) Ltd.

REFERENCE BOOKS

1. Fluid Mechanics and Hydraulic Machines by Rajput
2. Fluid Mechanics & Turbo machinery by Dixon, 7th Edn, Elesvier
3. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International
4. Fluid Mechanics- Fundementals and Applications by Y.A. Cengel, J.M.Cimbala, 6th Edn, McGrawHill
5. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, Kotaria& Sons.

MECHANICS OF SOLIDS & MATERIALS LAB SEMESTER - III			
Subject Code	21MEMEL3060	Internal Marks	15
Number of Practical Hours/Week	03	External Marks	35
Total Number of practice Hours	48	Exam Hours	03

Credits – 1.5

Course Objectives: Students Should be able to

1. Conduct Tensile and compression test using Universal Testing Machine.
2. Calculate Modulus of rigidity and stiffness of the spring using tensile spring tester.
3. Determine the impact resistance of the given material using Impact tester.
4. Find the RHN & BHN using Rockwell and Brinell Hardness testers.
5. Identify different metallographic structures of different ferrous alloys

List of experiments

1. Tension test
2. Compression test
3. Test on helical Spring to determine the rigidity modulus & stiffness
4. Torsion Test to determine the rigidity modulus of a shaft
5. Izod Impact test
6. Charpy Impact test
7. Brinell's hardness test
8. Rock well hardness test
9. Preparation and study of the Microstructure of pure metals like Iron, Cu and Al.
10. Preparation and study of the Microstructure of mild steels, low carbon steels, high – C steels.
11. Study of the micro structures of cast Irons.
12. Study of the micro structures of non-ferrous alloys.
13. Study of the micro structures of heat-treated steels

Course Outcomes: Students will be able to

1. Conduct Tensile and compression test using Universal Testing Machine
2. Calculate Modulus of rigidity and stiffness of the spring using tensile spring tester and Torsion tester
3. Determine the impact resistance of the given material using Impact tester
4. Find the RHN & BHN using Rockwell and Brinell Hardness testers
5. Identify different metallographic structures of different ferrous alloys

FLUID MECHANICS & MACHINES LAB SEMESTER - III			
Subject Code	21MEMEL3070	IA Marks	15
Number of Lecture Hours/Week	3	Exam Marks	35
Total Number of Lecture Hours	48	Exam Hours	3
Credits –1.5			

Course objectives: On successful completion of the course, students shall be able to:

1. Calculate different parameters such as coefficient of discharge, coefficient of impact, power, efficiency, etc. of various experiments.
2. Estimate pressure variation in a flowing fluid using Bernoulli's principle applications such as Venturi meter, Orifice meter.
3. Compute the head losses in various diameter pipes.
4. Calculate different parameters such as coefficient of impact.
5. Analyze the working of hydraulic turbines and pumps their performance curves.

LIST OF EXPERIMENTS

1. Determination of coefficient of discharge of Venturi meter
2. Determination of coefficient of discharge of Orifice meter
3. Determination of coefficient of discharge of a pipe line using Turbine flow meter
4. Determination of coefficient of discharge through an open channel using V – notch apparatus.
5. Determination of friction factor of a pipe
6. Verification of Bernoulli's equation
7. Determination of coefficient of impact of a jet striking a flat vane
8. Conduct performance test on Pelton Wheel
9. Conduct performance test on Francis turbine
10. Conduct performance test on single stage Centrifugal Pump
11. Conduct performance test on Reciprocating Pump

ADDITIONAL EXPERIMENTS

1. Conduct performance test on Kaplan turbine

Course Outcomes: On successful completion of the course, students will be able to

1. Calculate different parameters such as coefficient of discharge, coefficient of impact, power, efficiency, etc. of various experiments.
2. Estimate pressure variation in a flowing fluid using Bernoulli's principle applications such as Venturi meter, Orifice meter.
3. Compute the head losses in various diameter pipes.
4. Calculate different parameters such as coefficient of impact.
5. Analyze the working of hydraulic turbines and pumps their performance curves.

COMPUTER AIDED ENGINEERING DRAWING AND DRAFTING
(Skill Oriented Course)
SEMESTER III

Course Code	21MEMES3080	IA Marks	15
Number of Lecture Hours/week	1(L)+ 2(P)	Exam Marks	35
Total Number of Lecture Hours	48	Exam Hours	03

Credits-2

COURSE OBJECTIVES:

The student will acquire knowledge

1. To enhance the student's knowledge and skills in engineering drawing and to introduce drafting packages and commands for computer aided drawing and modeling.
2. To introduce various commands in AutoCAD to draw the geometric entities and to create 2D wire frame models.
3. To introduce various commands in AutoCAD to draw the geometric entities and to create 3D wireframe models.
4. To create geometrical model of simple solids, machines & machine parts
5. To interpret viewpoints and view ports, view point coordinates and views displayed and develop computer aided solid models with isometric and orthographic projections.

COMPUTER AIDED DRAFTING:

1. Generation of points, lines, curves, polygons, dimensioning. Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances, Study of DXE, IGES files
2. Types of modeling: object selection commands – edit, zoom, cross hatching, pattern filling, utility commands in 2D modeling
3. Object selection commands – edit, zoom, cross hatching, pattern filling, utility commands in 3D modeling.
4. Development of part drawings for various components in the form of orthographic representation of dimensioning and tolerances using wireframe and surface modeling.
5. Development of part drawings for various components in the form of isometric representation of dimensioning and tolerances using wireframe and surface modeling.
6. View point coordinates and view ports displayed, examples to exercise different options like save, restore, delete, joint, single option.
7. COMPUTER AIDED SOLID MODELING: Development of part drawings for various components in the form of isometric representation. PART MODELING: Generation of various 3D models through Pad, revolve, shell, sweep, parent child relation, Boolean operations and various standard translators.
8. Development of part drawings for various components in the form of orthographic projections.
9. Modeling of simple solids,
10. Modeling of Machines & Machine Parts. Assembly drawings: (Any four of the

following using solid model software) Generation of various Parts/assemblies: like Screw Jack, Oldham's Coupling, Foot step bearing, Couplings, knuckle and cotter joints, Crankshaft, Connecting Rod, Piston and Cylinder.

COURSE OUTCOMES:

On completion of the course student will be able to:

1. Understand skills in engineering drawing and to introduce drafting packages and commands for computer aided drawing and modeling
2. Utilize various commands in AutoCAD to draw the geometric entities and to create 2D wire frame models.
3. Interpret various commands in AutoCAD to draw the geometric entities and to create 3D wire frame models
4. Construct geometrical model of simple solids, machines & machine parts
5. Understand view points and view ports, view point coordinates and views displayed and develop computer aided solid models with isometric and orthographic projections.

BASIC ELECTRONIC ENGINEERING SEMESTER III			
Subject Code	21MEECM3090	Internal Marks	30
Number of Lecture Hours/Week	03	External Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 00			

Course Objectives:

This course will enable the students to:

1. Understand the basics of analog electronics circuits
2. Describe the basics of digital electronics.
3. Discuss the concepts of electronic communications.

Unit -1	
Semiconductor Devices and Applications: Introduction to P-N junction Diode and V-I characteristics, Half wave and Full-wave rectifiers, capacitor filter. Zener diode and its characteristics, Zener diode as voltage regulator. Regulated power supply IC based on 78XX and 79XX series, Introduction to BJT, its input-output and transfer characteristics, BJT as a single stage CE amplifier, frequency response and bandwidth.	**Hours – 12**
Unit -2	
Operational amplifier and its applications: Introduction to operational amplifiers, Op-amp input modes and parameters, Op-amp in open loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier applications: summing and difference amplifier, unity gain buffer, comparator, integrator and differentiator.	**Hours – 12**
Unit – 3	
Timing Circuits and Oscillators: RC-timing circuits, IC 555 and its applications as a stable and mono-stable multi-vibrators, positive feedback, Barkhausen's criteria for oscillation, R-C phase shift and Wein bridge oscillator.	**Hours – 8**
Unit – 4	
Digital Electronics Fundamentals: Difference between analog and digital signals, Boolean algebra, Basic and Universal Gates, Symbols, Truth tables, logic expressions, Logic simplification using K- map, Logic ICs, half and full adder/subtractor, multiplexers, de multiplexers, flip-flops, shift registers, counters, Block diagram of microprocessor/microcontroller and their applications.	**Hours – 10**
Unit – 5	
Electronic Communication Systems: The elements of communication system, IEEE frequency spectrum, Transmission media: wired and wireless, need of modulation, AM and FM modulation schemes, Mobile communication systems: cellular concept and block diagram of GSM system.	**Hours – 8**
Total	**50**

COURSE OUTCOMES:

On completion of the course student will be able to:

1. Understand the basics of semiconductor devices and their applications.
2. Describe the application using Operational amplifier.
3. Discuss the working of timing circuits and oscillators.
4. Understand building block of digital systems.
5. Summarize the basics of Electronic communication system.

QUESTION PAPER PATTERN:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries 14 marks each
4. Each full question will have sub question covering all topics under a course outcome

TEXT BOOKS:

1. Integrated Electronics - Jacob Millman, C. Halkies, C.D.Parikh, Tata Mc-Graw Hill, 2009.
2. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd.
3. Digital Design – M Morris Mano, Third Edition, Pearson Publications.
4. Electronic Communication Systems-George Kennedy,5th Edition, Tata Mc-Graw Hill

REFERENCE BOOKS:

1. Electronic Devices and Circuits – K Venkata Rao ,K Rama Sudha, Tata Mc-Graw Hill.
2. Electronic Devices and Circuits - Salivahanan, Kumar, Vallavaraj, 2nd Edition, Tata Mc-Graw Hill.
3. Fundamentals of Logic Design- Charles H.Roth,Jr., 5th Edition, India Edition

COURSE STRUCTURE AND SYLLABUS

SITE-21 REGULATIONS

For

II B.Tech. IV Semester

Mechanical Engineering

II B. Tech. IV Semester Proposed Course Structure for the Regulation SITE 21

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1.	BSC	21 CMMAT 4010	Engineering Mathematics –IV (Fourier series, Applications of PDE and Probability &	3	0	0	3
2.	PCC	21MEMET4020	Applied Thermodynamics	3	0	0	3
3.	PCC	21MEMET4030	Design of Machine Elements - I	3	0	0	3
4.	PCC	21MEMET4040	Production Technology	3	0	0	3
5.	PCC	21MEMET4050	Kinematics of Machinery	3	0	0	3
6.	HSC	21MEMST4060	Engineering Economics and Financial Management	3	0	0	3
7.	PCC	21MEMEL4070	Thermal Engineering Lab	0	0	3	1.5
8.	PCC	21MEMEL4080	Production Technology Lab	0	0	3	1.5
9.	SOC	21MEMES4090	Computer Aided Three-Dimensional Interactive Application (CATIA)	1	0	2	2
10.			**Total**	**19**	**0**	**8**	**23**
H/M			Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)	4	0	0	4

ENGINEERING MATHEMATICS-IV (Fourier series, Applications of PDE and Probability & Statistics) SEMESTER - IV			
Subject Code	21CMMAT4010/20	IA Marks	30
Number of Lecture Hours/Week	3	Exam Marks	70
Total Number of Lecture Hours	48	Exam Hours	03
Credits – 03			

Course Objectives:

1. To Find the Fourier series of a periodic functions.
2. To Identify solution methods for partial differential equations that model physical processes
3. To know the Basic Concepts of Probability and corresponding Discrete and Continuous probability distributions
4. To obtain the estimate of a parameter from sample statistic
5. To test the hypothesis.

Unit -1	
Fourier Series: Periodic functions, Dirichlet's condition, Fourier Series of periodic functions with period 2π and with arbitrary period. Fourier series of even and odd functions, Half range Fourier Series.	**Hours – 10**
Unit -2	
Applications of PDE: Method of Separation of variables, Solution of One-dimensional wave, Heat and two-dimensional Laplace equation.	**Hours – 08**
Unit – 3	
Discrete random Variables and Distributions: Introduction Random variables -Discrete random variables-Distribution Function-Mathematical Expectation. Discrete distributions: Binomial and Poisson distributions and their fitting to data. **Continuous random Variables and Distributions:** Introduction - Continuous random variables-Distribution function- Expectation. Continuous distributions: Uniform and Normal distributions, Normal approximation to Binomial distribution.	**Hours – 10**
Unit – 4	
Sampling theory Introduction-Population and samples-Sampling distribution of means and Variance (definition only)-Central limit theorem (without proof).	**Hours – 10**
Unit – 5	
Test of Hypothesis: Introduction-Hypothesis-Null and Alternative Hypothesis-Type I and Type II Errors-Level of Significance-One tail and two tail tests-Tests concerning one mean and two means (Large and Small samples), z test, t-distribution, Test of Goodness of fit - Tests on	**Hours – 10**

proportions- z-test.	

Course outcomes:

On completion of this course, students are able to

1. Find the Fourier series of a periodic functions (L3)
2. Identify solution methods for partial differential equations that model physical processes (L3).
3. Apply the Concepts of Probability and Find the statistical Parameters of Discrete and Continuous distributions (L3)
4. Estimate the properties of population from samples. (L5)
5. Design the Components of classical Hypothesis test, Conclude the statistical inferential methods based on small and large samples. (L6)

QUESTION PAPER PATTERN:

1. Question paper consists of 10 questions.
2. Each full question carrying 14 marks.
3. Each full question will have sub question covering all topics under a unit.
4. The student will have to answer 5 full questions selecting one full question from each unit.

Text Books:

1. Miller and Freund's, Probability and Statistics for Engineers,7/e, Pearson, 2008.

2. S.C.Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, 11/e, Sultan Chand & Sons Publications, 2012.

3. B.V.Ramana "Higher Engineering Mathematics" Tata Mc Graw-Hill, 2006.

Reference Books:

1. Shron L. Myers, Keying Ye, Ronald E Walpole, Probability and Statistics for Engineers and the Scientists,8th edition, Pearson 2007.
2. Jay L Devore, Probability and Statistics for Engineering and the Sciences, 8thEdition, Cengage.
3. Sheldon M. Ross, Introduction to probability and statistics Engineers and Scientists,4thEdition, Academic Foundation, 2011.
4. Johannes Ledolter and Robert V. Hogg, Applied Staistics for Engineers and Physical Scientists, 3rd Edition, Pearson, 2010.

APPLIED THERMODYNAMICS SEMESTER IV			
Subject Code	21MEMET4020	IA Marks	30
Number of Lecture Hours/Week	3(L)	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits - 03			

COURSE OBJECTIVES:

Enable the students to

1. Understand the working of various IC engines and associated systems such as lubricating system, cooling system, fuel injection system and ignition system.
2. Describe the working of steam power plant and their components and evaluate the performance and analysis of boilers.
3. Classify the steam nozzles and their performance evaluation.
4. Sketch the velocity diagrams of steam turbines and illustrate the compounding.
5. Analyze the performance of gas turbine and explain the working of air compressors.

Unit -1	**Teaching Hours**
I.C. ENGINES: Classification, Working principles of Four & Two stroke engine- SI & CI engines, Valve and Port Timing Diagrams, Engine systems- Carburetor, Fuel injection systems for CI engines, Ignition, Cooling and Lubrication system.	**Hours – 08**
Unit -2	
Vapour Power Cycles: Rankine cycle, Performance evaluation and improving methods. **Boilers**: Classification working principles of L.P & H.P boilers with sketches, mountings and accessories – working principles, boiler horse power, equivalent evaporation, efficiency and heat balance – draught, classification – height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney – artificial draught, induced and forced.	**Hours – 12**
Unit - 3	
Steam Nozzles: Function of a nozzle – applications - types, flow through nozzles, thermodynamic analysis – assumptions - velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity coefficient, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape: Super saturated flow, its effects, degree of super saturation and degree of under cooling - Wilson line	**Hours – 08**
Unit – 4	
Steam Turbines: Classification and principle of operation - Impulse turbine mechanical details and velocity diagrams, effect of friction.	**Hours – 12**

Reaction Turbine: Mechanical details, thermodynamic analysis of a stage, degree of reaction – velocity diagram - Analysis of steam turbines, velocity and pressure compounding of steam turbines	
Unit-5	
Gas Turbines: Gas power cycles, Brayton cycle, effect of reheat, regeneration and intercooling- Combined gas and vapor power cycles. **Compressors:** Reciprocating compressors, staging of reciprocating compressors, optimal stage pressure ratio, effect of intercooling and minimum work for multistage reciprocating compressors	**Hours – 10**

COURSE OUTCOMES:

On completion of this course, students should be able to:

1. Explain various internal combustion engines working principles and analyze various engine systems.
2. Determine the methods of improving Rankine cycle efficiency and design the constructional features of various types of boilers.
3. Evaluate critical pressure and other properties of steam in a steam nozzle.
4. Compute the efficiency of steam turbines through graphical and analytical methods.
5. Analyze, compare simple and modified Brayton cycles and estimate the performance of different types of compressors.

QUESTION PAPER PATTERN:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. CO1- CO5 questions carries 14 marks each
4. Each full question will have sub question covering all topics under a course outcome.

TEXT BOOKS:

1. Fundamentals of Thermodynamics, Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, John Wiley and Sons.
2. Thermal Engineering-R.S Khurmi/JS Gupta/S.Chand.
3. Gas Turbines / V Ganesan/3rd edition, TMH/2016.

REFERENCE BOOKS:

1. Heat Engineering – V.P Vasandani and D.S Kumar Metropolitan Book Company, New Delhi.
2. Thermodynamics and Heat Engines, Volume 2 - R.Yadav - Central book depot.
3. Engineering Thermodynamics, PK Nag 4th Edn, TMH.
4. Thermal Engineering – S. Domkundwar – 5th Edn – Dhanpat Rai publ.
5. Thermal Engineering-P.L.Bellaney/ Khanna publishers.
6. Thermal Engineering- M.L.Mathur-Jain publ.
7. Steam tables by C.P Kodandaraman – New age International.

DESIGN OF MACHINE ELEMENTS-I SEMESTER - IV			
Subject Code	21MEMET4030	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

COURSE OBJECTIVES

Students will be able to

1. Understand the customers' need, formulate the problem and observe the behavior of components subjected to loads, different types of modes of failure.
2. Gain the knowledge of fluctuating stresses, endurance limit and fatigue failure.
3. Design and analyze permanent joints (riveted, welded, etc.) under concentric and eccentric loading conditions.
4. Develop the knowledge of designing detachable joints (bolts, cotters, etc.) under various loading conditions.
5. Design and analyze coil springs (compression, tension, torsion) under various loads.

Unit -1	**Hours**
Introduction: Principles of mechanical design; Factor of safety, strength, rigidity, fracture, wear, and material considerations; Stress concentrations; Design for fatigue; Limits and fits. **Design**: Types of loads, stresses and strain, modes of failure, Principal stresses, theories of failure, Rankine theory, Guests theory, Von Mises theory, selection of failure theories.	**10**
Unit -2	
Strength of Machine Elements: Theoretical stress concentration factor – fatigue stress concentration factor, notch sensitivity – design for fluctuating stresses – endurance limit – estimation of endurance strength – Goodman's line – Soderberg's line – modified Goodman's line methods.	**8**
Unit – 3	
Design of Riveted Joints: Types of riveted joints, rivet heads, terminology, caulking and fullering, analysis of riveted joints, efficiency of riveted joints, eccentrically loaded riveted joints. **Design of Welded Joints:** Welding process, merits and demerits of welded joints over riveted joints, Types of welded joints, weld symbols, strength of parallel and fillet weld, strength of a welded joint, eccentrically loaded welded joints, welds subjected to bending moment, torsional moment.	**12**
Unit – 4	

Design of simple machine parts, design of cotter and knuckle joints. **Design of Threaded Joints**: Forms of screw threads, nomenclature, thread series, designation, power screws, and advantages over v-threads, stress in screwed threads, bolts of uniform strength, empirical relation for initial tightening, eccentrically loaded joints.	**10**
Unit – 5	
Mechanical Springs: Stresses and deflections of helical springs, extension, compression springs, springs for fatigue loading, Wahl's stress concentration factor, energy storage capacity – helical torsion springs – co-axial springs, leaf springs, Nipping of leaf springs.	**10**

COURSE OUTCOMES:

On the completion of this course, students are able to

1. Identify the customers' need, formulate the problem and different types of failure modes and criteria to observe the behavior of component subjected to loads.
2. Define fluctuating stresses, endurance limit and fatigue failure.
3. Analyze permanent joints (riveted, welded, etc.) under concentric and eccentric loading conditions.
4. Analyze detachable joints (bolts, cotters, etc.) under various loading conditions.
5. Evaluate stiffness, number of coils and length etc., of coil springs (compression, tension, torsion) under various loads.

QUESTION PAPER PATTERN:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice).
3. All questions carries 14 marks each.
4. Each full question will have sub question covering all topics under a course outcome.

TEXT BOOKS

1. Machine Design/V.Bandari/ TMH Publishers
2. Machine design / NC Pandya& CS Shah/Charotar Publishing House Pvt. Limited

REFERENCES BOOKS

1. Design of Machine Elements / V.M.Faires /McMillan
2. Machine design / Schaum Series/McGraw Hill Professional
3. Machine Design/ Shigley, J.E/McGraw Hill
4. Machine Design –Norton/ Pearson publishers

PRODUCTION TECHNOLOGY SEMESTER - IV			
Subject Code	21MEMET4040	Internal Marks	30
Number of Lecture Hours/Week	3(L)	External Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 03			

COURSE OBJECTIVES:

Enable the students:

1. To understand different casting techniques for product development.
2. To know about the applications of special casting processes
3. To understand basic manufacturing processes of welding
4. To understand the concepts of advanced welding processes for various applications.
5. To select appropriate metal forming and plastic working processes for a given application.

Unit -1	**Hours**
Introduction: Manufacturing processes and classification. **Casting:** Steps involved in making a casting. Patterns and Pattern making: Types of patterns, Materials used for patterns, Pattern allowances. Moulding sand: Molding sand composition, sand properties and Sand preparation. Core: Core sands, Types of cores, Core prints, Chaplets. Principles of Gating, Gating ratio and Design of Gating systems.	**10**
Unit -2	
Melting and Solidification of casting: Cupola furnace, Solidification of pure metal and alloys, Short & long freezing range alloys. Risers: Types function and design, Casting designs. **Special casting processes:** Centrifugal, Die and Investment casting. Casting defects-Causes and remedies. **Advanced Casting Techniques:** Stir Casting, Squeeze casting	**10**
Unit – 3	
Welding: Introduction, classification of welding processes, types of welded joints and their characteristics. Gas welding: Different types of flames and uses, Oxy–Acetylene gas welding, metal arc welding, sub merged arc welding. **Advanced weldings:** TIG & MIG welding. Resistance welding: Spot welding, Seam welding, Projection welding, Upset welding, and Flash butt welding.	**10**
Unit – 4	
Special welding processes: Thermit welding, Friction welding, Friction stir welding, Electron beam welding, and Laser beam welding. Soldering and Brazing, Welding defects, causes and remedies.	**10**
Unit – 5	
Metal Forming: Nature of plastic deformation, Hot and cold working.	**10**

Rolling: Principle, Types of rolling mills and products, Forces in rolling and power requirements. Extrusion process, Hot extrusion and cold extrusion, Impact extrusion. Forging, Tools and dies, Forging hammers, Rotary forging. Wire and tube drawings. **Sheet metal forming:** Blanking, Bending, Piercing, Stamping, Drawing, Coining, Embossing, Stretch forming, Hot and cold spinning. Blow and Injection moulding.	

Course outcomes:

1. Students able to understand the knowledge of various casting processes
2. Students should be able to identify various casting technique parameters and their design effect on processes.
3. Students should be able to understand the equipment to complete specified welding processes efficiently and correctly
4. Students should be able to apply knowledge of welding safety standards to both field and factory environments.
5. Students should be able to understand the metal forming and sheet metal forming processes and their relevance in current manufacturing industry

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries 14 marks each
4. Each full question will have sub question covering all topics under a course outcome

Text Books:

1. P.N. Rao,Manufacturing Technology, Vol I, TMH
2. Kalpakjian S & Steven RSchmid, Manufacturing Processes for Engineering Materials, 5thEd.PearsonPubl.
3. B.S.Raghuwanshi, Workshop Technology, Vol I, Dhanpatrai& Co
4. Kalpakjain S.& Steven R Schmid,Manufacturing Engineering and Technology, 4th Ed., Pearson Publ.

Reference Books:

1. P C Sharma,Production Technology, S. Chand
2. R.K. Jain and S.C. Gupta, Production Technology, Khanna Publishers
3. Production Technology, H.M.T. (Hindustan Machine Tools).

KINEMATICS OF MACHINERY SEMESTER - IV			
Subject Code	21MEMET4050	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

COURSE OBJECTIVES:

Students will be able to

1. Understand the purpose of kinematics, Kinematic joint and mechanism and to study the relative motion of parts in a machine without considering the forces involved.
2. Understand various mechanisms for straight line motion and their applications including steering mechanism
3. Understand the velocity and acceleration concepts and the methodology using graphical methods and principles and application of four bar chain. To understand the application of slider crank mechanism etc. And study of plane motion of the body
4. Understand the theories involved in cams. Further the students are exposed to the applications of cams and their working principles
5. Understand gears, power transmission through different types of gears including gear profiles.

Unit -1	**Hours**
MECHANISMS: Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematic pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially or successfully constrained and incompletely constrained .Grublers criterion ,Grashoff's law , Degrees of freedom, Kutzbach criterion for planar mechanisms, Mechanism and machines – classification of machines – kinematic chain – inversion of mechanism – inversions of quadric cycle, chain – single and double slider crank chains.	**10**
Unit -2	
LOWER PAIR MECHANISM: Exact and approximate copiers and generated types – Peaucellier, Hart and Scott Russel – Grasshopper – Watt T. Chebicheff and Robert Mechanisms and straight-line motion, Pantograph. Conditions for correct steering – Davis Steering gear, Ackerman's steering gear – velocity ratio; Hooke's Joint: Single–Universal coupling problems	**10**
Unit – 3	
KINEMATICS: Velocity and acceleration – Motion of a link in machine – Determination of Velocity and acceleration diagrams – Graphical method – Application of relative velocity method four bar chain. Velocity and acceleration analysis of for a given mechanism, Kleins construction, Coriolis acceleration, determination of Coriolis component of acceleration.	**10**

Plane motion of body: Instantaneous centre of rotation, centroids and axodes – relative motion between two bodies – Three centres in line theorem – Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.	
Unit – 4	
CAMS Definitions of cam and followers – their uses – Types of followers and cams – Terminology –Types of followers motion: Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases. Analysis of motion of followers: Roller follower – circular cam with straight, concave and convex flanks.	**10**
Unit – 5	
GEARS Higher pairs, friction wheels and toothed gears–types – law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth: cycloidal and involute profiles. Velocity of sliding – phenomena of interferences – Methods of interference. Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact –Introduction to gear Trains, Train value, Types – Simple and reverted wheel train – Epicyclic gear Train. Methods of finding train value or velocity ratio – Epicyclic gear trains.	**10**
Course outcomes: 1. To understand the relative motions of different kinematic mechanisms 2. To evaluate different straight line motion mechanisms and steering gear mechanisms 3. To determine the velocity and acceleration using IC, velocity methods 4. To draw the profiles of cams and followers 5. To know the methodology of gears and its transmission	
QUESTION PAPER PATTERN: 1. Question paper contains 10 Questions, 2 from each course outcome. 2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice) 3. All questions carries 14 marks each 4. Each full question will have sub question covering all topics under a course outcome	
TEXT BOOKS: 1. Mechanism and Machine Theory by Ashok G. Ambekar, PHI Publishers 2. Theory of Machines – S. S Rattan- TMH	
REFERENCES: 1. Theory of Machines Sadhu Singh, PearsonsEdn 2. Theory of machines and Machinery /Vickers /Oxford 3. Theory of Machines by Thomas Bevan/ CBS	

ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT SEMESTER IV			
Subject Code	21MEMST4060	Internal Marks	30
Number of Lecture Hours/Week	03	External Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 03			

COURSE OBJECTIVES:

This course will enable the students to

1. Understand the concept and nature of Managerial Economics and Concept of Demand and Demand forecasting.
2. Analyse the Cost Concepts, Cost-Volume-Profit Analysis and Market structures.
3. Learn different Accounting Systems, preparation of Financial Statements and Capital Budgeting proposals by using different methods.

Unit -I	**Hours**
Introduction to Managerial Economics and demand Analysis: Definition of Managerial Economics and Scope-Managerial Economics and its relation with other subjects-Concept of Demand-Types-Determents-Law of Demand its Exception-Elasticity of Demand-Types and Measurement- Demand forecasting and its Methods.	**10**
Unit –II	
Production and Cost Analysis: Production Function-Isoquants and Isocost-Law of Variable proportions- Cobb-Douglas Production Function-Economics of Sale-Cost Concepts- Opportunity Cost-Fixed vs Variable Costs-Explicit Costs vs Implicit Costs- Cost Volume Profit analysis- Determination of Break-Even Point (Simple Problems).	**10**
Unit-III	
Introduction To Markets, Pricing Policies & forms Organizations and Business Cycles: Market Structures: Perfect Competition, Monopoly and Monopolistic and Oligopoly – Features – Price Output Determination – Methods of Pricing: Market Skimming Pricing, And Internet Pricing: Flat Rate Pricing. Features and Evaluation of Sole Trader – Partnership – Joint Stock Company – State/Public Enterprises and their forms – Business Cycles – Meaning and Features – Phases of Business Cycle	**12**
Unit –IV	
Introduction to Accounting & Financing Analysis: Introduction to Double Entry Systems – Preparation of Financial Statements- Analysis and Interpretation of Financial Statements-Ratio Analysis (Simple Problems)	**10**
Unit-V	
Capital and Capital Budgeting: Capital Budgeting: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Need for Capital Budgeting-Techniques of Capital Budgeting-Traditional and Modern Methods.	**08**

COURSE OUTCOMES:

On completion of the course student will be able to:

1. Equipped with the knowledge of managerial economics and estimating demand for a product.
2. Examine the Production Concept and familiar with the concepts of iso-quants, iso-cost lines and MRTS
3. Predict the cost of production and its relevance to managerial decision making
4. Differentiate various the Markets and Pricing methods along with Business Cycles.
5. Prepare Financial Statements along with Analysis
6. Analyse and interpret various investment project proposals with the help of Capital Budgeting techniques.

QUESTION PAPER PATTERN:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries 14 marks each
4. Each full question will have sub question covering all topics under a course outcome

TEXT BOOKS:

1. Dr. A. R. Aryasri – Managerial Economics and Financial Analysis, TMH 2011.
2. Dr. B. Kuberudu and Dr. T. V. Ramana: Managerial Economics & Financial Analysis, Himalaya Publishing House 2011.

REFERENCE BOOKS:

1. Dr. P. Vijaya Kumar & Dr. N. Apparao Management Science Cengage, Delhi, 2012.
2. S. A. Siddiqui & A. S. Siddiqui: Managerial Economics and Financial Analysis, New Age International Publishers, 2012
3. Vanitha Agarwal : Managerial Economics, Pearson Publications 2011.

WEB REFERENCES:

1. https://www.iare.ac.in/sites/default/files/lecture_notes/IARE_MEFA_LECTURE_NOTES_1.pdf
2. https://www.edx.org/course/introduction-to-managerial-economics

THERMAL ENGINEERING LAB SEMESTER - IV			
Course Code	21MEMEL4070	IA Marks	15
Number of Lecture Hours/week	3(P)	Exam Marks	35
Total Number of Lecture Hours	36	Exam Hours	03
Credits 1.5			

Course Objectives:

This course will enable student to :

1. Impart knowledge in testing of fuels properties.
2. Understand the working scenario of Port and Valve timing of IC engines
3. Study different performance parameters of four stroke diesel engines.
4. Know different performance parameters of petrol engines.
5. Recognize the performance parameters of Air compressors & Learn the working of different types of boilers.

Syllabus

1. To find the flash point / fire point, viscosity, calorific value & carbon residue by using fuel property testing apparatus
2. Valve timing diagram of a four-stroke diesel engine
3. Valve timing diagram of a four-stroke petrol engine
4. Port timing diagram of 2-stroke petrol engine
5. Performance test on four stroke diesel engine test rig
6. Heat balance test on four stroke diesel engine test rig
7. Retardation test on four stroke diesel engine test rig
8. Morse test on four stroke multi cylinder petrol engine test rig
9. Performance test on variable compression ratio petrol engine test rig
10. Assembly and disassembly of a four stroke single cylinder petrol engine.
11. Performance test on two stroke petrol engine test rig
12. Economical speed test on two stroke petrol engine test rig.
13. Study of steam boilers
14. Performance test on reciprocating air compressor test rig

Course outcomes:

On completion of the course student will be able to:

1. To calculate given fuel properties
2. To draw Port and Valve timings of IC engines
3. To find performance parameter values of four stroke diesel engines
4. To determine performance parameter values of petrol engines.
5. To calculate efficiency of Air compressors & summarize the working of different types of boilers and able to suggest suitable boiler based on requirement

PRODUCTION TECHNOLOGY LAB SEMESTER - IV			
Subject Code	21MEMEL4080	Internal Marks	15
Number of Practice Hours/Week	3(P)	External Marks	35
Total Number of Practice Hours	54	Exam Hours	03
Credits – 1.5			

Course Objectives

Enable the students to

1. Impart hands-on practical exposure on pattern making.
2. Know the fundamentals of mould casting with the help of patterns.
3. Gain the concept of welding & different welding methods with safety precaution.
4. Analyze the concept of metal forming processes.
5. Understand the fundamentals of powder metallurgy
6. Understand the processing of plastics using injection & blow molding machines.

SYLLABUS

METAL CASTING

- Pattern Design and making- for one casting drawing.
- Sand properties testing- for strength and permeability
- Mould preparation, Melting and Casting

WELDING

- Gas welding
- Gas cutting
- Manual metal arc welding- Lap & Butt Joints
- TIG/MIG Welding
- Resistance spot welding
- Brazing and soldering

METAL FORMING AND POWDER METALLURGY

- Blanking & Piercing operations and study of simple, compound and progressive dies
- Deep drawing and extrusion operations
- Bending and other operations
- Basic powder compaction and sintering

PROCESSING OF PLASTICS

- Injection moulding
- Blow moulding

COURSE OUTCOMES

1. **Demonstrate** hands-on practical exposure on pattern processes
2. **Know** the process ofmould preparation using patterns.
3. **Acquire** fundamental knowledge on metal forming processes.
4. **Operate** arc welding, gas welding, and resistance welding equipment
5. **Apply** the practical concepts of powder metallurgy.
6. **Identify** the difference between injection and blow moulding.

COMPUTER AIDED THREE-DIMENSIONAL INTERACTIVE APPLICATION (CATIA)

(Skill Oriented Course)

SEMESTER IV

Course Code	21MEMES4090	IA Marks	15
Number of Lecture Hours/week	3	Exam Marks	35
Total Number of Lecture Hours	48	Exam Hours	03

Credits- 2

The student will develop a skill to use software to create 2D and 3D models.

Session-1

- Geometrical Shape Design (GSD) introduction to workbench Creation of surfaces

Session-2

- Practice of extrude, revolve and primitive tools

Session-3

- Creating basic curves (wireframe) Practice of circles, spline, helix and spiral

Session-4

- Creating surfaces from surfaces Practice of blend, multi-sections & fill

Session-5

- Trimming surfaces Practice of splitting and trimming of surfaces

Session-6

- Creating curves on surfaces, connect curves, iso-parametric, conic and corners Basic GSD operations,
- Practice 3 to 4 GSD components

Session-7

- Projections
- Advanced GSD operations, conversion of surfaces to solids
- Practice 3 to 4 sheet metal components

Session-8

- Assembly introduction to workbench Importing of parts and products
- Practice of product structure tool with basic assembly
- Assembly constraints

Session-9

- Practice of various constraint tools
- Types of Assembly approach
- Top-down assembly and Bottom-up assembly

Session-10

- Creating 2 to 3 assemblies with top down and bottom-up approach

COURSE OUTCOMES:

On completion of the course student will be able to:

1. Can use interface of CATIA
2. Can use command panel, menus, viewports and command icons in CATIA
3. Can create two dimensional drawings in CATIA
4. Can create 3D part drawings using commands in CATIA

COURSE STRUCTUREAND SYLLABUS

SITE-21 REGULATIONS

For

III B.Tech. V Semester

Mechanical Engineering

III B. Tech. V Semester Course Structure for the Regulation SITE 21

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PCC	21MEMET5010	Machine Tools and Metrology	3	0	0	3
2	PCC	21MEMET5020	Dynamics of Machinery	3	0	0	3
3	PCC	21MEMET5030	Design of Machine Elements-II	3	0	0	3
4	PEC	21MEMEP504X	Professional Elective-I	3	0	0	3
5	OEC	21MEXXO505X	Open Elective Course-I	3	0	0	3
6	PCC	21MEMEL5060	Machine Tools and Metrology Lab	0	0	3	1.5
7	PCC	21MEMEL5070	Theory of Machines Lab	0	0	3	1.5
8	SOC	21CMAHS5080	Soft Skills & Aptitude Builder - 1	1	0	2	2
9	MC	21MEMEN5090	Machine Drawing Practice Lab	0	0	3	0
10	SI	21MEMER5100	Summer Internship (2 months) after II year to be evaluated during V semester	0	0	0	1.5
Total credits							**21.5**
11	H/M		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)	4	0	0	4

Professional Elective Course -I

S.No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP504A	Conventional and Non-Conventional Power Stations	3	0	0	3
2		21MEMEP504B	Nano Technology	3	0	0	3
3		21MEMEP504C	Industrial Robotics with Artificial Intelligence	3	0	0	3
4		21MEMEP504D	Advanced Materials	3	0	0	3
5		21MEMEP504E	Industrial Management	3	0	0	3
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

MACHINE TOOLS AND METROLOGY SEMESTER - V			
Subject Code	21MEMET5010	**Internal Marks**	30
Number of Lecture Hours/Week	3	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

The course should enable the students to:

1. Acquire the knowledge on theory of metal cutting and mechanisms of machining
2. Understand about the various lathe machines cutting processes
3. Understand about the various slotting, planning drilling & boring cutting processes
4. Understand the features of Milling process, milling machines, Milling operations and different types of indexing.
5. Understand the basics of Metrology like Surface roughness, surface finish, limits and tolerances etc.

Unit -1	**Hours**
Metal Cutting: Elements of metal cutting process, geometry of single point cutting tool, tool signature, chip formation and types of chips, chip breakers, mechanics of orthogonal cutting – Merchant's force diagram, cutting forces, cutting speeds, feed, depth of cut, tool life, coolants, tool materials. **Jigs & Fixtures:** Principles of design of jigs and fixtures, principles of location and clamping, applications.	**10**
Unit -2	
Lathe Machines: Engine lathe – principle of working, specification of lathe, types of lathes, construction of engine lathe, lathe operations, work holders & tool holders – lathe attachments, turret and capstan lathes. Principal features of automatic lathes – classification – single spindle and multi spindle automatic lathes	**08**
Unit – 3	
Shaping, Slotting & Planning Machines: Introduction - principle of working – principle parts – specifications - operations performed - slider crank mechanism **Drilling & Boring Machines:** Introduction – construction of drilling machines – types of drilling machines– specifications- types of drills – geometry of twist drill - operations performed – tool holding devices – deep hole drilling machines- Boring Machines – fine Boring Machines – jig boring machines	**10**
Unit – 4	
Milling Machines: Principles of working – specifications – classification of milling machines, principal features of horizontal, vertical and universal milling machines, machining operations, types of cutters and	**12**

geometry of milling cutters, accessories to milling machines, introduction to indexing, classification, methods of indexing- simple & compound. **Finishing Processes:** Theory of grinding, classification of grinding machines, cylindrical and surface grinding machines, tool and cutter grinding machines, different types of abrasives, bonds and selection of a grinding wheel.	
Unit – 5	
Systems Of Limits and Fits: Introduction, nominal size, tolerance, limits, deviations, fits -Unilateral and bilateral tolerance system, hole and shaft basis systems, and problems. **Linear Measurements:** Slip gauges, dial indicators, vernier caliper and micrometers. **Angular Measurements:** Bevel protractor, angle slip gauges, angle dekkor and sine bar	**10**
Course outcomes: At the end of the course the student will be in a position to: 1. Analyze mechanics of orthogonal cutting to metal machining. 2. Acquire the knowledge on operations in conventional, automatic, Capstan & turret lathes. 3. Explain shaping, slotting, planning, drilling and boring machines. 4. Make gear and keyway in milling machines using indexing mechanisms and principles of finishing processes 5. Outline the linear and angular measuring instruments	
Text Books: 1. Production Technology by R.K. Jain and S.C. Gupta/ Hanna Publishers 2. Workshop Technology – B.S.Raghu Vamshi – Vol II/ Dhanpat Rai & Co 3. Manufacturing Technology Vol-II/P.N Rao/Tata McGraw Hill 4. Engineering Metrology / R.K.Jain / Khanna Publishers	
Reference Books: 1. Metal cutting Principles by M.C. Shaw/ Oxford University Press 2. Metal cutting and machine tools by Boothroyd/ CRC Press 3. Engineering Metrology / Mahajan / Dhanpat Rai Publishers	
Question paper pattern: 1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice) 2. All questions carries 14 marks each 3. Each full question will have sub question covering all topics under a course outcome	

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3						1					1	2	
2	2						1					1	2	
3	2						1					1	3	
4	2						1					1	2	
5	3						1					1	2	
Course	**3**						**1**					**1**	**3**	

DYNAMICS OF MACHINERY SEMESTER - V			
Subject Code	21MEMET5020	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. Demonstrate the gyroscopic and analyze effects under different forces and torques
2. Analyze the existence of friction and its importance in rotating parts like clutches, brakes and dynamometers.
3. Identify the dynamic forces and torques developed in the rotating parts like cranks, flywheels and governors.
4. Estimate the unbalanced forces and torques developed in rotating and reciprocating parts of an engine.
5. Identify different types of vibrations in machine parts and evaluate their effects.

Unit -1	**Hours**
Precession: Gyroscopes, effect of precessional motion on the stability of moving vehicles such as motor car, motor cycle, aero planes and naval ships.	**8**
Unit -2	
Friction: Inclined plane, friction of screw and nuts, pivot and collar, uniform pressure, uniform wear, friction circle and friction axis **Clutches**: Friction clutches- single disc or plate clutch, multiple disc clutch, cone clutch, centrifugal clutch. **Brakes and Dynamometers**: Simple block brakes, internal expanding brake, band brake of vehicle. General description and operation of dynamometers: Prony, Rope brake, Epicyclic, Bevis Gibson and belt transmission	**12**
Unit – 3	
Turning Moment Diagrams: Dynamic force analysis of slider crank mechanism, inertia torque, angular velocity and acceleration of connecting rod, crank effort and turning moment diagrams – fluctuation of energy – fly wheels and their design. **Governors**: Watt, porter and proell governors, spring loaded governors– Hartnell and Hartung with auxiliary springs, effort, sensitiveness, isochronism and hunting.	**12**
Unit – 4	
Balancing: Balancing of rotating masses single and multiple – single and different planes, using analytical and graphical methods. Primary and	**8**

secondary balancing of reciprocating masses. **Unbalanced forces and couples in multi cylinder engines:**V-engines, in-line and radial engines for primary and secondary balancing. Locomotive balancing, hammer blow, swaying couple, variation of tractive effort.	
Unit – 5	
Vibrations: Introduction, Terms used in vibrations, Applications. **Longitudinal Vibrations**: Free vibration of spring mass system – Natural frequency-types of damping – damped free vibration. **Forced Vibration:** Simple problems on forced damped vibration, magnification factor, vibration isolation and transmissibility. **Transverse Vibrations:** Transverse loads, vibrations of beams with concentrated and distributed loads. Dunkerly's method, Rayleigh's method, whirling of shafts, critical speeds. **Torsional Vibrations:** Two and Three rotor systems.	**10**

Course outcomes:

1. Demonstrate the gyroscopic effect on moving bodies like aeroplane, ship, 2-wheeler and 4-wheeler vehicles in various conditions using the concepts of gyroscope
2. Analyze the application and effect of friction in moving bodies like clutches, brakes and dynamometers in producing and transmission of energy.
3. Identify the dynamic forces and torques developed in the rotating parts like cranks, flywheels and governors.
4. Estimate the balanced and unbalanced forces and torques developed in rotating and reciprocating parts of an engine due to the presence of various components on the shaft.
5. Evaluate various types of vibrations and its effects produced like whirling, resonance and others in machine parts during stationary and working conditions.

TEXT BOOKS:

1. Theory of Machines / S.S. Rattan/ Mc. GrawHill
2. Mechanism and Machine Theory /Ashok G.Ambedkar/ PHI Publications

REFERENCES:

1. Theory of Machines / Thomas Bevan / Oxford UniversityPress
2. Theory of machines /Khurmi/S.Chand
3. Mechanism and Machine Theory / JS Rao and RV Dukkipati / NewAge
4. Theory of Machines / Shigley /MGH

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1		2	1	2									1	
2	2	1	2										2	
3	1	2	1										2	
4	2	2	1										2	
5	1	3	3	1									2	
Course	**2**	**3**	**2**	**1**									**2**	

DESIGN OF MACHINE ELEMENTS-II SEMESTER - V			
Subject Code	21MEMET5030	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Students will be able to

1. Design and analyze the pressure distribution in journal bearings.
2. List out engine components such as cylinder, piston, connecting rod and crankshaft.
3. Summarize the design procedure for shafts and couplings with different geometrical features under various loading conditions.
4. Determine geometrical relations for length of belt and chain.
5. Distinguish types of pulleys/sprockets for belt and chain drives from manufacturer's catalogue and explain procedure for beam strength and wear strength, effective load and module based on beam strength.

Unit -1	**Hours**
Bearings: Classification of bearings- applications, types of journal bearings – lubrication – bearing modulus – full and partial bearings – clearance ratio – heat dissipation of bearings, bearing materials – journal bearing design – ball and roller bearings – static loading of ball & roller bearings, bearing life.	**10**
Unit -2	
Engine Parts: Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends – cranks and crank shafts, strength and proportions of overhung and center cranks – crank pins, crank shafts. Pistons, forces acting on piston – construction design and proportions of piston, cylinder, cylinder liners.	**10**
Unit – 3	
Design of Shafts: Design of solid and hollow shafts for strength and rigidity, Design of shafts for combined bending and axial loads – Shaft sizes. **Design of Shaft Couplings:** Rigid couplings: Muff, Split-muff and flange couplings – Flexible couplings, Flange coupling (modified).	**10**
Unit – 4	
Design of Belt and Rope Drives: Selection of flat belts, Pulleys for flat belts, Arms of cast iron pulley, Selection of V-belts and V-grooved pulley, Construction of wire rope, Stresses in wire ropes, Rope sheaves and drums. **Design of Chain Drives:** Introduction to chain drives, Roller chains, geometric relationships, Polygonal effect, Power rating of roller chains, Proportions of sprocket wheels, Design of chain drive.	**10**
Unit – 5	

Design of Spur Gear Drives: Force analysis on spur gear tooth, Gear blank design, module and face width, Beam strength of gear tooth, Effective load on gear tooth, Lewis Fatigue equation, Estimation of module based on beam strength, Wear strength of gear tooth, Estimation of module based on wear strength, **Design of Helical Gear Drives:** Force analysis on helical gear tooth, Beam strength of helical gears, Effective load on gear tooth, Wear strength of helical gears, Herringbone gears.	**10**

Course outcomes:

On the completion of this course, students are able to

1. **Analyze** the pressure distribution in journal bearings.
2. **Compute** design parameters of engine components such as cylinder, piston, connecting rod and crankshaft.
3. **Analyze** shafts and couplings with different geometrical features under various loading conditions.
4. **Calculate** geometrical relations for length of belt and chain.
5. **Identify** types of pulleys/sprockets for belt and chain drives from manufacturer's catalogue and learned calculation procedure for beam strength and wear strength, effective load and module based on beam strength.

TEXT BOOKS

1. Machine Design/V. Bandari/ TMH Publishers
2. Machine design / NC Pandya& CS Shah/Charotar Publishing House Pvt. Ltd

REFERENCES BOOKS

1. Design of Machine Elements / V.M.Faires/McMillan
2. Machine design / Schaum Series/McGraw Hill Professional
3. Machine Design/ Shigley, J.E/McGraw Hill
4. Machine Design –Norton/ Pearson publishers

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice).
2. All questions carries 14 marks each.
3. Each full question will have sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3										3	3	
2	3	3	2									3	3	
3	3	3	2									3	3	
4	3	3	2									3	3	
5	3	3	2									3	3	
Course	**3**	**3**	**2**									**3**	**3**	

PROFESSIONAL ELECTIVE COURSES -I

CONVENTIONAL & NON-CONVENTIONAL POWER STATIONS SEMESTER - V			
Subject Code	21MEMEP504A	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:
Enable the students to

1. Acquire knowledge on sources of energy and understand the working of Thermal Power Plants.
2. Acquire knowledge on Diesel and Hydro Power Stations and their auxiliaries
3. Apply the basic knowledge of nuclear energy and identify Different types of nuclear power plants and their auxiliaries.
4. Understand the principles and working of solar, wind and Bio gas plants
5. Understand the Principles and working of Geothermal energy, tidal, wave energy power plants and apply the principles of direct energy conversion systems

Unit -1	Hours
Introduction to the sources of energy: Resources and development of power in India. **Steam Power Plant:** Plant layout, working of different circuits, overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, cyclone furnace, dust collectors. **Gas Turbine Plant:** Introduction- classification - construction – layout with auxiliaries	12
Unit -2	
Diesel Power Plant: Plant layout with auxiliaries – fuel supply system, air starting equipment. combined cycle power plants and comparison. **Hydroelectric Power Plant:** Water power – hydrological cycle / flow measurement– hydrographs – storage and pondage – classification of dams and spillways. **Hydro Projects and Plant:** Classification – typical layouts – plant auxiliaries – plant operation pumped storage plants.	10

Unit – 3	
Nuclear Power Station: Nuclear fuel – breeding and fertile materials – nuclear reactor – reactor operation. **Types of Reactors:** Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous reactor, gas cooled reactor, radiation hazards and shielding – radioactive waste disposal.	10
Unit – 4	
Solar Power plant: classification of concentrating collectors, Flat plate and concentrating collectors, solar ponds. Solar plants, photovoltaic energy conversion **Wind Energy:** Sources and potentials, horizontal and vertical axis windmills, performance characteristics. **Bio-Mass:** Principles of Bio-Conversion, Anaerobic /aerobic digestion, types of Bio-gas digesters.	10
Unit – 5	
Geothermal Energy: Resources, types of wells, methods of harnessing the energy. **Tidal and Wave energy:** Potential and conversion techniques **Direct Energy Conversion:** Thermoelectric generators, principles and working of MHD generator, Fuel cells	8

Course outcomes:

On completion of this course, students should be able to:

1. List, describe the main sources of energy and describe the functions of the major equipment and auxiliaries of a Thermal power plants
2. Identify, demonstrate the components of an IC Engine and hydro power plant and compare the various combined cycle power plants.
3. Explain the basic principles of nuclear reactions and explain working principle of different types of nuclear power plants.
4. Apply the knowledge of Solar, Wind energy and Biomass, in generation of power.
5. Identify the principles of direct energy conversion systems and explain the basic principles of Geothermal, Tide and Wave Energy

Text Books:

1. A Text Book of Power Plant Engineering – R.K. Rajput – Laxmi Publications.
2. A Course in Power Plant Engineering – Arora, Domkundwar – Dhanpat Rai & Co
3. Power Plant Engineering – P.C.Sharma / S.K.Kataria Publications
4. Non- conventional Energy Sources / G.D. Rai/ Khanna Publishers

Reference Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill
2. Renewable Energy Resources / Tiwari and Ghosal / Narosa
3. An Introduction to Power Plant Technology / G.D. Rai/Khanna Publishers.
4. Power Plant Engineering – G. R. Nagpal – Khanna Publishers

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3		3										3	
2	3		3				3						3	
3	3		3										3	
4	2		3				3						3	
5	3		3				3						3	
Course	**3**		**3**				**2**						**3**	

NANO TECHNOLOGY SEMESTER - V			
Subject Code	21MEMEP504B	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Enable the students to

1. Acquire knowledge on importance of Nanoscience & Nanotechnology
2. Identify the properties of nanomaterials & their applications in material science.
3. Apply the concept of synthesis & fabrication of nanomaterials.
4. Understand the various characterization techniques of nanomaterials.
5. Understand the concept of carbon nanotechnology & its applications.

Unit -1	**Hours**
Introduction to Nanotechnology: Importance of nano-technology, Emergence of Nanotechnology, History of nanoscience, Definition of nanometer, nanomaterial & nanotechnology, classification of nanomaterials, basic applications of nanotechnology in science & technology.	**08**
Unit -2	
Properties of Materials: Mechanical, thermal, and magnetic properties of nanomaterials, effect of size reduction on properties. Applications of nanotechnology in surface science, energy & environment.	**08**
Unit – 3	
Synthesis: Synthesis of bulk polycrystalline samples, growth of single crystals, preparation of nanoparticle- bottom-up approach- sol gel synthesis **Fabrication**: Hydro thermal growth, thin film growth, PVD and CVD, top-down approach- Ball milling, micro fabrication, lithography, requirements for realizing semiconductor nanostructures.	**12**
Unit – 4	
Characterization Techniques: X-Ray diffraction, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, atomic force microscopy, piezo response microscopy, diffuse reflectance spectra, Raman spectroscopy. Applications of nano structured thin films, applications of quantum dots.	**12**
Unit – 5	
Carbon Nanotechnology: Allotropes of Carbon, Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology. Applications of nanocrystalline diamond films, grapheme, and applications of carbon nanotubes, applications of carbon nanotechnology in biology and medicine.	**10**

Course outcomes:

On completion of this course, students are able to

1. Explain the importance of Nanotechnology & its emergence in various fields.
2. Identify various properties of nanomaterials in different applications.
3. Select synthesis and fabrication methods, techniques and process parameters for processing of nanomaterials.
4. Evaluate the properties of nanomaterials using different characterization tools & equipment.
5. Discuss the concept of carbon allotropes in Nano Technology & their applications

Text Books:

1. Nanoscience and nanotechnology: M.S. Ramachandra Rao & Shubra singh/ Wiley publishers.

Reference Books:

1. Introduction to nanotechnology by Charles P.Poole., J.Owens/ Wiley publishers.
2. Nanotechnology by Jermy J Ramsden, Elsevier publishers
3. Nano Essentials- T Pradeep/TMH

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2		2		1								1	
2	1	2		2								1	2	
3		1	2	2	1							1	2	
4				2	2							1	1	
5					2		2					2	2	
Course	**1**	**1**	**1**	**2**	**2**		**1**					**1**	**2**	

INDUSTRIAL ROBOTICS WITH ARTIFICIAL INTELLIGENCE SEMESTER - V			
Subject Code	21MEMEP504C	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Enable the students to

1. Gain the knowledge of industrial robots, configurations and actuators.
2. Apply spatial transformations to obtain forward and inverse kinematics.
3. Generate trajectory planning for path description and generation.
4. Describe the functioning of sensors and the specific applications of robots in industry.
5. Understand the concepts of Artificial Intelligence in manufacturing industry.

Unit -1	**Hours**
Introduction: An overview of Robotics, Automation and Robotics, CAD/CAM and Robotics — present and future applications – classification by coordinate system. Components of industrial robotics: Components, common types of arms, number of degrees of freedom, end effectors, requirements and challenges of end effectors, Actuators-Pneumatic, Hydraulic actuators, electric & stepper motors.	**10**
Unit -2	
Motion analysis: Homogeneous transformations as applicable to rotation and translation – problems. **Manipulator kinematics:** Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics – problems.	**10**
Unit – 3	
Trajectory planning: General considerations in path description and generation. Trajectory planning, path planning, Skew motion, joint integrated motion –straight line motion- Robot programming, languages and software packages.	**10**
Unit – 4	
Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors. **Robot applications in manufacturing:** Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection	**10**
Unit – 5	
Artificial Intelligence in Manufacturing Industry: Introduction, developments of Artificial intelligence in manufacturing Industry; Advantages, limitations and applications of Artificial Intelligence in Manufacturing industry- fault diagnosis, Quality inspection, inventory control, industrial safety and maintenance.	**10**

Course outcomes:

1. Identify various robot configurations, actuators and sensors for a robot based on specific application.
2. Carry out the motion analysis and kinematic analysis for forward and inverse kinematics
3. Perform trajectory planning for a robot manipulator
4. Explain the specific applications of a robot in industry.
5. Apply the concepts of Artificial Intelligence in manufacturing industry.

TEXT BOOKS

1. Industrial Robotics / Groover M P /Pearson Edu/ McGraw Hill
2. Robotics and Control / Mittal R K &Nagrath I J / TMH
3. Robotics / Fu K S/ McGraw Hill
4. Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd edition, Prentice Hall.

REFERENCE BOOKS

1. Robotic Engineering / Richard D. Klafter/ Prentice Hall
2. Introduction of robotics/ John J Craig/ Pearson Edu
3. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley
4. Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2	2	3		3								2	
2	3	3	3										2	
3	3	3	2		3								2	
4	3	2	2		3								2	
5	2	2	3		3								2	
Course	**3**	**3**	**3**		**3**								**2**	

ADVANCED MATERIALS SEMESTER - V			
Subject Code	21MEMEP504D	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives

The objective for this course is

1. To understand the mechanics of different materials.
2. To understand the concepts such as anisotropic material behavior, constituent properties and manufacturing processes of different composites.
3. To understand the suitability of smart and nano materials for engineering applications.

Unit -1	**Hours**
INTRODUCTION TO COMPOSITE MATERIALS: Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber- reinforced composites and nature-made composites, and applications **REINFORCEMENTS:** Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and born carbide fibres.	**10**
Unit -2	
Polymer composites, thermoplastics, thermosetting plastics, manufacturing of PMC, MMC & CCC and their applications. **MANUFACTURING METHODS:** Autoclave, tape production, moulding methods, filament winding, hand layup, pultrusion, RTM.	**10**
Unit – 3	
MACROMECHANICAL ANALYSIS OF A LAMINA: Introduction, generalized Hooke's law, reduction of Hooke's law in three dimensions to two dimensions, relationship of compliance and stiffness matrix to engineering elastic constants of an orthotropic lamina, laminate-laminate code	**10**
Unit – 4	
FUNCTIONALLY GRADED MATERIALS: Types of functionally graded materials-classification-different systems-preparation-properties and applications of functionally graded materials. **SHAPE MEMORY ALLOYS:** Introduction-shape memory effect-classification of shape memory alloys-composition-properties and applications of shape memory alloys.	**10**
Unit – 5	
NANO MATERIALS: Introduction-properties at nano scales-advantages & disadvantages-applications in comparison with bulk materials (nano – structure, wires, tubes, composites). state of art nano advanced- topic delivered by student.	**10**

Course outcomes:

After learning the course, the students should be able to

1. Explain various composite materials with their constituents, advantages, limitations and applications
2. Describe various manufacturing methods of polymer matrix composites materials.
3. Derive stress strain relationships for orthotropic materials and analyze orthotropic lamina.
4. Explain various functionally graded materials with their properties, preparation and applications
5. Explain different smart materials with their application.

TEXT BOOKS

1. Nano material /A.K. Bandyopadyay/New age Publishers
2. Material science and Technology: A comprehensive treatment/Robert W.Cahn,/VCH
3. Engineering Mechanics of Composite Materials / Isaac and M Daniel/Oxford University Press

REFERENCE BOOKS

1. Mechanics of Composite Materials / R. M. Jones/ Mc Graw Hill Company, New York, 1975.
2. Analysis of Laminated Composite Structures / L. R. Calcote/Van Nostrand Rainfold,NY 1969
3. Analysis and performance of fibre Composites /B. D. Agarwal and L. J. Broutman /Wiley Interscience, New York, 1980
4. Mechanics of Composite Materials - Second Edition (Mechanical Engineering) /Autar K.Kaw / CRC Press

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2	2										2		
2	2				2							2		
3	1	1			1							1		
4	2					2					2	2		
5											2	2		
Course	**2**	**1**			**1**	**1**					**2**	**2**		

INDUSTRIAL MANAGEMENT SEMESTER - V			
Subject Code	21MEMEP504E	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives

The objective for this course is

1. To impart fundamental knowledge and skill sets required in the Industrial Management and Engineering profession, which include the ability to apply basic knowledge of mathematics, probability and statistics, and the domain knowledge of Industrial Management and Engineering
2. To produce graduates with the ability to adopt a system approach to design, develop, implement and innovate integrated systems that include people, materials, information, equipment and energy.
3. To enable students to understand the interactions between engineering, business, technological and environmental spheres in the modern society.
4. To enable students to understand their role as engineers and their impact to society at the national and global context.

Unit -1	**Hours**
INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, differences between production management and industrial engineering, quantitative tools of IE and productivity measurement. concepts of management, importance, functions of management, scientific management, Taylor's principles, theory X and theory Y, Fayol's principles of management.	**10**
Unit -2	
PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts, plant maintenance, preventive and breakdown maintenance.	**10**
Unit – 3	
WORK STUDY: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs	**10**
Unit – 4	
STATISTICAL QUALITY CONTROL: Quality control, Queing assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts – X and R – charts X and S charts and their applications, numerical examples. **TOTAL QUALITY MANAGEMENT:** zero defect concept, quality circles, implementation, applications, ISO quality systems. six sigma – definition, basic concepts	**10**

Unit – 5	
RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job-evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, types. **VALUE ANALYSIS:** Value engineering, implementation procedure, enterprise resource planning and supply chain management.	**10**

Course outcomes:

After learning the course, the students should be able to

1. Design and conduct experiments, analyse, interpret data and synthesize valid conclusions
2. Design a system, component, or process, and synthesize solutions to achieve desired needs
3. Use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints
4. Function effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management

TEXT BOOKS

1. Industrial Engineering and management / O.P Khanna/Khanna Publishers.
2. Industrial Engineering and Production Management/Martand Telsang/S.Chand & Company Ltd. New Delhi

REFERENCE BOOKS

1. Industrial Management / Bhattacharya DK/Vikas publishers
2. Operations Management / J.G Monks/McGrawHill Publishers.
3. Industrial Engineering and Management Science/T.R. Banga,S.C.Sharma, N. K. Agarwal/Khanna Publishers
4. Principles of Management /Koontz O' Donnel/McGraw Hill Publishers.
5. Industrial Engineering and Management /NVS Raju/Cengage Publishers

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2					2					2	1		
2	2				2				1		1	1		
3	2				2				1	1	2	1		
4	1				1				1	1	3	1		
5									1	1	3	1		
Course	**2**				**2**	**1**			**1**	**1**	**3**	**1**		

MACHINE TOOLS AND METROLOGY LAB SEMESTER - V			
Subject Code	21MEMEL5060	**IA Marks**	15
Number of Lecture Hours/Week	3	**Exam Marks**	35
Total Number of Lecture Hours	48	**Exam Hours**	3
Credits – 1.5			

Course objectives: The students should be able to:

1. Know the basic operations such as turning, shaping, slotting, milling, grinding, etc
2. Describe the effect of process parameters.
3. Gain the knowledge of different coolants used in drilling and grinding operations.
4. Measure lengths, diameters and heights
5. Determine the pitch of screws and gears

EXPERIMENTS

1. Step turning and thread cutting on lathe machine
2. Producing a hole on given specimen using drilling machine
3. Producing a flat surface on given work piece using shaping machine
4. Machining a spur gear using slotting machine
5. Producing a keyway slot using milling machine
6. Producing a cylindrical surface using cylindrical grinding machine
7. Producing a flat surface using surface grinding machine
8. Producing a flat surface using planer machine
9. Grinding of single point cutting tool angles using tool & cutter grinding machine
10. Measuring lengths, heights, diameters using vernier calipers, micrometer, height gauge
11. Measuring bore diameter using internal micrometer and dial bore indicator
12. Measuring taper angle using bevel protractor, sine bar
13. Measurement of pitch of screw and gear and clearance angle of cutting tool by tool maker's microscope.

Course outcomes: Upon successful completion of this course, the students will be able to:

1. Understand the mechanism of chip formation.
2. Analyze various cutting tool parameters in different machining operations.
3. Operate different machine tools.
4. Apply the knowledge of different instruments for linear and angular measurements.
5. Choose the appropriate measuring instrument for a specific requirement.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3		2				1					1	2	
2	2		2				1					1	2	
3	2		2				1					1	2	
4	2		3		3		1					1	2	
5	3		2		3		1					1	1	
Course	**3**		**3**		**2**		**1**					**1**	**2**	

THEORY OF MACHINES LAB SEMESTER - V			
Subject Code	21MEMEL5070	**IA Marks**	15
Number of Lecture Hours/Week	03(P)	**Exam Marks**	35
Total Number of Lecture Hours	48	**Exam Hours**	03
Credits –1.5			

Course objectives:

Students should be able to

1. Demonstrate working of gears, gear trains and kinematic mechanisms
2. Evaluate moment of inertia of flywheel, coefficient of friction for belt drive
3. Examine speed regulations of hart nell governor, observe the effect of gyroscopic couple and cam jump phenomena
4. Estimate unbalanced forces in static and dynamic balancing of rotating masses and determine performance characteristics of a screw jack
5. Understand the characteristics of vibrations in beams and shafts.

Experiments:

1. Slider displacement, velocity and acceleration against crank rotation for single slider crank mechanism/four bar mechanism
2. Demonstration of various types of gears: Spur, Helical, Worm and Bevel Gears
3. Determination of coefficient of friction between belt and pulley
4. Moment of inertia of a flywheel
5. Analysis of motion of a motorized gyroscope when the couple is applied along its spin axis
6. Determination of the position of sleeve against controlling force and speed of a governor and to plot the characteristic curves of radius of rotation
7. Follower displacement vs cam rotation for various cam follower systems
8. Study of static and dynamic balancing using rigid blocks
9. Study of simple and compound screw jack and determination of the mechanical advantage, velocity ratio and efficiency
10. Determination of the frequency of undamped free vibration of spring mass system
11. Determination of the frequency of damped force vibration of a spring mass system
12. Determination of whirling speed of shaft theoretically and experimentally.

Course outcomes: Upon Completion of this course, the students will be able to:

1. Study different types of four bar mechanism, gears and gear trains.
2. Estimate the coefficient of friction between belt and pulley drive and also find the moment of inertia of a flywheel.
3. Calculate the gyroscopic couple of a rotating disc under various loads and speed conditions and analyse speed regulations of Hartnell governor and cam jump phenomenon.
4. Distinguish between static and dynamic balancing of rotating masses and performance characteristics of a screw jack.

5. Find the natural frequency of a vibratory system with various beams and critical speed of a shaft for different configurations.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2	2	1	1								1	2	
2	2	2	2	1								1	2	
3	2	3	1	2								1	2	
4	2	3	2	1								1	2	
5	2	3	2	2								1	2	
Course	**2**	**3**	**2**	**2**								**1**	**2**	

MACHINE DRAWING PRACTICE LAB SEMESTER-V			
Subject Code	21MEMEN5090	**Internal Marks**	30
Number of Lecture Hours/Week	01(L)+03(P)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 00			

COURSE OBJECTIVES:

This course will enable students to:

1. Study the conventions and rules to be followed by engineers for making accurate drawings.
2. Understand and apply national and international standards while drawing machine component.
3. Acquire knowledge of fastening arrangements such as riveting.
4. Familiarize in drawing assembly, orthographic and sectional views of various joints.
5. Familiarize in drawing assembly, orthographic and sectional views of various couplings.

Unit -1	**Hours**
Drawing of Machine Elements and simple parts Selection of views, additional views for the following machine elements and parts. a) Popular forms of screw threads, bolts, nuts and foundation bolts b) Keys, cotter joints and knuckle joint. c) Riveted joints for plates	**10**
Unit -2	
Drawing of Machine Elements and simple parts Selection of views, additional views for the following machine elements and parts. a) Shaft coupling, spigot and socket pipe joint. b) Journal, pivot and collar and foot step bearings.	**10**
Unit – 3	
Assembly Drawing - I Drawings of assembled views for the part drawings of the following using conventions. Engine parts – Stuffing Box, Petrol Engine connecting rod, Cross Heads, Piston Assembly	**10**
Unit – 4	
Assembly Drawing - II Drawings of assembled views for the part drawings of the following using conventions. Machine parts - screws jack, machine vices, Plummer Block, Lathe Tailstock.	**10**
Unit – 5	

Assembly Drawing - III Drawings of assembled views for the part drawings of the following using conventions. Valves: Steam stop valve, Spring loaded safety valve, Feed check valve and Air cock.	**10**

COURSE OUTCOMES:

On completion of the course, student will be able to

1. Identify the national and international standards pertaining to machine drawing.
2. Illustrate various machine components through drawings.
3. Construct an assembly drawing of a machine unit
4. Interpret a set of working drawings of a machine assembly including detail drawings, bill of materials, part specifications
5. Analyze the part or assembly drawings as per the conventions.

Question paper pattern:

Section A:

1. This section contains three questions carrying 10 marks each.
2. Answer any Two questions in Section- A 10 x 2 = 20 marks.

Section B:

1. Question from Section-B is compulsory – 50 x 1= 50 marks

Text Books:

1. Machine Drawing – N.Siddeswar, K.Kannaiah & V.V.S.Sastry – TMH
2. Machine Drawing –K.L.Narayana, P.Kannaiah & K. Venkata Reddy / New Age/ Publishers

Reference Books:

1. Production and Drawing – K.L. Narayana & P. Kannaiah/ New Age
2. Machine Drawing – P.S.Gill
3. Machine Drawing – N.D. Junnarkar, Pearson
4. Machine Drawing – Ajeeth Singh, McGraw Hill

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	1		2							1		1	1	
2	1		2							1		1	1	
3	2		2							1		2	1	
4	2		2							1		2	1	
5	1		2							1		2	1	
Course	**1**		**2**							**1**		**2**	**1**	

COURSE STRUCTUREAND SYLLABUS

SITE-21 REGULATIONS

For

III B.Tech. VI Semester

Mechanical Engineering

III B. Tech. VI Semester Course Structure for the Regulation SITE 21

S.No.	CC	Course Code	Course Title	L	T	P	Cr
1	PCC	21MEMET6010	CAD/CAM/CIM	3	0	0	3
2	PCC	21MEMET6020	Finite Element Methods	3	0	0	3
3	PCC	21MEMET6030	Heat Transfer	3	0	0	3
4	PEC	21MEMEP604X	Professional Elective-II	3	0	0	3
5	OEC	21MEXXO605X	Open Elective Course-II	3	0	0	3
6	PCCL	21MEMEL6060	CAD/CAM Lab	0	0	3	1.5
7	PCCL	21MEMEL6070	Heat Transfer Lab	0	0	3	1.5
8	PCCL	21MEMEL6080	Instrumentation and Mechatronics Lab	0	0	3	1.5
9	SOC	21CMAHS6090	Soft Skills & Aptitude Builder - 2	1	0	2	2
10	MC	21CMBIN6100	Biology for Engineers	2	0	0	0
11	I/RI	Research Internship - 2 Months (Mandatory) after Third year (to be evaluated during VII semester					
Total Credits							**21.5**
12	H/M		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)	4	0	0	4

Professional Elective-II

S. No.	CC	Subject Code	Name of the subject	L	T	P	Cr
1	PEC	21MEMEP604A	Gas Dynamics and Jet Propulsion	3	0	0	3*
2		21MEMEP604B	Mechanical Vibrations	3	0	0	3*
3		21MEMEP604C	Instrumentation and Mechatronics	3	0	0	3*
4		21MEMEP604D	Unconventional Machining Processes	3	0	0	3*
5		21MEMEP604E	Energy Management	3	0	0	3*
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

CAD/CAM/CIM SEMESTER - VI			
Subject Code	21MEMET6010	**Internal Marks**	30
Number of Lecture Hours / Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. Describe the structure and usage of a graphic system in an industry by the knowledge gained on CAD/CAM systems
2. Use the knowledge on curves in calculating the and data points used in generating various curves with the help of modeling software and generation techniques.
3. Outline the working and application of NC machines and develop the part programs necessary for manufacturing a machine component using NC/CNC machines
4. Modify the conventional manufacturing system to an organized system for increasing the production using proper planning and group technology techniques.
5. Demonstrate the implementation of CAD/CAM techniques in a completely integrated manufacturing industry using CAQC and CIM knowledge

Unit -1	**Hours**
Introduction to CAD/CAM: Introduction to CAD/CAM/CIM, Sequential and concurrent engineering Fundamentals of CAD, Product cycle, Design process, CAD/CAM hardware **Fundamentals of Computer Graphics:** Raster scan graphics coordinate system, Database structure for graphics modeling, clipping, hidden surface removal. **Transformations of Geometry:** Translation, Scaling, Reflection, Rotation, Homogeneous representation of transformation, Concatenation of transformations.	**10**
Unit -2	
Geometric Modelling of Curves: Wire frame modelling, Wireframe entities, Curve representation, Parametric representation of analytic curves, Parametric representation of Hermite cubic spline, Bezier and B-spline curves. **Geometric Modelling of Surfaces:** Surface modeling, Basic surface entities, Parametric representation of analytic & Synthetic surfaces. **Geometric Modelling of Solids:** Solid modeling, Solid entities, Boolean operations, Boundary representation of Solid Modelling, CSG approach of Solid Modelling.	**12**
Unit – 3	
DRAFTING AND MODELING SYSTEMS: Basic geometric commands, layers, display control commands, editing, dimensioning, solid	**12**

modelling. **Computer Aided Manufacturing (CAM):** Introduction to Computer Numerical Control (CNC), Basic components of NC system, NC coordinate system, Motion control systems, Feedback devices, CNC tooling, features of machining center, turning center. **CNC Programming:** Part programming fundamentals, Manual Part Programming, Computer assisted part programming, APT Programming, Geometric & motion commands, Post processor commands.	
Unit – 4	
Group Technology: Introduction, part families, parts classification and coding, features of parts classification of coding system, OPITZ, MICLASS and Production Flow Analysis, composite part concept, machine cell design and applications. **Computer Aided Process Planning (CAPP)**: Introduction to CAPP, Variant & Generative methods of CAPP, Benefits of CAPP.	**10**
Unit – 5	
Computer Aided Quality Control: Introduction, Terminology in Quality control, Computer in QC, contact and noncontact inspection techniques, computer aided testing, integration of CAQC with CAD/CAM. **Computer Integrated Manufacturing Systems (CIMS):** Introduction to CIM, Scope of CIM, Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, computer control systems, human labor in manufacturing systems, CIMS benefits.	**10**

Course outcomes:

1. Demonstrate computer graphic system used for design & manufacturing in industries for production and services.
2. Develop newly transforms entities for 2D, 3D representations and generation of curves, surfaces and solids entities for a graphic system using the mathematical modeling techniques for a computer graphic system.
3. Develop designs and suitable part programs for working of a NC/CNC/DNC machine for machining any given component using the knowledge gained on the design tools and CNC machines.
4. Choose the best production system applicable for manufacturing a machine component using the planning and group technology techniques
5. Examine the adaptable automation in a manufacturing system for increasing the production using the computer aided quality control and computer integrated manufacturing techniques

TEXT BOOKS:

1. CAD/CAM- Computer Aided Design & Manufacturing/M.D. Groover & E.W. Zimmer.
2. CAD/CAM/Ibrahim Zeid/Tata McGrawhill, Delhi.

REFERENCES:

1. CAD/CAM/CIM/Radhakrishna/New age international.
2. CAD/CAM/P.N.Rao/Tata McGrawhill , Delhi
3. CAD/CAM/CIM/P. Radhakrishna & S. subramanyan

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	2			1									2
2	3	3	2		2							2		2
3	3	2	1		2							2	3	
4	2	2	1		2							1	3	
5	3	2			3							2	3	2
Course	**3**	**3**	**1**		**3**							**2**	**2**	**2**

FINITE ELEMENT METHODS SEMESTER - VI			
Subject Code	21MEMET6020	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Students will be able to

1. Understand basic principles and procedure of finite element analysis.
2. Study the theory and characteristics of finite elements that represent engineering structures.
3. Apply finite element solutions to structural, thermal, dynamic problem.
4. Solve the complex geometry problems and solution techniques.
5. Understand the concept of dynamic analysis in finite element methods.

Unit -1	**Hours**
INTRODUCTION: Introduction to finite element method, stress and equilibrium, strain–displacement relations, stress–strain relations, plane stress and plane strain conditions, variational and weighted residual methods, concept of potential energy, Formulation of Finite element characteristic matrices and vectors (Element Stiffness Matrix and Load Vectors), Assembly of element stiffness for one dimensional problem.	**10**
Unit -2	
FINITE ELEMENT FORMULATION: Concept of discretization, Interpolation, Compatibility, Assembly and boundary considerations. Shape functions for one dimensional quadratic and cubic elements in natural coordinates, treatment of boundary conditions, Temperature effects, node numbering, mesh generation, local and global coordinates, convergence requirements.	**8**
Unit – 3	
Analysis of Plane Trusses: Plane Trusses, Local and Global Coordinate systems, Element Stiffness Matrix, Stress Calculations, Example of plane Truss with three members. **Analysis of Beams:** Two node beam Element, shape functions, element stiffness matrix and load vectors, simple problems on beams with distributed and point loads.	**12**
Unit – 4	
Finite element modeling of two-dimensional stress analysis with constant strain triangles, Shape functions of CST element. **Higher Order and Iso Parametric Elements:** Two dimensional four nodded isoperimetric elements, Lagrangian interpolation functions and Numerical Integration.	**10**
Unit – 5	
Steady State Heat Transfer Analysis: one dimensional analysis of a	**10**

fin and two-dimensional analysis of thin plate, analysis of a uniform shaft subjected to torsion.

Dynamic Analysis: Formulation of finite element model, element consistent and lumped mass matrices, evaluation of Eigen values and Eigen vectors, free vibration analysis.

Course outcomes:

On the completion of this course, students are able to

1. Identify and formulate different stress and strain relations, displacement relations on a particular object using FEM methods.
2. Apply and solve different element shapes using stiffness matrix.
3. Differentiate and analyse different types of trusses and beams.
4. Apply one dimensional quadratic equation on isoparametric elements and numerical integrations.
5. Apply the dynamic analysis on various beam elements.

TEXT BOOKS

1. J.N. Reddy, An Introduction to Finite Element Method, Tata McGraw Hill
2. P.Seshu. Text Book of Finite Element Analysis, Prentice Hall
3. S.S.Rao,The Finite Element Methodin Engineering, 3rd., Butter worth
4. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall

REFERENCES BOOKS

1. S.S. Bavakati, Finite Element Analysis, New age Publishers
2. R.D Cook, Finite Element Modeling for Stress Analysis, John Wiley&Sons Inc.
3. O.C. Zienkiewicz and R.L. Taylor, Finite Element Methods, Butterworth

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice).
2. All questions carries 14 marks each.
3. Each full question will have sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3	3			2								2
2	3					2								
3	3	3	3			2								2
4	3	3				2								2
5	3	3				2								2
Course	**3**	**2**	**2**			**2**								**2**

HEAT TRANSFER SEMESTER - VI			
Subject Code	21MEMET6030	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. **Understand** the modes of heat transfer and their applications in different energy systems.
2. **Gain** the knowledge on effectiveness and efficiency of fins for various heat transfer applications.
3. **Understand** the concepts of continuity, momentum and energy principles of fluid flow problems in heat transfer.
4. **Select appropriate** correlations to evaluate heat transfer coefficients for forced and natural convection over exterior surfaces and flow through pipes.
5. **Acquire** the knowledge on heat exchanger performance by using LMTD and NTU methods and Familiarize radiation heat transfer concepts of black body surfaces and gray body surfaces

Unit -1	**Hours**
Introduction: Modes and mechanisms of heat transfer – basic laws of heat transfer – General discussion about applications of heat transfer. **Conduction Heat Transfer:** Fourier rate equation – general heat conduction equation in Cartesian, cylindrical and spherical coordinates. Steady, unsteady and periodic heat transfer – initial and boundary conditions. **One Dimensional Steady State Heat Conduction:** Conductive heat transfer through slab, cylinder, sphere – Homogeneous slabs, hollow cylinders – overall heat transfer coefficient– critical radius of insulation – Variable thermal conductivity – systems with heat sources or heat generation	**10**
Unit -2	
Extended Surfaces (Fins): Types, applications, fin materials, heat transfer from fins with uniform cross section – long fin, fin with insulated tip and short fin, Fin efficiency and Effectiveness – application to error measurement of temperature. **One Dimensional Transient Conduction:** Lumped heat capacity systems– significance of Biot and Fourier numbers- chart solutions of transient conduction systems	**10**
Unit – 3	
Convection: Dimensional analysis– Buckingham Pi Theorem for forced and free convection – non-dimensional numbers and their significance – concepts of continuity, momentum and energy equations. **Forced Convection:** Concepts about hydrodynamic and thermal	**10**

boundary layers and their thicknesses – use of empirical correlations for convective heat transfer – flat plates, cylinders, horizontal pipe flow and annulus flow.	
Unit – 4	
Natural Convection: Development of hydrodynamic and thermal boundary layer along a vertical plate – use of empirical relations for vertical plates and cylinders, horizontal plates and cylinders. **Boiling:** Pool boiling – regimes- calculations on nucleate boiling, critical heat flux and film boiling. **Condensation:** Film wise and drop wise condensation –Nusselt"s theory of condensation on a vertical plate – film condensation on vertical and horizontal cylinders using empirical correlations.	**10**
Unit – 5	
Heat Exchangers: Classification of heat exchangers, temperature distribution, – overall heat transfer coefficient, fouling factor –concepts of LMTD and NTU methods – Effectiveness of the heat exchanger. **Radiation Heat Transfer:** Basic concepts and definitions: Absorptivity, Reflectivity, Transmissivity – concept of black body – Laws of radiation – heat transfer between two finite black surfaces and two grey surfaces – concept of shape factor – Emissivity — radiation shields.	**10**

Course outcomes:

After the completion of the course students will be able to

1. **Formulate** heat transfer conduction equations on engineering systems.
2. **Analyze** the conduction and convection heat transfer coefficients on fins which are used in real time applications.
3. **Solve** fluid flow problems using continuity, momentum and energy principles.
4. **Evaluate** heat transfer coefficients for forced convection and natural convection.
5. **Determine** heat exchanger performance and effectiveness by using the method of LMTD & NTU and calculate the radiation heat transfer between black body & gray body surfaces.

TEXT BOOKS:

T1: Fundamentals of Engg. Heat and Mass Transfer / R. C. Sachdeva / New Age International.

T2: Heat and Mass Transfer – R. K. Rajput / S. Chand revised 9th edition

REFERENCE BOOKS:

R1: Heat and Mass Transfer –Cengel- McGraw Hill

R2: Heat and Mass Transfer – Arora and Domkundwar, Dhanpatrai & Sons.

R3: Heat and mass transfer - D.S.Kumar, katson publishers.

Note: Heat and Mass transfer Data Book by C P Kothandaraman and Subrahmanyan is used to design and analyze various thermal processes and thermal equipment.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3	3									2	2	3
2	2	3	2									2	2	2
3	3	3	2									3	2	3
4	3	2	2									2	2	3
5	3	3	3									3	2	3
Course	**3**	**3**	**2**									**3**	**2**	**3**

GAS DYNAMICS AND JET PROPULSION SEMESTER - VI			
Subject Code	21MEMEP604A	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives

1. To understand the basic principle of Gas Dynamics
2. To analyze flow with normal and Oblique shocks
3. To understand about Simple frictional flow: adiabatic flow with friction
4. To Examine the effect of heat transfer on flow parameters, Rankine Hugoniat equations
5. To understand and analyze the basic principle and importance of Jet Propulsion, - thrust equation - effective jet velocity - specific impulse - rocket engine performance.

Unit -1	**Hours**
control volume and system approach acoustic waves and sonic velocity - Mach number - classification of fluid flow based on Mach number - Mach cone compressibility factor - general features of one-dimensional flow of a compressible fluid - continuity and momentum equations for a control volume.	**10**
Unit -2	
basic equation - stagnation enthalpy, temperature, pressure and density stagnation, acoustic speed - critical speed of sound- dimensionless velocity governing equations for isentropic flow of a perfect gas - critical flow area - stream thrust and impulse function. Steady one-dimensional isentropic flow with area change-effect of area change on flow parameters chocking- convergent nozzle - performance of a nozzle under decreasing back pressure -De Lavel nozzle - optimum area ratio effect of back pressure - nozzle discharge coefficients - nozzle efficiencies.	**10**
Unit – 3	
adiabatic flow with friction in a constant area duct-governing equations – Fanno line limiting conditions - effect of wall friction on flow properties in an Isothermal flow with friction in a constant area duct-governing equations - limiting conditions. Steady one-dimensional flow with heat transfer in constant area ducts- governing equations – Rayleigh line entropy change caused by heat transfer - conditions of maximum enthalpy and entropy	**10**
Unit – 4	
Intersection of Fanno and Rayleigh lines. Shock waves in perfect gas-properties of flow across a normal shock - governing equations - Rankine Hugoniat equations - Prandtl velocity relationship - converging diverging nozzle flow with shock thickness - shock strength.	**10**
Unit – 5	

Jet Propulsion: Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines. Types of rocket engines – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – space flights.	**10**

Course outcomes:

At the end of the course, the student will be able to:

1. Solve flow equations for quasi one-dimensional flow through variable area ducts.
2. Analyze the flow through constant area ducts with friction and heat transfer.
3. Analyze flows with normal and oblique shocks.
4. Solve flow problems with Rankine Hugoniat equations and Prandtl velocity relationship.
5. Analyze the performance of tubro propeller engines.

Text Books:

1. Compressible fluid flow /A. H. Shapiro / Ronald Press Co., 1953
2. Fundamentals of compressible flow with aircraft and rocket propulsion/S. M. Yahya/New Age international Publishers
3. Fundamental of Gas dynamics-2nd edition/ M J Zucker/ Wiley publishers

Reference Books:

1. Gas dynamics / M.J. Zucrow& Joe D.Holfman / Krieger Publishers
2. Gas dynamics and Jet propulsion /PR.S.L.Somasundaram/New age international Publisher
3. Thermal Engineering /R.K.Rajput

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3	1										3	
2	3	3	2										3	
3	3	3	1									1	3	
4	3	1	1									1	3	
5	2	2										1	2	
Course	**3**	**2**	**1**									**1**	**3**	

MECHANICAL VIBRATIONS SEMESTER - VI			
Subject Code	21MEMEP604B	**Internal Marks**	30
Number of Lecture Hours/Week	3 (L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03

Credits - 03

COURSE OBJECTIVES: The students should be able to

1. Analyze the various 1-D periodic responses of a vibrating system with and without damping
2. Learn to derive the equations of motion and solution for Two and multi degree freedom systems by the application of analytical methods
3. Understand the numerical methods for quick estimation of 1st natural frequency of multi degree freedom systems.

4 Have the knowledge of the various physical vibration measuring instruments.

5. Learn to solve vibrations problems of continuous systems.

Unit -1	**Hours**
Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility	**8**
Unit -2	
Vibration Measurement: Vibrometers, velocity meters & accelerometers Two degree of freedom systems: Principal modes – undamped and damped free and forced vibrations; undamped vibration absorbers.	**10**
Unit - 3	
Multi degree of freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete Time systems	**12**
Unit - 4	
Numerical Methods: Rayleigh's, stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods.	**10**
Unit-5	
Application of concepts: Free vibration of strings – longitudinal oscillations of bars - transverse vibrations of beams - Torsional vibrations of shafts. Critical speeds without and with damping, secondary critical speed.	**10**

COURSE OUTCOMES: The students will be able to

1. Analyze the various 1-D periodic responses of a vibrating system with and without damping.

2. Able to derive equations of motion and solutions for two and multi degree freedom systems by the application of analytical methods.
3. Able to understand the numerical methods for quick estimation of 1st natural frequency of multi degree freedom systems.
4. Apply the knowledge of the various physical vibration measuring instruments and their applications in real life vibration data acquisition.
5. Distinguish the types of vibrations occurring in machine parts and judge their effects.

Question paper pattern

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome

Text Books

1.L. Meirovitch, Fundamental of Vibrations, Mc-Graw Hill Inc., 2001
2. Grover G. K., Mechanical Vibrations , Nem Chand and Bros (2009)

Reference Books

1. W. T. Thomson, M. D. Dahleh and C.Padmanabhan, Theory of Vibration with Applications, Pearson Education India: NewDelh, 5th Edition, 2008
2. S. S. Rao, 2003, Mechanical Vibrations, Pearson India: New DelhithEdition, 2018
3. Rao V. Dukkipati and J. Srinivas, Textbook of Mechanical Vibrations, Prentice-Hall of India Pvt.Ltd, 4th Edition, 2004.

Web Sources:

1.https://nptel.ac.in/courses/112/107/112107212/
2.https://nptel.ac.in/courses/112/107/112107087/

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3											3	
2	3	3											3	
3	3	3											3	
4	3	3											3	
5	3	2											2	
Course	**3**	**2**											**3**	

INSTRUMENTATION AND MECHATRONICS SEMESTER - VI			
Subject Code	21MEMEP604C	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. To provide basic knowledge of measurement techniques, different errors measuring from the instruments. and provide basic knowledge of displacement measuring instruments.
2. To learn about various temperature and pressure measuring instruments.
3. To describe various instruments used to measure level, flow, speed, acceleration & vibrations.
4. To Identify and calculate methods of stress and strains in measurements and various instruments to measure humidity, force, torque and power.
5. To categorize the importance of control systems in instruments

Unit -1	**Hours**
Definition–Basic principles of measurement – measurement systems, generalized configuration and functional Descriptions of measuring instruments – examples. Dynamic performance characteristics – sources of error, classification and elimination of error. **Measurement of Displacement:** Theory and construction of various transducers to measure displacement – piezoelectric, inductive, capacitance, resistance, ionization and photoelectric transducers, calibration procedures.	**12**
Unit -2	
Measurement of Temperature: Classification – ranges – various principles of measurement – expansion, electrical resistance – thermistor – thermocouple – pyrometers – temperature indicators. **Measurement of Pressure:** Units – classification – different principles used. Manometers, piston, bourdon pressure gauges, bellows-diaphragm gauges. low pressure measurement – thermal conductivity gauges, Ionization pressure gauges, Mcleod pressure gauge.	**10**
Unit – 3	
Measurement of Level: Direct method – indirect methods- capacitive, ultrasonic, magnetic, cryogenic fuel level indicators – bubbler level indicators. **Flow Measurement:** Rotameter, magnetic, ultrasonic, turbine flow meter, hot – wire anemometer, laser Doppler anemometer (LDA). **Measurement of Speed:** Mechanical tachometers- electrical tachometers – stroboscope, non-contact type of tachometer	**10**

Measurement of Acceleration and Vibration: Different simple instruments – principles of seismic instruments – Vibrometer and accelerometer using this principle.	
Unit – 4	
Stress Strain Measurements: Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – usage for measuring torque, strain gauge rosettes. **Measurement of Force, Torque and Power-** Elastic force meters, load cells, torsion meters, Dynamometers.	**10**
Unit – 5	
Control Systems: Introduction, importance – classification – open and closed systems, Servo mechanisms–examples with block diagrams **Introduction to Mechatronics:** Mechatronics systems – elements & levels of mechatronics system, advantages and disadvantages of mechatronics systems Mechatronics design process, microprocessor-based controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control	**8**

Course outcomes:

On completion of this course, students should be able to:

1. **Interpret** the methods of measurement techniques, errors of the instruments and explain the working of various displacement measuring instruments.
2. **Select** the temperature and pressure measuring instruments based on their applications
3. **Choose** a suitable instrument required to measure the variables like level, flow, speed and vibration
4. **Identify** the various types of stress strain measuring gauges and explain the working of various force, torque and power measuring devices
5. **Distinguish** between open and closed loop control systems

Text Books:

1. Measurement Systems: Applications & design by D.S Kumar.
2. Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers
3. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition

Reference Books:

1. Mechanical Measurements / BeckWith, Marangoni, Linehard, PHI/PE.
2. Measurement systems: Application and design, Doeblin Earnest. O. Adaptation by Manik and Dhanesh/ TMH.
3. Gregory K. McMillan, Process/Industrial Instruments and Controls

Handbook, Fifth Edition, Mcgraw-Hill: New Yark, 1999

4. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2	3	2			2						2	3	
2	2	3	2			2						2	3	
3	2	3	2			2						2	3	
4	2	3	2			2						2	3	
5	2	3	2		1	2						2	3	
Course	**2**	**3**	**2**		**1**	**2**						**2**	**3**	

UNCONVENTIONAL MACHINING PROCESSES SEMESTER - VI			
Subject Code	21MEMEP604D	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives

The general objectives of the course are to enable the students to

1. To compare conventional and unconventional machining processes and also describe the USM method.
2. To State the mechanism of material removal in various electro chemical machining processes.
3. To identify the mechanism of material removal in various thermal metal removal processes
4. To acquire thorough knowledge of Electron Beam Machining, Laser Beam Machining Plasma Arc Machining and comparison of thermal and non-thermal processes.
5. To inculcate the concepts of AJM, WJM, AWJM and various finishing processes

Unit -1	**Hours**
INTRODUCTION: Need for non-traditional machining methods-classification of modern machining processes – considerations in process selection, applications. Ultrasonic machining: Elements of the process, mechanics of material removal, MRR process parameters, economic considerations, applications and limitations.	**10**
Unit -2	
ELECTRO – CHEMICAL MACHINING: Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring process, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM – Simple problems for estimation of metal removal rate, fundamentals of chemical, machining, advantages and applications.	**10**
Unit – 3	
THERMAL METAL REMOVAL PROCESSES: General principle and applications of Electric Discharge Machining, Electric Discharge Grinding and wire EDM – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface	**10**
Unit – 4	
Electron Beam Machining, Laser Beam Machining - Basic principle and theory, mechanics of material removal, process parameters, efficiency & accuracy, applications **Plasma Machining:** Application of plasma for machining, metal removal	**10**

mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries.	
Unit – 5	
Abrasive jet machining, Water jet machining and abrasive water jet machining: Basic principles, equipments, process variables, mechanics of material removal, MRR, application and limitations, magnetic abrasive finishing, abrasive flow finishing, Electrostream drilling, shaped tube electrolytic machining.	**10**

Course outcomes:

At the end of the course, the student will be able to:

1. Describe the need and importance of unconventional machining processes and also explain the material removal rate using USM method
2. Select the different elements of Chemical and Electrochemical machining processes and its applications.
3. Illustrate different parameters of Electric Discharge Machining processes and its applications.
4. Demonstrate the material removal process using Laser Beam Machining, Plasma Arc Machining and Electron Beam Machining.
5. To Recommend the concepts of AJM, WJM, AWJM and various finishing processes

Text Books:

1. Advanced machining process/ VK Jain/ Allied publishers.
2. Modern Machining Processes/ Pandey P.C and Shan H.S. / THM

Reference Books:

1. New Technology / Bhattacharya A/ The Institution of Engineers, India 1984
2. Manufacturing technology-II / P.N. Rao / Mc Graw Hill publications

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2					2						1	1	
2	2					2						1	2	
3	2					2						1	2	
4	2					2						1	1	
5	2					2						1	1	
Course	**3**					**2**						**2**	**2**	

ENERGY MANAGEMENT SEMESTER - VI			
Subject Code	21MEMEP604E	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives

The general objectives of the course are to enable the students to

1. Demonstrate the importance and role of energy management in the functional areas like Manufacturing Industry, Process Industry, Commerce and Govemment.
2. To know the different energy resources
3. Understand thermodynamic power cycles and the associated processes and fuels.
4. Understand the economics of energy conversion
5. Enable the students to understand the basic energy conversion and management principles and to identify sources of energy loss and target savings
6. Enable students in carrying out budgeting and risk analysis

Unit -1	**Hours**
INTRODUCTION: Principles of energy management Managerial organization, Functional areas for i) manufacturing industry, ii) Process industry, iii) Commerce, iv) Government, Role of Energy manager in each of these organizations. Initiating, Organizing and managing energy management programs	**10**
Unit -2	
ENERGY AUDIT: Definition and concepts. Types of energy audits, Basic energy concepts, Resources for plant energy studies. Data gathering, Analytical techniques. Energy Conservation: Technologies for energy conservation, Design for conservation of energy materials, Energy flow networks. Critical assessment of energy usage. Formulation of objectives and constrains, Synthesis of alternative options and technical analysis of options. Process integration.	**10**
Unit – 3	
ECONOMIC ANALYSIS: Scope, Characterization of an investment project. Types of depreciation, Time value of money. Budget considerations, Risk analysis.	**10**
Unit – 4	
METHODS OF EVALUATION OF PROJECTS: Payback, Annualized costs, Investor's rate of retum, Present worth, Internal rate of return. Pros and cons of the common method of analysis. Replacement analysis.	**10**
Unit – 5	
ALTERNATIVE ENERGY SOURCES: SOLAR ENERGY: Types of devices for solar energy collections, Thermal storage system, Control systems.	**10**

Wind Energy. Availability, Wind Devices. Wind Characteristics, performance of turbines and systems.	

Course outcomes:

At the end of the course, the student will be able to:

1. Explain the fundamentals of energy management and its influence on environment
2. Describe methods of energy production for improved utilization.
3. Apply the principles of thermal engineering and energy management to improve the performance of thermal systems.
4. Analyze the methods of energy conservation and energy efficiency for buildings, airconditioning, heat recovery and thermal energy storage systems.
5. Assess energy projects on the basis of economic and financial criteria.

Text Books:

1. Energy Management by Murfy
2. General Aspects of Energy Management and Audit, National Productivity Council of India, Chennai (Course Material- National Certification Examination for Energy Management)

Reference Books:

1. New Technology / Bhattacharya A/ The Institution of Engineers, India 1984
2. Manufacturing technology-II / P.N. Rao / Mc Graw Hill publications
3. Energy Management Handbook, W.C. Turner, 5th Edition, Marcel Dekker, Inc, New York, 2005.
4. Guide to Energy Management, B. L. Capehart, W. C. Turner, W. J. Kennedy, CRC Press, New York, 2005.
5. Energy Management by O.P. Collagan

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1				1		3	2	3		2	1	2	3	
2				1		3	2	3		2	1	2	2	
3				1		3	2	3		2	1	2	3	
4				1		3	2	3		2	1	2	3	
5				1		3	2	3		2	1	2	3	
Course				**1**		**3**	**2**	**3**		**2**	**1**	**2**	**3**	

CAD/CAM LAB SEMESTER - VI			
Subject Code	21MEMEL6060	**IA Marks**	15
Number of Lecture Hours/Week	03(P)	**Exam Marks**	30
Total Number of Lecture Hours	48	**Exam Hours**	03
Credits –1.5			

Course objectives: Students should be able to

1. Understand modeling tools for drawing machine components
2. Gain the knowledge of 3D drawing of machine components
3. Gain the knowledge of Assembly drawing of machine components
4. Study the NC and CNC codes
5. Prepare simple parts on the CNC Machining center.

Introduction

Introduction to various modeling and simulation packages, their importance and applications in industries.

1. DRAFTING:

Development of part drawings for various components in the form of orthographic and isometric. representation of dimensioning and tolerances scanning and plotting. study of script, DXE and IGES files.

2. PART MODELING

1. 3D Solid part modeling of mechanical components
2. 3D Part modeling of mechanical components using revolve option
3. 3D Part modeling of mechanical components using hollow
4. 3D Part modeling of mechanical components using sweep
5. 3D Part modeling of mechanical components using swept boss
6. 3D Part modeling of mechanical components using boundary boss
7. 3D Part modeling of mechanical components using rib, pattern, draft

3. ASSEMBLY MODELING

8. Assembly of screw jack using Bottom-up approach
9. Assembly of any one cotter joint using Bottom-up approach

4. CNC MACHINING

10. Study of NC and CNC codes used in CNC machining.
11. NC Programming Practice for machining various components related to turning
12. NC Programming Practice for machining various components related to milling
13. Automated CNC Tool path & G-Code generation using Pro-E/Master CAM

Course outcomes: Upon Completion of this course, the students will be able to:

1. Identify the various sketch and part design tools in modeling software
2. Draw machine components by modeling software
3. Apply the knowledge of part drawing
4. Apply the knowledge of assembly drawing
5. Prepare part programme for engineering components on CNC Machining center

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3	2	2								2		3
2	3	3	2	2								2		3
3	3	3	2	2								2		3
4	3	3	2	2								2		3
5	3	3	2	2								2		3
Course	**3**	**3**	**2**	**2**								**2**		**3**

HEAT TRANSFER LAB SEMESTER - VI			
Subject Code	21MEMEL6070	**Internal Marks**	15
Number of Lecture Hours/Week	3(P)	**External Marks**	35
Total Number of Lecture Hours	45	**Exam Hours**	03
Credits – 1.5			

Course Objectives: Enable the students to

1. Illustrate basic heat transfer principles and test the thermal conductivity of a metal rod.
2. Evaluate overall heat transfer coefficient in case of composite wall and heat exchanger.
3. Analyze the efficiency and temperature distribution of a pinfin.
4. Compare the emissivity of black and grey body.
5. Estimate heat transfer coefficient in case of external flows.
6. Interpret the data for Convection and Radiation.

LIST OF EXPERIMENTS

1. Determination of overall heat transfer co-efficient of a composite slab
2. Determination of heat transfer rate through a lagged pipe.
3. Determination of heat transfer rate through a concentric sphere.
4. Determination of thermal conductivity of a metal rod.
5. Determination of efficiency of a pin-fin.
6. Determination of heat transfer coefficient in forced convection & natural convection.
7. Determination of COP of VCR system.
8. Determination of effectiveness of parallel and counter flow heat exchangers.
9. Determination of emissivity of a given surface.
10. Determination of Stefan Boltzman constant.
11. Determination of critical heat flux.
12. Determination of heat transfer rate in drop and film wise condensation.

ADDITIONAL EXPERIMENTS

1. Determination of heat transfer rate in radiator using radiator test rig.
2. Determination of heat transfer rate in twisted tape inserted co-axial heat exchanger.
3. Demonstration of heat pipe.

Course outcomes:

On completion of this course, students should be able to:

1. Determine thermal conductivity of different common metallic materials
2. Determine the quantity of heat transfer between fluids and solid boundaries
3. Analyze different heat exchangers and Evaluate the amount of heat exchanged between fluids flowing within heat exchangers
4. Explain simple experimental work in radiative heat transfer
5. Determine the Stefan Boltzman constant & Critical heat flux

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	2	2	3									3	
2	3	2	2	3									3	
3	3	3	2	3									3	
4	3	3	3	3									3	
5	3	2	2	3									3	
Course	**3**	**2**	**3**	**3**									**3**	

INSTRUMENTATION &MECHATRONICS LAB SEMESTER - VI			
Subject Code	21MEMEL6080	**Internal Marks**	15
Number of Lecture Hours/Week	3(P)	**External Marks**	35
Total Number of Lecture Hours	45	**Exam Hours**	03
Credits – 1.5			

Course objectives: The students should be able to:

1. Understand the experimental work in the laboratory and calibration of various instruments for measuring temperature, displacement
2. Measure low and medium pressures using Mechanical and Electrical sensors.
3. Measure flow, speed and vibration using analogue and digital sensors.
4. Characterize the load and displacement using transducer kit
5. Develop PLC programs for control of traffic lights, water level and lifts.

LIST OF EXPERIMENTS

1. Instrumentation & Measurement

1. Displacement measurement by using capacitive trainer
2. Temperature measurement by using thermocouples
3. Pressure measurement by using bourdon tube pressure gauge.
4. Pressure measurement by using Mcleod gauge.
5. Flow measurement by using Rotameter.
6. Speed measurement by using Digital tachometer.
7. Vibration measurement by using seismic pickup.

2. DYNA 1750 Transducers Kit

8. Displacement measurement by using LVDT.
9. Load measurement by using strain gauge load cell.
10. Temperature measurement by using thermistors/RTD

3. PLC PROGRAMMING

11. Logic Gates Using Ladder Logic Programme
12. Traffic Light controller Using Ladder Logic Programme
13. Water level controller Using Ladder Logic Programme
14. Lift controller Using Ladder Logic Programme

COURSE OUTCOMES:

After completion of the course student will be able to:

1. Know requirement of calibration, errors in measurement of displacement and temperature.
2. Select proper measuring instrument for measuring low and medium pressures.
3. Select proper measuring instrument for measuring flow, speed and Vibration measurement.
4. Measure load, displacement and temperature using analogue and digital sensors.
5. Develop the PLC programs for Lift, water level control and traffic light

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2	3	2			2						2	3	
2	2	3	2			2						2	3	
3	2	3	2			2						2	3	
4	2	3	2			2						2	3	
5	2	3	2		1	2						2	3	
Course	**2**	**3**	**2**		**1**	**2**						**2**	**3**	

BIOLOGY FOR ENGINEERS SEMESTER - VI			
Subject Code	21CMBIN6100	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 0			

Course Objectives:

Enable the students to

1. Convey that Biology is as important as scientific discipline as Mathematics, Physics and Chemistry.
2. Convey that "Genetics is to biology what Newton's laws are to Physical Sciences".
3. Convey that without catalysis life would not have existed on earth.
4. Molecular basis of coding and decoding genetic information is universal.
5. Analyze biological processes at the reductionist level.

Unit -1	**Hours**
Introduction: Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Mention the most exciting aspect of biology as an independent scientific discipline. Why we need to study biology. How biological observations of the 18th Century lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor.	**10**
Unit -2	
Classification: Hierarchy of life forms at phenomenological level-classification based on (a) cellularity - Unicellular or multicellular (b) ultra-structure- prokaryotes or eucaryotes. (c) energy and Carbon utilization -Autotrophs, heterotrophy, lithotropes (d) Ammonia excretion – aminotelic, uricoteliec, ureotelic (e) Habitata- acquatic or terrestrial (e) Molecular taxonomy- three major kingdoms of life. Model organisms for the study of biology come from different groups. E.coli, S.cerevisiae, D. Melanogaster, C. elegance, A. Thaliana, M. Musculus.	**10**
Unit – 3	
Genetics &Biomolecules: Mendel's laws, Concept of segregation and independent assortment. Concept of allele. Gene mapping, Gene interaction, Epistasis. Meiosis and Mitosis be taught as a part of genetics. Emphasis to be give not to the mechanics of cell division nor the phases but how genetic material passes from parent to offspring. Concepts of recessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics. **Molecules of life:** Monomeric units and polymeric structures. Discuss about sugars, starch and cellulose. Amino acids and proteins.	**10**

Nucleotides and DNA/RNA. Two carbon units and lipids..	
Unit – 4	
Enzymes & Proteins: Enzymology: How to monitor enzyme catalyzed reactions. How does an enzyme catalyze reactions - Enzyme classification. Mechanism of enzyme action. -examples. Enzyme kinetics and kinetic parameters. Why should we know these parameters to understand biology? RNA catalysis. **Proteins:** structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements. **Information Transfer:** The molecular basis of coding and decoding genetic information is universal Molecular basis of information transfer. DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosides. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination.	**10**
Unit – 5	
Microbiology & Metabolism: Thermodynamics as applied to biological systems - Exothermic and endothermic versus undergone and exergoinc reactions. Concept of Keq and its relation to standard free energy - Spontaneity - ATP as an energy currency. This should include the breakdown of glucose to CO2 + H2O (Glycolysis and Krebs cycle) and synthesis of glucose from CO2 and H2O (Photosynthesis). Energy yielding and energy consuming reactions. Concept of Energy charge. **Concept of single celled organisms:** Concept of species and strains. Identification and classification of microorganisms. Microscopy. Ecological aspects of single celled organisms. Sterilization and media compositions. Growth kinetics	**10**

Course outcomes:

On completion of this course, students should be able to:

1. understanding how biological observations of the 18th Century that lead to major discoveries..
2. Convey that classification per say is not what biology is all about but highlight the underlying criteria, such as morphological, biochemical and ecological
3. Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring.
4. Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine.
5. Convey that “Genetics is to biology what Newton’s laws are to Physical Sciences”.

Text Books:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education

Ltd.Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers
2. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening, G; Doi, R.H., John Wiley and Sons.

Reference Books:

1. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H.Freeman and Company
2. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher..
3. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm,C.Brown Publishers Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
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Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2		2		2	2	2					2		
2	2		2		2	2	2					2		
3	2		2		2	2	2					2		
4	2		2		2	2	2					2		
5	2		2		2	2	2					2		
Course	**2**		**2**		**2**	**2**	**2**					**2**		

COURSE STRUCTUREAND SYLLABUS

SITE-21 REGULATIONS

For

III B.Tech. VII Semester

Mechanical Engineering

IV B. Tech. VII Semester Course Structure for the Regulation SITE 21

S.No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP701X	Professional Elective-III	3	0	0	3
2	PEC	21MEMEP702X	Professional Elective-IV	3	0	0	3
3	PEC	21MEMEP703X	Professional Elective-V	3	0	0	3
4	OEC	21MEXXO704X	Open Elective Course-III	3	0	0	3
5	OEC	21MEXXO705X	Open Elective Course-IV	3	0	0	3
6	HSC	21MEMET7060	Operation Research	3	0	0	3
7	SOC	21MEMES7070	Modelling and Analysis (FEA)	1	0	2	2
8	I/RI	21MEMER7080	Research Internship - 2 Months (Mandatory) after Third year (to be evaluated during VII semester	0	0	6	3
Total Credits							**23**
9	H/M		Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)	4	0	0	4

Professional Elective Course -III

S.No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP701A	Prime Movers for Automobiles	3	0	0	3
2		21MEMEP701B	Mechanics of Composites	3	0	0	3
3		21MEMEP701C	Non – Destructive Evaluation	3	0	0	3
4		21MEMEP701D	Micro Electro Mechanical Systems	3	0	0	3
		21MEMEP701E	Product Design and Development	3	0	0	3
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

Professional Elective Course -IV

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP702A	Refrigeration & Air Conditioning	3	0	0	3
2		21MEMEP702B	Synthesis and Characterization of Materials	3	0	0	3
3		21MEMEP702C	Smart Manufacturing and IIOT	3	0	0	3
4		21MEMEP702D	Tribology	3	0	0	3
5		21MEMEP702E	Hydrogen & Fuel Cells	3	0	0	3
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

Professional Elective Course -V

S. No.	CC	Course Code	Course Title	L	T	P	Cr
1	PEC	21MEMEP703A	Solar Energy Engineering and Applications	3	0	0	3
2		21MEMEP703B	Additive Manufacturing	3	0	0	3
3		21MEMEP703C	Production Planning and Control	3	0	0	3
4		21MEMEP703D	Machine Tool Design	3	0	0	3
5		21MEMEP703E	Computational Fluid Dynamics	3	0	0	3
NPTEL/SWAYAM/MOOCs (Course of 12 Weeks duration) to be offered							

PRIME MOVERS FOR AUTOMOBILES SEMESTER - VII			
Subject Code	21MEMEP701A	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. To make the student learn and understand the reasons and effects of various losses that occur in the actual engine operation.
2. To familiarize the student with the various engine systems along with their function and necessity.
3. To learn about normal combustion phenomenon and knocking in S.I. and C.I. Engines and to find the several engine operating parameters that affect the smooth engine operation.
4. To make the student learn to perform testing on S.I and C.I Engines for the calculations of performance
5. To learn about engine emission control, alternate fuels and electric vehicles.

Unit -1	**Hours**
Actual Cycles and their Analysis: Introduction, Comparison of Air Standard and Actual Cycles, Time Loss Factor, Heat Loss Factor, Exhaust Blow down-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines.	**10**
Unit -2	
I C ENGINES: Classification - Working principles, Valve and Port Timing Diagrams, - Engine systems – Fuel, Carburetor, Fuel Injection System, Ignition, Cooling and Lubrication, principle of wankle engine, principles of supercharging and turbo charging.	**10**
Unit – 3	
Combustion in S.I. Engines: Normal Combustion and abnormal combustion – Importance of flame speed and effect of engine variables – Types of Abnormal combustion, pre-ignition and knocking (explanation of) – Fuel requirements and fuel rating, anti-knock additives – combustion chamber – requirements, types. **Combustion in C.I. Engines:** Four stages of combustion – Delay period and its importance – Effect of engine variables – Diesel Knock– Need for air movement, suction, compression and combustion induced turbulence – open and divided combustion chambers and nozzles used – fuel requirements and fuel rating	**10**
Unit – 4	
Measurement, Testing and Performance: Parameters of performance	**10**

- measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, Brake power – Determination of frictional losses and indicated power – Performance test – Heat balance sheet and chart.	
Unit – 5	
Engine Emissions: SI and CI engine emissions. Harmful effects. Emissions measurement methods. Methods for controlling emissions. EURO and BHARAT emission norms. **Alternate Fuels for IC Engines:** Need for use of alternate fuels. Use of alcohol fuels. Biodiesel. Biogas and Hydrogen in engine **Batteries:** Battery: Battery parameters; Types of batteries- Technical characteristics-Ragone plots. **Electric Vehicles:** Introduction: History of EVs, EV system, basic structure- Electric vehicle drive train-advantages and limitations.	**10**

Course outcomes:

On completion of this course, students should be able to:

1. **Illustrate** and analyze the Air Standard Cycles, Fuel Air Cycles and Actual Cycles
2. **Explain** various internal combustion engines and analyze its underlying thermodynamic cycles and to gain knowledge in engine systems
3. **Illustrate** various combustion processes and design of combustion chambers in S.I. & C.I. engines.
4. **Examine** the performance testing of IC engines and to evaluate various performance parameters.
5. **Outline** emission formation mechanism of IC engines, its effects and the legislation standards and understand the latest developments in IC Engines, alternate fuels Electric Vehicles.

Text Books:

1. I.C. Engines / V. Ganesan- TMH
2. Heat engines, Vasandani& Kumar publications Thermal

Reference Books:

1. Thermal Engineering / RK Rajput/ Lakshmi Publications
2. IC Engines – M.L.Mathur & R.P.Sharma – Dhanpath Rai & Sons.
3. I.C. Engines – Applied Thermo sciences–C.R. Ferguson & A.T. Kirk patrick-2nd Edition-Wiley Publ

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2	3											3	
2	2	3											3	
3	2	3											3	
4	2	3	3										3	
5	2	3					3					3	3	
Course	**2**	**3**	**1**				**1**					**1**	**3**	

MECHANICS OF COMPOSITES SEMESTER - VII			
Subject Code	21MEMEP701B	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives: Enable the students to

1. Understand the mechanics of composite materials.
2. Study the Elastic behavior of composite lamina
3. Study the aspects of the Micromechanical Analysis of a Lamina
4. Develop the Micromechanical Analysis of a Lamina
5. Study the Failure, Analysis, and Design of Laminates

Unit -1	**Hours**
Introduction to composite materials, Geometric definitions, Classification of composites, Types of fibers, Types of the matrix, Hybrid composite, scale of analysis- micro and macro mechanics approaches, Degree of Anisotropy. Manufacturing methods of the composites, Autoclave moulding, Filament winding, Resin transfer moulding.	**12**
Unit -2	
Elastic behaviour of composite lamina (Micro mechanics), Micro mechanics methods, Geometric aspects and elastic symmetry, Longitudinal elastic properties (Continuous fibers), Transverse elastic properties, In-plane shear properties (Continuous fibers), Longitudinal properties (short fibers)	**10**
Unit – 3	
Elastic behaviour of composite lamina (Macro mechanics approach), stress strain relations: General anisotropic material, Specially orthotropic material, transversely isotropic material, Orthotropic material under plane stress, isotropic material.	**10**
Unit – 4	
Standard sizes of the specimen for tensile and compressive, Fatigue tests, impact test of unidirectional composites. Failure of the composite materials: fibre failures, matrix failure, interface failure. Failure Theories Tsai-Wu, Tsai-hill, Puck criterion, Maximum stress, maximum strain.	**10**
Unit – 5	
Failure, Analysis, and Design of Laminates: Introduction, Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, static analysis of laminated plates.	**8**

Course outcomes:

On completion of this course, students should be able to:

1. Understand the composite materials and manufacturing methods
2. Study the behaviour of composite Lamina
3. Study the properties of various types of composite materials. .

4. Apply Failure theories to calculate stresses in composite materials
5. Study the Failure, Analysis, and Design of Laminates

Text Books:

1. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994.
2. B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, Wiley- Interscience, New York, 1980.
3. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By Autar K. Kaw, Publisher: CRC.

Reference Books:

1. R. M. Jones, Mechanics of Composite Materials, McGraw Hill Company, New York, 1975
2. Mechanics of Composite Materials Recent Advances by ZviHashin, Carl T.Herakovich
3. L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1969.
4. Principles of composite material mechanics by Ronald F.Gibson

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2	2	3									2	3	
2	2	2	3									2	3	
3	2	2	3									2	3	
4	2	2	3									2	3	
5	2	2	3									2	3	
Course	**2**	**2**	**3**									**2**	**3**	

NON - DESTRUCTIVE EVALUATION SEMESTER - VII			
Subject Code	21MEMEP701C	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. **Know** basics of NDE methods and Learn concepts & principles of Visual and Liquid penetrant testing methods.
2. **Explore** the concepts of Ultrasonic testing equipment, its techniques and applications.
3. **Determine** the importance of Magnetic particle testing, testing procedure, Calibration techniques, evaluation and Industrial applications.
4. **Explain** the principles of radiography, its techniques, safety aspects and industrial applications.
5. **Understand** the concept of Eddy current test system, its effectiveness, advantages and applications.

Unit -1	**Hours**
Introduction: Introduction to non-destructive testing, Visual testing. **Liquid Penetrant Testing:** Basic Concepts, Liquid Penetrant System, Test Procedure, LPT Equipment, Standardization and Calibration, Interpretation and Evaluation, Advantages, Effectiveness, Limitations, Applications of LPT	**10**
Unit -2	
Ultrasonic Testing: Basic Principles, Ultrasonic Equipment and Variables affecting Ultrasonic Test, Ultrasonic Techniques, Standardization and Calibration, Interpretation and Guidelines for Acceptance, Rejection - Advantages, Effectiveness and Limitations of Ultrasonic Testing, Applications	**10**
Unit – 3	
Magnetic Particle Testing: Basic Principles of Magnetic Particle Testing, Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Magnetic Particle Test equipment, Magnetic Particle Test Procedure, Standardization and Calibration, advantages, limitations of the Magnetic Particle Test and applications	**10**
Unit – 4	
Radiographic Testing: Basic Principles of Radiographic test, Sources of X and Gamma Rays, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography, Advantages, Effectiveness, Limitations and applications of Radiographic Testing	**10**
Unit – 5	
Eddy Current Testing: Principles of Eddy Current testing, Eddy Current Test System, Test Procedure, Applications of Eddy Current Testing, Effectiveness of Eddy Current Testing, Advantages, Limitations	**10**

and applications of Eddy Current Testing	

Course outcomes:

On completion of this course, students should be able to:

1. **Explain** the working of Visual Inspection and Liquid penetrant test methods and its applications.
2. **Describe** the working of Ultrasonic testing, its calibration procedure, effectiveness, limitations and applications.
3. **Explain** the working of Magnetic particle testing procedure, the variables of the process, and measure defects of using MPT.
4. **Illustrate** the working of Radiographic testing equipment & its sources, safety aspects, industrial applications.
5. **Explain** the working of Eddy current testing equipment & procedure, advantages, limitations, industrial applications.

Text Books:

1. Non-destructive Test and Evaluation of Materials by J Prasad, CGK Nair, TMH Publishers.
2. Non-Destructive Testing by Dr. S.Ramachandran, Airwalk Publications.
3. Non-Destructive Testing Techniques by Ravi Prakash, New Age International Private Limited.

Reference Books:

1. Non-Destructive Testing of Materials by V. Jayakumar, Lakshmi Publications.
2. Basics of Non-Destructive Testing by Lari& Kumar, S.K.Kataria& Sons Publishers.
3. Ultrasonic Inspection Training for NDT: E. A. Gingel, Prometheus Press.
4. ASTM Standards, Vol 3.01, Metals and alloys

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	2		3							2	2	2	
2	2	2		3							2	2	2	
3	2	2		3							2	2	2	
4	3	2		3							2	2	1	
5	3	2		3							2	2	1	
Course	**3**	**2**		**3**							**2**	**2**	**1**	

MICRO ELECTRO MECHANICAL SYSTEMS SEMESTER - VII			
Subject Code	21MEMEP701D	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. Integrate the knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
2. Understand the rudiments of Micro fabrication techniques.
3. Identify and understand the various sensors and actuators
4. Different materials used for MEMS
5. Applications of MEMS to disciplines beyond Electrical and Mechanical engineering

Unit -1	**Hours**
INTRODUCTION: Definition of MEMS, MEMS history and development, micro machining, lithography principles & methods, structural and sacrificial materials, thin film deposition, impurity doping, etching, surface micro machining, wafer bonding, LIGA. **MECHANICAL SENSORS AND ACTUATORS:** Principles of sensing and actuation: beam and cantilever, capacitive, piezo electric, strain, pressure, flow, pressure measurement by micro phone, MEMS gyroscopes, shear mode piezo actuator, gripping piezo actuator, Inchworm technology.	**10**
Unit -2	
THERMAL SENSORS AND ACTUATORS: Thermal energy basics and heat transfer processes, thermisters, thermo devices, thermo couple, micro machined thermo couple probe, peltier effect heat pumps, thermal flow sensors, micro hot plate gas sensors, MEMS thermo vessels, pyro electricity, shape memory alloys (SMA), U-shaped horizontal and vertical electro thermal actuator, thermally activated MEMS relay, micro spring thermal actuator, data storage cantilever. **MAGNETIC SENSORS AND ACTUATORS:** Magnetic materials for MEMS and properties, magnetic sensing and detection, magneto resistive sensor, more on hall effect, magneto diodes, magneto transistor, MEMS magnetic sensor, pressure sensor utilizing MOKE, magnetic MEMS actuators, by directional micro actuator, feedback circuit integrated magnetic actuator, large force reluctance actuator, magnetic probe-based storage device.	**10**
Unit – 3	
MICRO-OPTO-ELECTRO MECHANICAL SYSTEMS: Principle of MOEMS technology, properties of light, light modulators, beam splitter, micro lens, micro mirrors, digital micro mirror device (DMD), light	**10**

detectors, grating light valve (GLV), optical switch, wave guide and tuning, shear stress measurement.	
Unit – 4	
RADIO FREQUENCY (RF) MEMS: RF – based communication systems, RF MEMS, MEMS inductors, varactors, tuner/filter, resonator, clarification of tuner, filter, resonator, MEMS switches, phase shifter. **MICRO FLUIDIC SYSTEMS:** Applications, considerations on micro scale fluid, fluid actuation methods, dielectro phoresis (DEP), electro wetting, electro thermal flow, thermo capillary effect, electro osmosis flow, opto electro wetting (OEW), tuning using micro fluidics, typical micro fluidic channel, microfluid dispenser, micro needle, molecular gate, micro pumps.	**10**
Unit – 5	
CHEMICAL AND BIO MEDICAL MICRO SYSTEMS: Sensing mechanism & principle, membrane transducer materials, chem.-lab-on-a-chip (CLOC) chemo resistors, chemo capacitors, chemo transistors, electronic nose (Enose), mass sensitive chemo sensors, fluroscence detection, calorimetric spectroscopy.	**10**

Course outcomes:

On completion of this course, students should be able to:

1. Understand working principles of currently available micro sensors, actuators, and motors, valves, pumps, and fluidics used in Microsystems.
2. choose a various Thermal & Magnetic Sensors and Actuators
3. understand and analyse, linear and digital electronic circuits.
4. Explain the RF MEMS & Different materials used for MEMS
5. Demonstrate a detailed understanding of the fundamental principles of nanotechnology and their application to biomedical engineering.

Text Books:

1. MEMS, Nitaigour Premchand Mahalik, TMH Publishing co.

Reference Books:

1. Foundation of MEMS, Chang Liu, Prentice Hall Ltd.
2. Bio-MEMS (Micro systems), Gerald Urban, Springer.
3. MEMS and Micro Systems: Design and Manufacture, Tai-Ran Hsu, TMH Publishers.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2		2	2	3							2		
2	2		2	2	3							2		
3	2		2	2	3							2		
4	2		2	2	3							2		
5	2		2	2	3							2		
Course	**2**		**2**	**2**	**3**							**2**		

PRODUCT DESIGN AND DEVELOPMENT SEMESTER - VII			
Subject Code	21MEMEP701E	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

The main learning objective of this course is to prepare the students for the understanding the principles of product development process, customer needs, setting product specification, testing and prototyping for new product design and development.

Unit -1	**Hours**
INTRODUCTION: A Generic Development Process – Adapting the Generic Product Development Process - Product Development Process Flows- Digital tools for product design– Identifying Customer Needs - Product Specifications: Establishing Target Specifications; Setting the Final Specifications.	**10**
Unit -2	
CONCEPT GENERATION: The Activity of Concept Generation - Concept Selection: Concept Screening; Concept Scoring – Concept Testing – Concept innovation using TRIZ	**10**
Unit – 3	
PRODUCT ARCHITECTURE Implications of the Architecture; Establishing the Architecture; Delayed Differentiation; Platform Planning; Related System-Level Design Issues – Industrial Design: Assessing the Need for Industrial Design; Impact of Industrial Design; The Industrial Design Process; Management of the Industrial Design Process; Assessing the Quality of Industrial Design.	**10**
Unit – 4	
DFM AND PROTOTYPING Design for Manufacturing: Estimate the Manufacturing Costs; Reduce the Costs of Components; Reduce the Costs of Assembly; Reduce the Costs of Supporting Production; Consider the Impact of DFMA– Prototyping: Type; Uses; Principles; Technologies; Planning for Prototypes.	**10**
Unit – 5	
PRODUCT DEVELOPMENT ECONOMICS Elements of Economic Analysis; Economic Analysis Process – sustainable product development: framework and metrics – life cycle assessment of a product: stages and impact	**10**

Course outcomes:

On completion of this course, students should be able to:

1. Apply the principles of generic development process; conduct customer need analysis; and set product specification for new product design and development.
2. Generate, select, screen, and test concepts for new product design and

development.
3. Apply the principles of product architecture and industrial design to design and develop new products.
4. Apply the principles of DFMA and Prototyping to design and develop new product.
5. Apply the concepts of economics principles sustainable product development and life cycle assessment.

Text Books:

1. Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press, 2018.
2. Karl, T. Ulrich and Steven, D. Eppinger, "Product Design and Development", McGraw Hill, 2003.

Reference Books:

1. Belz A., 36-Hour Course: "Product Development" McGraw-Hill, 2010.
2. Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
3. Pugh S., "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, 1991.
4. Rosenthal S., "Effective Product Design and Development", Business One, 1992.
5. Silva, A., Handbook of Research on Trends in Product Design and Development: Technological and Organizational Perspectives: Technological and Organizational Perspectives, IGI Global, 2010.
6. Devdas Shetty, "Product design for Engineers", Cengage Learning

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1			2			2				2	2	3	2	
2			2			2				2	2	3	2	
3			2			2				2	2	3	2	
4			2			1				2	2	3	2	
5			2			2				2	2	3	2	
Course			**2**			**2**				**2**	**2**	**3**	**2**	

REFRIGERATION & AIR CONDITIONING SEMESTER - VII			
Subject Code	21MEMEP702A	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. To impart the basic concepts of Refrigeration and Air Conditioning.
2. To develop a sound physical understanding of the subject so that the learner will demonstrate the ability to design a refrigeration or air-conditioning equipment that meets the required specifications.
3. Comparative study of different refrigerants with respect to properties, applications and Environmental issues, air conditioning processes on psychrometric charts.
4. 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.

Unit -1	**Hours**
Introduction to Refrigeration: Necessity and applications – unit of refrigeration and C.O.P., Mechanical refrigeration – types of ideal cycles of refrigeration, **Air Refrigeration**: Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits – refrigeration systems used in air crafts and problems.	**12**
Unit -2	
Vapour Compression Refrigeration (VCR): Working principle and essential components of the plant, Simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts, effect of sub-cooling and superheating – cycle analysis actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems. **VCR System Components:** Compressors, Condensers, Evaporators, Expansion devices–classification–working principles.	**10**
Unit – 3	
Refrigerants – Desirable properties – classification - refrigerants used – nomenclature – ozone depletion –global warming. **Vapour Absorption Systems**: Other types of Refrigeration systems – Vapour Absorption Refrigeration Systems, Absorbent – Refrigerant combinations, Water- Ammonia Systems, Water-Lithium Bromide System, Contrast between the two systems, Modified Version of Aqua-	**10**

Ammonia System with Rectifier and Analyser Assembly.	
Unit – 4	
Psychrometry: Introduction to Psychrometry, Psychrometric Properties & Processes, Air-water vapour mixtures, Psychrometric Chart. Numerical problems **Load calculations**: Concepts of RSHF, GSHF & ERSHF-ADP temperature, problems	**10**
Unit – 5	
Introduction to Air conditioning: Classification, Applications of Air-Conditioning, Requirements of human comfort and concept of effective temperature- comfort chart – comfort air conditioning – need for ventilation and consideration of infiltrated air- requirements of industrial air-conditioning. **Air conditioning equipment**: Cooling, heating, humidification and dehumidification, filters, grills and registers fans and blowers. heat pump – heat sources – different heat pump circuits.	**8**

Course outcomes:

On completion of this course, students should be able to:

1. **Determine** the COP for Bell-Coleman cycle and various types of aircraft refrigeration system.
2. **Calculate** the COP of the VCR cycle and indicate on T-S and P-H diagrams.
3. **Select** the suitable refrigerant for the refrigeration system as per the requirements, various vapour absorption refrigeration systems and non-conventional refrigeration systems.
4. **Analyze** the cooling load and heating load using the principle of Psychrometry
5. **Decide** suitable components for the air condition system as per need and compare the heat pump circuits

Text Books:

1. A Course in Refrigeration and Air conditioning / SC Arora & Domkundwar/Dhanpatrai
2. Refrigeration and Air Conditioning / CP Arora / TMH.

Reference Books:

1. Refrigeration and Air Conditioning / Manohar Prasad / New Age.
2. Principles of Refrigeration /Dossat / Pearson Education.
3. Refrigeration and Air-conditioning, Stoecker W.F., and Jones J.W., Mc Graw - Hill, New Delhi
4. Refrigeration and Air-conditioning by R K Rajput

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.

3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3											3	
2	3	3	2				1						3	
3	3	3	2										3	
4	3	3	2										3	
5	3	3	2										3	
Course	**3**	**3**	**2**				**1**						**3**	

SYNTHESIS AND CHARACTERIZATION OF MATERIALS SEMESTER - VI			
Subject Code	21MEMEP702B	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. Students gains deeper knowledge and understanding about the synthesis of materials.
2. To understand the importance of improvement of synthesis and characterization of their materials.
3. Understand the requirements for suitable techniques for each deposition techniques used.
4. To understand various advanced characterization equipment used to characterize different types of materials.
5. Gain knowledge about thermal testings and characterizations on composite materials

Unit -1	**Hours**
Synthesis of nano materials: Gold, Silver, different types of nano oxides, TiO2, ZnO by using sol-gel method, Co-precipitation, Hydrothermal, Microwave, thermal and bio synthesis methods, Nano tubes and Nano wires, Carbon nano tubes, Graphene preparation, powder syntheses, crystal growth techniques, zone refining, properties and applications.	**10**
Unit -2	
Top down and bottom-up synthesis- Mechanical alloying, Mechanical ball-milling, Ion implantation, Inert gas condensation, Arc discharge, RF-plasma arc technique, Laser ablation, Template assisted synthesis, Clusters, Colloids, Zeolites, Porous silicon	**10**
Unit – 3	
Deposition techniques: Chemical vapour deposition (CVD), Metal Organic chemical vapour deposition (MOCVD) **Epitaxial growth techniques**: Molecular beam epitaxy, Atomic layer deposition, Pulsed laser deposition, Pulsed electrochemical deposition, Magnetron sputtering, Spin coating, Introduction to Lithography techniques	**10**
Unit – 4	
Principle, Theory, Working and Application; X-Ray Diffraction, Field Emission Scanning Electron Microscopy, High Resolution-Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunnelling Microscopy.	**10**
Unit – 5	
Photoluminescence Spectroscopy, Raman Spectroscopy, X-Ray Photoelectron Spectroscopy (XPS), Thermal analysis – Differential	**10**

Scanning Calorimetry (DSC) – Thermo gravimetric Analysis (TGA)– Differential Thermal Analysis (DTA) – Dynamic Mechanical Analysis (DMA), Mechanical Testing- Nano Indentation -Vibrating Sample Magnetometer, Zeta Potential and Particle size measurement.	

Course outcomes:

On completion of this course, students should be able to:

1. The students are expected to understand basic principles of the synthesis and characterization techniques presented in the course, specific usage, their advantages and limitations
2. To understand the role of Top down and bottom-up synthesis and their importance in materials property.
3. Students should be able to understand the requirements for suitable techniques for each deposition techniques used.
4. They should be able to operate the instruments based on the knowledge gained on various applications.
5. To analyze various thermal testings and mechanical nano Indentation

Text Books:

1. Nano material, A.K. Bandyopadyay, New age Publishers
2. Material science and Technology: A comprehensive treatment, Robert W.Cahn,
3. Engineering Mechanics of Composite Materials, Isaac and M Daniel, Oxford University Press

Reference Books:

1. Mechanics of Composite Materials R. M. Jones, McGraw Hill Company, New York, 1975.
2. Analysis of Laminated Composite Structures, L. R. Calcote/Van Nostrand Rainfold, New York 1969
3. Analysis and performance of fibre Composites, B. D. Agarwal and L. J. Broutman, Wiley

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2		2	3		2				2			3	
2	2		2	3		2				2			3	
3	2		2	3		2				2			3	
4	2		2	3		2				2			3	
5	2		2	3		2				2			3	
Course	**2**		**2**	**3**		**2**				**2**			**3**	

SMART MANUFACTURING & IIOT SEMESTER - VII			
Subject Code	21MEMEP702C	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. Learn different types of FMS layouts
2. Gain the knowledge of Automated Production Lines
3. Understanding the performance of material handling and storage techniques
4. Describe the Automated Assembly Systems
5. Understanding the characteristics of IIoT

Unit -1	**Hours**
Introduction to Flexible Manufacturing System: Evolution of Manufacturing Systems, Definition, objective and Need, Components, Merits, Demerits and Applications. **Classification of FMS Layouts:** Layouts and their Salient features, Single line, dual line, loop, ladder, robot center type etc.	**10**
Unit -2	
Automated Production Lines: Fundamentals- System configurations, work part transfer mechanisms, Storage buffers, and Control of the production line. Applications — Machining systems and System Design Considerations. Analysis of Transfer lines — Transfer lines with No internal parts storage, Transfer lines with internal storage buffers.	**08**
Unit – 3	
Automated Material Handling: Automated Guided Vehicle (AGV) Systems, Types and applications, Vehicle Guidance Technology, Vehicle Management and Vehicle safety. **Automated Storage Systems:** Automated Storage/Retrieval Systems (AS/RS) and Carousel Storage Systems.	**10**
Unit – 4	
Automated Assembly Systems: System configurations, Parts delivery at workstations, and applications, quantitative analysis of assembly systems-Parts Delivery System at Workstations, Multi-Station Assembly Machines, Single Station Assembly Machines, Partial Automation.	**12**
Unit – 5	
Introduction to IIoT: Characteristics of IIoT, levels & deployment templates, Sensing, Actuation, Communication Protocols, Machine-to-Machine Communications, Difference between IIoT and M2M,	**10**

Communication modules - RFID, Bluetooth, Wi-Fi, Zigbee.	

Course outcomes: At the end of the course the student will be in a position to:

1. Apply FMS with manufacturing systems including job- shop and mass production systems.
2. Determine the basic components and their functions of automated production lines.
3. Analyze materials handling and storage systems in manufacturing.
4. Differentiate various automated assembly systems.
5. Assess the characteristics of IIoT and analyze the difference between M2M and IIoT.

TEXT BOOKS

1. Groover, M.P "Automation, Production Systems and Computer Integrated Manufacturing 3rd Edition, Prentice Hall Inc., New Delhi, 2007.
2. William W Luggen, "Flexible Manufacturing Cells and System" Prentice Hall of Inc New Jersey, 1991
3. A. Bahga and V. Madisetti, Internet of Things, A hands-on approach, VPT, 1st edition, 2014.

REFRENCE BOOKS

1. Automation by Buckinghsm W, Haper& Row Publishers, New York, 1961
2. Reza A Maleki "Flexible Manufacturing system" Prentice Hall of Inc New Jersey, 1991
3. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0, CRC Press, 2020.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	1			3		2						3	
2	3	2	2		3		1						3	
3	3	1	2		3		2						3	
4	3	1	2		3		2						3	
5	3	2	2		3		2						3	
Course	**3**	**2**	**2**		**3**		**2**						**3**	

Tribology SEMESTER - VII			
Subject Code	21MEMEP702D	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. To provide broad based understanding of the interdisciplinary subject 'tribology' and surface characterization techniques.
2. To learn about the contact of solid surfaces and their interactions consequences of wear, wear mechanisms, wear theories and analysis of wear problems
3. To understand the genesis of friction, the theories/laws of sliding and rolling friction
4. To learn about the principles of lubrication, lubrication regimes, theories of hydrodynamic, elasto hydrodynamic and mixed/ boundary lubrication
5. To learn about tribo testing and experimental techniques in tribology and tribological modelling and simulation
6. To learn about tribology of different machine components and emerging areas such as micro/nano tribology

Unit -1	**Hours**
Introduction: Nature of surfaces and contact-Surface topography-friction and wear mechanisms, wear maps, effect of lubricants- methods of fluid film formation. Lubrication: Choice of lubricants, types of oil, Grease and solid lubricants- additives- lubrication systems and their selection.	**10**
Unit -2	
Selection of rolling element bearings: Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load-bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.	**08**
Unit – 3	
Hydrostatic Bearings: Thrust bearings – pad coefficients- restriction-optimum film thickness-journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure.	**10**
Unit – 4	
Hydrodynamic bearings: Fundamentals of fluid formation – Reynold's equation; Hydrodynamic journal bearings – Sommerfield number-performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings-optimum	**12**

condition with largest minimum film thickness.	
Unit – 5	
Seals: different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals. Failure of Tribological components: Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferro graphy. Dry rubbing Bearings: porous metal bearings and oscillatory journal bearings – qualitative approach only.	**10**

Course outcomes: At the end of the course the student will be in a position to:

1. Demonstrate basic understanding of friction, lubrication and wear recesses. Become familiar with mathematical tools used to analyze tribological processes.
2. Become familiar with rolling element bearings and the lubricants used therein.
3. Enhance students' awareness of tribological issues in the design of machine components, such as rolling element bearings, journal bearings, thrust bearings, seals and braking systems.
4. Describe the detailed operation of selected Hydrodynamic journal bearings
5. Exposed to design a tribological system for optimal performance.

TEXT BOOKS

1. Rowe WW& O' Dionoghue," Hydrostatic and Hybrid bearing design " Butter worths& Co.Publishers Ltd,1983.
2. Collacott R.A," Mechanical Fault diagnosis and condition monitoring", Chapman and Hall, London 1977.
3. Bernard J.Hamrock, " Fundamentals of fluid film lubricant", McGraw-Hill Co.,1994.
4. Introduction to Tribology of bearings – B.C.Majumdar – S Chand Publishing.

REFRENCE BOOKS

1. Neale MJ, (Editor) "Tribology hand Book" NeumannButterworths, 1975.
2. Connor and Boyd JJO (Editors) "Standard hand book of lubrication engineers" ASLE,Mc Graw Hill Book & Co.,1968
3. Shigley J, E Charles,"Mechanical Engineering Design", McGraw Hill Co., 1989

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	1			3		2						3	
2	3	2	2		3		1						3	
3	3	1	2		3		2						3	
4	3	1	2		3		2						3	
5	3	2	2		3		2						3	
Course	**3**	**2**	**2**		**3**		**2**						**3**	

Hydrogen & Fuel Cells SEMESTER - VII			
Subject Code	21MEMEP702E	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. To introduce to emerging technologies like production and storage of Hydrogen
2. To impart knowledge on use of hydrogen for achieving sustainable growth and facilitate analysis of the challenges in transition to hydrogen economy

Unit -1	**Hours**
Hydrogen Energy Economy: Hydrogen Energy Economy – Conception, Present status and a vision – Applications of Hydrogen - Transport application-cars, light trucks, buses - Stationary and Portable-Electronic gadgets.	**10**
Unit -2	
Hydrogen And Production Techniques: Hydrogen – Physical and chemical properties, salient characteristics - Production of hydrogen – Steam reforming – Water electrolysis – Gasification and woody biomass conversion – Biological hydrogen production – Photo dissociation – Direct thermal or catalytic splitting of water.	**08**
Unit – 3	
Hydrogen Storage & Transport: Hydrogen storage options – Compressed gas – Liquid hydrogen – Hydride – Chemical Storage – Comparisons - Transport of Hydrogen - Pipelines, gaseous, liquid and compound materials.	**10**
Unit – 4	
Fuel Cells: History – Principle - Working - Thermodynamics and kinetics of fuel cell process – Performance evaluation of fuel cell – Comparison on battery Vs fuel cell - Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC – Relative merits and demerits.	**12**
Unit – 5	
Application Of Fuel Cell: Fuel cell usage for domestic power systems - large scale power generation – Automobile - Space - Environmental analysis of usage of Hydrogen in Fuel cell - Future trends in fuel cells.	**10**

Course outcomes: At the end of the course the student will be in a position to:

1. Gets exposure to different fuel cells in particularly Hydrogen fuel cells
2. Gain an advanced understanding of hydrogen, electrolysis and fuel cell, the various types available and how they work
3. Learn about Hydrogen storage & Transport methods

4. Explain the working of AFC, PAFC, SOFC, MCFC, DMFC, PEMFC type of Fuel cells
5. Understand the merits, demerits applications of Fuel cells

TEXT BOOKS

1. Hydrogen and Fuel Cells: A Comprehensive Guide, Rebecca L. and Busby, Penn Well Corporation, Oklahoma (2005)

REFRENCE BOOKS

1. Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorensen (Sørensen), Elsevier, UK (2005)
2. Fuel Cell and Their Applications, Kordesch, K and G.Simader, Wiley-Vch, Germany (1996).
3. Fuel Cells: Theory and Application, Hart, A.B and G.J.Womack, Prentice Hall, NewYork Ltd., London (1989)
4. The Hydrogen Economy, Jeremy Rifkin, Penguin Group, USA (2002).
5. Fuel Cells – Principles and Applications, Viswanathan, B and M Aulice Scibioh, Universities Press (2006)

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3				3		2				2	2	3	
2	3		2		3		1				1	1	3	
3	3		2		3		2				2	2	3	
4	3		2		3		2				2	2	3	
5	3		2		3		2				2	2	3	
Course	**3**		**2**		**3**		**2**				**2**	**2**	**3**	

SOLAR ENERGY ENGINEERING AND APPLICATIONS SEMESTER - VII			
Subject Code	21MEMEP703A	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. To understand the basics of the Solar Radiation.
2. To understand the concept of Photo Voltaics.
3. To understand the Solar Cell Technologies.
4. To understand thin film technologies.
5. To understand the methods of solar energy collections.

Unit -1	**Hours**
Solar Radiation: Solar energy option, solar power, structure of the sun, the solar constant, sun-earth relationships, solar radiation types, solar radiation on titled surface, instruments for measuring solar radiation and sun shine. Solar Tracking Systems – Single axis – Dual axis	**10**
Unit -2	
Photovoltaic Fundamentals: Place of PV in energy supply – PV Cells - Modules and arrays - Review of semiconductor physics and operating principle - Introduction to P-N and P-I-N junctions - Cell parameters limits-Losses in solar cells-Solar cell design for high Isc,, Voc and FF.	**8**
Unit – 3	
Solar Cell Technologies: Silicon based technologies (mono-crystalline, poly-crystalline – ribbon - silicon film) - Flow of silicon material - Manufacturing processes (wafer, cell and module) for Mono and poly Si technologies - Efficiency of Si cells	**12**
Unit – 4	
Thin film technologies (Silicon and Non-silicon): Material-deposition techniques - Amorphous Si cells/modules - micro-morph cell - Silicon film- non-silicon technologies viz Cadmium telluride - Cu Indium Gallium Diselenide.	**10**
Unit – 5	
SOLAR ENERGY COLLECTION: Solar Flat plate collectors - Concentrating Collectors - Compound Parabolic Collector - Collector Efficiency, solar ponds, solar applications- solar heating/cooling technique, solar distillation and drying, solar cookers, central power tower concept and solar chimney	**10**

Course outcomes:

On the completion of this course, students are able to

1. Discuss the basics of the Solar Radiation
2. Describe the concept of Photo Voltaics.

3. Describe the Solar Cell Technologies
4. Differentiate Thin film technologies
5. Illustrate the methods of solar energy collections

Text Books:

1. Sukhatme S.P. and J.K.Nayak, *Solar Energy – Principles of Thermal Collection and Storage*, TMH.
2. Khan B.H., Non-Conventional Energy Resources, Tata McGrawHill, New Delhi, 2006
3. Green Manufacturing Processes and Systems, Edited by J. PauloDavim, Springer 2013

References Books:

1. Principles of Solar Energy / Frank Krieth & John F Kreider.
2. Non-Conventional Energy / Ashok V Desai /Wiley Eas
3. Renewable Energy Technologies/ G.D Roy

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice).
2. All questions carries 14 marks each.
3. Each full question will have sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	1		1			2						3	
2	3	2	2	1			1						3	
3	3	1	2	2			2						3	
4	3	1	2	2			2						3	
5	3	2	2	2			2						3	
Course	**3**	**2**	**2**	**2**			**2**						**3**	

ADDITIVE MANUFACTURING SEMESTER - VII			
Subject Code	21MEMEP703B	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. To understand the fundamental concepts of Additive Manufacturing (i.e. Rapid Prototyping) and its advantages and limitations.
2. To classify various types of Liquid Based Rapid Prototyping Systems Processes and know their working principle, advantages, limitations etc.
3. To classify various types of Solid Based Rapid Prototyping Systems Processes and know their working principle, advantages, limitations etc.
4. To classify various types of Powder Based Rapid Prototyping Systems Processes and know their working principle, advantages, limitations etc.
5. To have a holistic view of various applications of these technologies in relevant fields such as Mechanical, Bio-medical, Aerospace, electronics etc.

Unit -1	**Hours**
Introduction: Prototype, Roles of Prototype, Need for time compression in product development, Need of Additive Manufacturing (AM), Generic AM process, Distinction between AM and CNC, Classification of AM Processes, Steps in AM process, Advantages of AM, Major Applications. Stereolithography (SL), Materials, SL resin curing process, Micro-stereolithography, Process Benefits and Drawbacks, Applications of Photopolymerization Processes.	**12**
Unit -2	
Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. **Solid Ground Curing (SGC**): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.	**10**
Unit – 3	
Laminated object manufacturing (LOM): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. **Fused deposition modeling (FDM):** Models and specifications, process, working principle, applications, advantages and disadvantages, case	**10**

studies.	
Unit – 4	
Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. **3-D Printing:** Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.	**10**
Unit – 5	
Engineering Applications of Additive Manufacturing: Analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, arts and architecture. **RP Applications in Medical and Bioengineering**: Planning and simulation of complex surgery, customized implants & prosthesis, design and production of medical devices, forensic science and anthropology, visualization of bimolecular.	**8**

Course outcomes:

1. To study the working principles and process parameters of Additive Manufacturing processes
2. To understand the liquid based Additive Manufacturing process parameters and application of these techniques
3. To learn the solid based Additive Manufacturing process parameters and application of these techniques
4. To understand about the powder based Additive Manufacturing process parameters and application of these techniques
5. To study the applications of Additive Manufacturing processes in various fields

Text Books:

1. Rapid prototyping: Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific publications
2. A Treatise on Additive manufacturing/ R B Choudary/ Khanna Publishers

Reference Books:

1. Rapid Manufacturing / D.T. Pham and S.S. Dimov/Springer
2. Wohlers Report 2000 /Terry T Wohlers/Wohlers Associates
3. Rapid Prototyping & Manufacturing / Paul F.Jacobs/ASME Press

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.

3. Each full question will have a sub question covering all topics under a course outcome.

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2	2										2	2	2
2	1	2	2										1	2
3	1	2	1										2	
4	2	1											2	1
5	2	1											2	1
Course	**2**	**2**	**2**									**2**	**2**	**2**

PRODUCTION PLANNING AND CONTROL SEMESTER - VII			
Subject Code	21MEMEP703C	**IA Marks**	30
Number of Lecture Hours/Week	3(L)	**Exam Marks**	70
Total Number of Lecture Hours	50	**Exam**	03
Credits – 03			

COURSE OBJECTIVES: Students should be able to:

1. Understand the concepts of production and service systems
2. Apply forecasting techniques for various firms, namely qualitative & quantitative methods to optimize/make best use of resources in achieving their objectives.
3. Identify different strategies employed in manufacturing and service industries to plan inventory and Impart knowledge on the Materials Requirement Planning and Kanban, LOB and JIT Methods.
4. Determine the exact routing and scheduling which will be followed in production. And apply different scheduling policies in planning and control and make best use of resources.
5. Measure the effectiveness, identify likely areas for improvement, develop and implement improved planning and control methods for production systems.

Unit -1	**Hours**
Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department – internal organization of department.	**Hours – 08**
Unit -2	
Forecasting – importance of forecasting – types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitative methods.	**Hours – 10**
Unit – 3	
Inventory management – functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems Introduction to MRP I, MRP II, ERP, LOB (Line of Balance), JIT and KANBAN system.	**Hours – 10**
Unit – 4	
Routing & Scheduling– definition – routing procedure –route sheets – bill of material – factors affecting routing procedure, schedule –definition – difference with loading, Scheduling policies – techniques, standard scheduling methods, line balancing, aggregate planning.	**Hours – 12**
Unit-5	
Dispatching– activities of dispatcher – dispatching procedure –	**Hours – 10**

follow up – definition – reason for existence of functions – types of follow up, expediting, controlling aspects. Applications of computer in production planning and control.	

COURSE OUTCOMES

On completion of this course, students will be able to:

1. Illustrate the systems concept for the design of production and service systems.
2. Develop forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques
3. Discuss the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances.
4. Select and use an appropriate principles/methods/ techniques/ modern concept with reference to given application/situation in the preparation of route sheets with scheduling and loading in manufacturing systems.
5. Create and engage in life-long learning in the context of technological change in Operations Management and also able to identify dispatching, follow-up activities in the system

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Text Books

1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
2. Manufacturing, Planning and Control/PartikJonssonStig-Arne

Reference Books

1. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller/Prentice-Hall
2. Production Planning and Control/Mukhopadyay/PHI
3. Production Control A Quantitative Approach / John E. Biegel/Prentice-Hall

Web references

1. http://nptel.ac.in/courses/112102106/
2. http://nptel.ac.in/courses/112107143/
3. http://nptel.ac.in/courses/112107142/33
4. http://nptel.ac.in/courses/112107142/31
5. https://nptel.ac.in/courses/112107142/36

Course Outcomes to Program Outcomes mapping:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1		2	1						1		1		1	
2		2	1								3		1	
3		2									3		2	
4			1	1	1		3						1	
5				1	1		3				2	2	1	
Course		**1**	**1**	**1**	**1**		**3**		**1**		**2**	**1**	**2**	

MACHINE TOOL DESIGN SEMESTER - VII			
Subject Code	21MEMEP703D	**IA Marks**	30
Number of Lecture Hours/Week	3(L)	**Exam Marks**	70
Total Number of Lecture Hours	50	**Exam**	03
Credits – 03			

COURSE OBJECTIVES: Students should be able to:

1. To learn and applications of the basics and working principles of different types of machine tools
2. To grasp the knowledge of critical functional and operational requirements of different types of machine tools
3. To learn the knowledge of design of different types of machine tools to meet varied functional and operational requirements.

Unit -1	**Hours**
Basic features: Classification of machine tools-Basic features of construction and fundamental kinematic mechanisms of general purpose, special purpose machine tools, transfer machines, Automatic and N.C. machines. Mechanisms used for converting rotary to linear motion: Mechanisms for intermittent motion.	**Hours – 08**
Unit -2	
Kinematics, Drives of Machine tools: Selection of range of speeds and feeds. Layout in G.P., A.P. and H.P, standardization of speeds and feeds. Productivity loss. Selection of highest and lowest speeds, range ratio. Design of ray diagram and structural diagrams for machine tool gear boxes. Sliding, clustered and clutched drives, support drive.	**Hours – 10**
Unit – 3	
Feed gear boxes: Norton and Meander drives pre-selection of speed, stepped and stepless regulation. Strength, rigidity and design analysis: Analysis of beds, frames, columns. Materials for structures. Methods to improve the rigidity of structures. Types of Guide ways-overall compliance of machine tool. Thermal effects-functional accuracy of machine tool.	**Hours – 10**
Unit – 4	
Spindle units: Spindle units of lathe, drilling, milling and grinding machines, materials for spindles. Spindle design. Effect of clearance on the rigidity of spindle. Hydrodynamic, hydrostatic, rolling bearings. Selection of bearings.	**Hours – 12**
Unit-5	
Jigs & Fixtures: Principles of design of jigs and fixtures and uses, classification of jigs & fixtures, principles of location and	**Hours – 10**

clamping, types of clamping & work holding devices, typical examples of jigs and fixtures.	

COURSE OUTCOMES

On completion of this course, students will be able to:

1. Understand the basic working principles of different machine tools with kinematic mechanisms.
2. Distinguish the functional and operational requirements of different machine tools
3. Design speed and feed gear boxes for a particular configuration.
4. Design machine tool structures for strength and rigidity
5. Understand various controls used in machine tools

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Text Books

1. Sen G.S., & Battacharya, "Principles of Machine Tools", New Central Book Agency, Calcutta, 1986.
2. Machine Tool Design and Numerical Control/ NK Mehata / Tata MeGraw Hills, 2012

Reference Books

1. Basu S.K., "Design of Machine Tools", Allied Publishers, 1980.
2. Russe W. Henke, "Introduction to Fluid Power Circuits and Systems", Addison Wesley, 1970.
3. Metal Cutting and Tool Design – Dr.B.J.Ranganath - Vikas Publishing House Pvt. Ltd.- 2 nd Edition - 2018
4. A Textbook of Production Engineering – P.C.Sharma- S.Chand Publishers.

Course Outcomes to Program Outcomes mapping:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1		2	1						1		1	1	1	
2		2	1						1		3	1	1	
3		2	1								3	1	2	
4		1	1				3					1	2	
5		1	1				3				2	2	1	
Course		**2**	**1**				**2**		**1**		**2**	**1**	**2**	

COMPUTATIONAL FLUID DYNAMICS SEMESTER - VII			
Subject Code	21MEMEP703E	**IA Marks**	30
Number of Lecture Hours/Week	3(L)	**Exam Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

COURSE OBJECTIVES: Students should be able to:

- To study the basic governing equations and understand the basic properties of CFD.
- To impart the knowledge of numerical techniques to the solution of fluid dynamics and heat transfer problems.
- Specify need for implementation aspects to finite difference equations, consistency, explicit and implicit methods.
- Acquire knowledge of first order wave equation, stability of hyperbolic and elliptic equations.
- Recognize finite volume method, linear interpolation and quadratic interpolation. Common matrix methods such as direct methods for matrix inversion and direct methods for banded matrices.

Unit -1	**Hours**
Number system and errors, representation of integers, fractions, floating point arithmetic, loss of significance and error propagation, condition and instability, computational methods for error estimation, convergence of sequences. Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices.	**08**
Unit -2	
conservation of mass, Newton's second law of motion, expanded forms of navier-stokes equations, conservation of energy principle, special forms of the Navier-stokes equations. Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function - vorticity formulation.	**10**
Unit – 3	
Finite difference applications in heat conduction and convention – heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure. Finite differences, discretization, consistency, stability, and fundamentals of fluid flow modelling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.	**10**
Unit – 4	
Introduction to first order wave equation, stability of hyperbolic and elliptic equations, fundamentals of fluid flow modelling, conservative	**12**

property, the upwind scheme.	
Unit-5	
FINITE VOLUME METHOD: Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.	**10**

COURSE OUTCOMES

On completion of this course, students will be able to:

1. Understand and be able to numerically solve the governing equations for fluid flow and solve partial differential equations and analyze the behavior of them
2. Apply Numerical techniques and matrix methods to solve banded matrices
3. Apply finite difference techniques to solve the heat transfer and fluid flow energy equations
4. Evaluate fluid flow problem using various mathematical methods.
5. Investigate problems using finite volume methods.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Text Books

1. Numerical heat transfer and fluid flow / Suhas V. Patankar/Butter-worth Publishers
2. Computational fluid dynamics - Basics with applications /John. D. Anderson / Mc Graw Hill.

Reference Books

1. Computational Fluid Flow and Heat Transfer/ Niyogi/Pearson Publications
2. Fundamentals of Computational Fluid Dynamics /Tapan K. Sengupta / Universities Press.
3. Computational fluid dynamics: An introduction, 3rd edition/John.F Wendt/Springer publishers

Course Outcomes to Program Outcomes mapping:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	1		2	2				1		1	3	1	
2	3	2		3	3				2		3	2	1	
3	3	2		2	2				2		3	2	2	
4	3	2		2	3				1			2	1	
5	3	1		2	3				1		2	2	1	
Course	**3**	**2**		**2**	**3**				**1**		**2**	**2**	**2**	

OPERATIONS RESEARCH SEMESTER - VII			
Subject Code	21MEMET7060	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. Understand the definition, scope, objectives, phases, models and limitations of operations research and developing the ability to formulate the linear programming problems for minimizing the project cost and maximizing its profit.
2. Solve linear programming problems using various techniques based on the constraints
3. Understand about different application areas of operations research like transportation problem, assignment model.
4. Suggest optimal sequence and replacement policy to be maintained for better and economic growth of the industry.
5. Suggest optimal game strategies and estimation of waiting times in waiting line problems in the competitive business world.

Unit -1	**Hours**
Introduction to Operations Research: Definition, Features, types of OR models, Methodology, Tools, Limitations and applications of Linear Programming. **Linear Programming-I:** Introduction, Formulation of Linear Programming Problem (LPP), Assumptions for solving LPP, Applications of LPP, Graphical method of solving LPP.	**10**
Unit -2	
Linear Programming-II: Introduction, steps in solving problems using simplex method, Principle of simplex - Maximization and minimization problems, solution by simplex method, limitations of LPP simplex method. Dual simplex method. **Linear Programming-III:** Artificial variable concepts – Big -M method and Two-phase method	**10**
Unit – 3	
Transportation Problem: Basics, Basic Feasible Solution of Transportation problem with several methods, performing optimality test, degeneracy in transportation problem. **Assignment model:** Definition, Formulation, Different methods of solutions, Hungarian assignment method, unbalanced assignment problems, travelling salesman problems.	**10**
Unit – 4	
Sequencing problems: Introduction, basics, types of sequencing problems, priority sequencing, sequencing n-jobs through two machines, n-jobs and m-machines, two jobs 3-machines case.	**10**

Replacement: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.	
Unit – 5	
Queuing Theory: Introduction, Queuing system, elements of Queuing system Operating characteristics of a Queuing system, Classification of queuing models: Model-I [M/M/1: ∞ / FIFO], Model-III [M/M/1: N/FIFO]. **Game Theory**: Introduction, Two Person Zero sum games, Maximin - Minimax principle, Games without saddle points- mixed strategies, Graphical solution of 2Xn, mX2 games, and Dominance property	**10**

Course outcomes:

1. Formulate and solve mathematical model (linear programming problem) for real situations like production and distribution of goods using basic linear programming techniques li graphical methods
2. Apply the concepts of linear programming for decision making like simplex and dual simplex algorithms in production industries.
3. Calculate the optimal values of cost, job distribution and placement using transportation, assignment methods
4. Select the best optimal sequencing and replacement time for the machines in an industry for its better and economic growth using sequencing and replacement techniques.
5. Select the best optimal time and strategy to be followed by any organization to identify the waiting times and strategies to be implemented using waiting lines and game theory techniques for a continuous and successful growth of an industry.

TEXT BOOKS:

1. Operation Research /Premkumar Gupta, D.S.Hira / S.Chand
2. Operations Research / S.D. Sharma-KedarnathRamnath (JNTU)

REFERENCES:

1. Operations Research / R. Pannerselvam / PHI Publications.
2. Operation Research /J.K.Sharma/MacMilan.
3. Operation Research An Introduction / Taha / Pearson
4. Operations Research / A.M.Natarajan, P. Balasubramani, A. Tamilarasi / Pearson Education.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3										3	3	3
2	3	3	2									3	3	3
3	3	3	2									3	3	3
4	3	3	2									3	3	3
5	3	3	2									3	3	3
Course	**3**	**3**	**2**									**3**	**3**	**3**

MODELING & ANALYSIS
(Skill Oriented Course)
SEMESTER - VII

Subject Code	21MEMES7070	**IA Marks**	15
Number of Lecture Hours/Week	01(L)+02(P)	**Exam Marks**	35
Total Number of Lecture Hours	39	**Exam Hours**	03

Credits –2

Course objectives: Students should be able to
1. Know importance and applications of FEA package in industries
2. Know tools usage of simulation Software for analyzing machine components
3. Analyze the 1D structural analyses problems
4. Analyze the 2D machine components by meshing
5. Analyze the thermal & model analyses problems

INTRODUCTION

Introduction to various Finite Element Analysis (FEA) packages and their importance and applications in industries.

STRUCTURAL AND THERMAL ANALYSIS USING FEA Tool

1. Analysis of Beam having point load and UDL using APDL
2. Determination of deflection and stresses in 2D and 3D trusses.
3. Linear and Non-Linear Buckling Analysis
4. Determination of deflections in beams component and principal and Von-mises stresses in plane stress, plane strain and axi-symmetric components.
5. Determination of stresses in 3D and shell structures (at least one example in each case)
6. Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
7. Steady state heat transfer analysis of plane and Axi-symmetric components.

Course outcomes: Upon Completion of this course, the students will be able to:
1. Apply the knowledge of FEA package for industrial applications
2. Remember tools usage of simulation Software for analyzing machine components
3. Solve 1D structural problems using analysis software
4. Analize 2D structural and axi-symmetric problems using analysis software
5. Compute heat transfer problems using analysis software

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3	2	2								2		3
2	3	3	2	2								2		3
3	3	3	2	2								2		3
4	3	3	2	2								2		3
5	3	3	2	2								2		3
Course	**3**	**3**	**2**	**2**								**2**		**3**

SYLLABUS
SITE-21 REGULATIONS

For
OPEN ELECTIVE COURSES

Offered by
Mechanical Engineering

OPEN ELECTIVE COURSES

S. No.	Subject Code	Name of the subject
1.	21XXMEOX0XA	Operations Research
2.	21XXMEOX0XB	Fundamentals of Mechanical Engineering
3.	21XXMEOX0XC	Industrial Robotics
4.	21XXMEOX0XD	Engineering Materials
5.	21XXMEOX0XE	Introduction to Material Handling
6.	21XXMEOX0XF	Production Planning and Control
7.	21XXMEOX0XG	Non-Conventional Sources of Energy
8.	21XXMEOX0XH	Fluid Mechanics and Fluid Machinery

OPERATIONS RESEARCH SEMESTER - XX			
Subject Code	21XXMEOX0XA	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. Understand the definition, scope, objectives, phases, models and limitations of operations research and developing the ability to formulate the linear programming problems for minimizing the project cost and maximizing its profit.
2. Solve linear programming problems using various techniques based on the constraints
3. Understand about different application areas of operations research like transportation problem, assignment model.
4. Suggest optimal sequence and replacement policy to be maintained for better and economic growth of the industry.
5. Suggest optimal game strategies and estimation of waiting times in waiting line problems in the competitive business world.

Unit -1	**Hours**
Introduction to Operations Research: Definition, Features, types of OR models, Methodology, Tools, Limitations and applications of Linear Programming. **Linear Programming-I:** Introduction, Formulation of Linear Programming Problem (LPP), Assumptions for solving LPP, Applications of LPP, Graphical method of solving LPP.	**10**
Unit -2	
Linear Programming-II: Introduction, steps in solving problems using simplex method, Principle of simplex - Maximization and minimization problems, solution by simplex method, limitations of LPP simplex method. Dual simplex method. **Linear Programming-III:** Artificial variable concepts – Big -M method and Two-phase method	**10**
Unit – 3	
Transportation Problem: Basics, Basic Feasible Solution of Transportation problem with several methods, performing optimality test, degeneracy in transportation problem. **Assignment model:** Definition, Formulation, Different methods of solutions, Hungarian assignment method, unbalanced assignment problems, travelling salesman problems.	**10**
Unit – 4	

Sequencing problems: Introduction, basics, types of sequencing problems, priority sequencing, sequencing n-jobs through two machines, n-jobs and m-machines, two jobs 3-machines case. **Replacement:** Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.	**10**
Unit – 5	
Queuing Theory: Introduction, Queuing system, elements of Queuing system Operating characteristics of a Queuing system, Classification of queuing models: Model-I [M/M/1: ∞ / FIFO], Model-III [M/M/1: N/FIFO]. **Game Theory**: Introduction, Two Person Zero sum games, Maximin - Minimax principle, Games without saddle points- mixed strategies, Graphical solution of 2Xn, mX2 games, and Dominance property	**10**
Course outcomes: 1. Formulate and solve mathematical model (linear programming problem) for real situations like production and distribution of goods using basic linear programming techniques li graphical methods 2. Apply the concepts of linear programming for decision making like simplex and dual simplex algorithms in production industries. 3. Calculate the optimal values of cost, job distribution and placement using transportation, assignment methods 4. Select the best optimal sequencing and replacement time for the machines in an industry for its better and economic growth using sequencing and replacement techniques. 5. Select the best optimal time and strategy to be followed by any organization to identify the waiting times and strategies to be implemented using waiting lines and game theory techniques for a continuous and successful growth of an industry.	
TEXT BOOKS: 1. Operation Research /Premkumar Gupta, D.S.Hira / S.Chand 2. Operations Research / S.D. Sharma-KedarnathRamnath (JNTU)	
REFERENCES: 1. Operations Research / R. Pannerselvam / PHI Publications. 2. Operation Research /J.K.Sharma/MacMilan. 3. Operation Research An Introduction / Taha / Pearson 8. Operations Research / A.M.Natarajan, P. Balasubramani, A. Tamilarasi / Pearson Education.	
Question paper pattern: 4. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice) 5. All questions carries 14 marks each 6. Each full question will have sub question covering all topics under a course outcome	

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3										3	3	3
2	3	3	2									3	3	3
3	3	3	2									3	3	3
4	3	3	2									3	3	3
5	3	3	2									3	3	3
Course	**3**	**3**	**2**									**3**	**3**	**3**

FUNDAMENTALS OF MECHANICAL ENGINEERING SEMESTER - XX			
Subject Code	21XXMEOX0XB	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to

1. Understand the concepts of fluid properties like specific gravity, viscosity, density, surface tension
2. To study the classification of turbines and work done and efficiency of the different turbines and also study about draft tube theory and to determine the function efficiency.
3. To study about specific speed and performance characteristics of different types of turbines.
4. To study automobile engine working, valve timing and associated systems such as lubricating system, cooling system, fuel feed system, ignition system etc., their necessity, requirements, construction details, different types and their working
5. To study the construction, working principles and advantages of belt and rope drives, selection of belt drive- types of belt drives, V-belts, types of coupling.

Unit -1	**Hours**
Fluid Mechanics: Dimensions and units: physical properties of fluids-specific gravity, viscosity and its significance, surface tension, capillarity, and vapor pressure. Atmospheric gauge and vacuum pressure – Measurement of pressure. Manometers- Piezometer, U-tube, inverted and differential manometers.	**10**
Unit -2	
Impact of jets: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.	**10**
Unit – 3	
Hydraulic Turbines and Governing systems: Classification of turbines; Working principle, Efficiency calculation and Design principles for Pelton Wheel, Francis and for Kaplan turbines; Governing of turbines; Performance and characteristic curves.	**10**
Unit – 4	
I. C. Engines: Classification, working principles – valve and port timing diagrams – air standard cycles –fuel injection system, carburetion, ignition, cooling and lubrication – Engine performance evaluation. **Spark Ignition and Combustion Ignition engines** – Classification, working principles, Types of engines.	**10**
Unit – 5	
Belt drives: Introduction, Belt and rope drives, selection of belt drive-	**10**

types of belt drives, V-belts, velocity ratio of belt drives, slip of belt, creep of belt, tensions for flat belt drive, angle of contact, centrifugal tension, maximum tension of belt, **Coupling:** Brief introduction of coupling, Rigid couplings - muff, split muff and flange couplings, flexible couplings - flange coupling	

Course outcomes:

1. Understand the concepts of fluid properties like specific gravity, viscosity, density, surface tension.
2. To study the classification of turbines and work done and efficiency of the different turbines and also study about draft tube theory and to determine the function efficiency.
3. This study is also used for the estimation of efficiency and performance of the turbine with the study of characteristics curves.
4. To study automobile engine working, valve timing and associated systems such as lubricating system, cooling system, fuel feed system, ignition system etc., their necessity, requirements, construction details, different types and their working
5. To study the construction, working principles and advantages of belt and rope drives, selection of belt drive- types of belt drives, V-belts, types of coupling.

TEXT BOOKS:

1. Basic Mechanical Engineering / Pravin Kumar/ Pearson
2. Thermal Engineering- R.S Khurmi/JS Gupta/S.Chand.
3. Introduction to Engineering Materials / B.K. Agrawal/ McGraw Hill

REFERENCES:

1. Fundamental of Mechanical Engineering/ G.S. Sawhney/PHI
2. Thermal Science and Engineering / Dr. D.S. Kumar/ Kataria

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
1	2	1	2									3	2	
2	2	2	3									2	**2**	
3	2	2	3									2	**2**	
4	3	3										2	**2**	
5	2	2	3	**1**								2		**2**
Course	**2**	**2**	**3**	**1**								**2**	**2**	**2**

INDUSTRIAL ROBOTICS SEMESTER - XX			
Subject Code	21XXMEOX0XC	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:
Enable the students to

1. Understand various applications of robotics and classification of coordinate system and control systems
2. Build the concepts of components of industrial robotics.
3. Determine kinematic analysis with D-H notation, forward and inverse kinematics
4. Model trajectory planning for a manipulator by avoiding obstacles
5. Understand different types of actuators and importance of application of robots in manufacturing

Unit -1	**Hours**
Introduction: Automation and Robotics, CAD/CAM and Robotics – An overview of Robotics –present and future applications – classification by coordinate system and control system.	8
Unit -2	
Components of the Industrial Robotics: Function line diagram representation of robot arms, common types of arms. Components, Architecture, number of degrees of freedom – Requirements and challenges of end effectors, determination of the end effectors, comparison of Electric, Hydraulic and Pneumatic types of locomotion devices.	8
Unit – 3	
Motion Analysis: Homogeneous transformations as applicable to rotation and translation – problems. **Manipulator Kinematics:** Specifications of matrices, D-H notation joint coordinates and world coordinates Forward and inverse kinematics – problems.	10
Unit – 4	
Trajectory Planning: General considerations in path description and	12

generation. Trajectory planning and avoidance of obstacles, path planning, Skew motion, joint integrated motion –straight line motion – Robot programming, languages and software packages-description of paths with a robot programming language.	
Unit – 5	
Robot Actuators and Feed Back Components: Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors. Feedback components: position sensors– potentiometers, resolvers, encoders – Velocity sensors. **Robot Applications in Manufacturing:** Material Transfer - Material handling, loading and unloading- Processing - spot and continuous arc welding & spray painting - Assembly and Inspection.	12

Course outcomes:

1. Understand various applications of robotics and classification of coordinate system and control systems
2. Build the concepts of components of industrial robotics.
3. Apply kinematic analysis with D-H notation, forward and inverse kinematics
4. Generate trajectory planning for a manipulator by avoiding obstacles.
5. Understand different types of actuators and various applications of robots in manufacturing

TEXT BOOKS:

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Robotics / John J. Craig/ Pearson
3. Robotics and Control/ Mittal R K & Nagrath I J/ TMH.

REFERENCES:

1. Introduction to Robotics/ Saeed B Niku / Wiely Publications.
2. Robotics/ Fu K S/ Mc Graw Hill.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	2	2	3		3								2	
2	3	3	3										2	
3	3	3	2		3								2	
4	3	2	2		3								2	
5	2	2	3		3								2	
Course	**3**	**3**	**3**		**3**								**2**	

ENGINEERING MATERIALS SEMESTER XX			
Subject Code	21XXMEOX0XD	**Internal Marks**	30
Number of Lecture Hours/Week	03	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits - 03			

Course objectives:

This course will enable students to:

1. Classify different bonds in solids and understand crystallization of the metals, for the formation of the solid solutions and compounds.
2. Understand different phase diagrams.
3. Recognize the property requirements of a given application and suggest a suitable ferrous and non-ferrous metal and their alloys.
4. Illustrate the property requirements of a given application and suggest appropriate heat treatment
5. Identify the property requirements of a given application and suggest a suitable ceramic, composite materials

Unit -1	**Hours**
Structure of Metals and Constitution of alloys: Bonds in Solids – Metallic bond - crystallization of metals, grain and grain boundaries, effect of grain boundaries on the properties of metal / alloys – determination of grain size. Necessity of alloying, types of solid solutions, Hume Rothery's rules, intermediate alloy phases, and electron compounds. Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery.	**10**
Unit -2	
Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorpous alloy systems, equilibrium cooling and heating of alloys, lever rule, coring, miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys.	**8**
Unit - 3	
Ferrous & non-ferrous metals and their alloys Structure and properties of white cast iron, malleable cast iron, grey cast iron, spheroid graphite cast iron, alloy cast irons. Classification of steels, structure and properties of plain carbon steels, low alloy steels, Hadfield manganese steels, tool and die steels. Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys	**12**
Unit – 4	

Heat treatment of Alloys: Annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface-hardening methods (carburizing, carbo-nitriding, cyaniding, induction hardening and flame hardening), age hardening treatment, and cryogenic treatment of alloys. vacuum and plasma hardening	**8**
Unit-5	
Ceramic and composite materials: Crystalline ceramics, glasses, cermets, abrasive materials, nanomaterial's – definition, properties and applications of the above. Classification of composites, various methods of component manufacture of composites, particle – reinforced materials, fiber reinforced materials, metal ceramic mixtures, metal – matrix composites and C – C composites.	**12**

Course outcomes:

On completion of the course, student will be able to

1. Classify different bonds in solids and understand crystallization of the metals, for the formation of the solid solutions and compounds.
2. Different phase diagrams and study of binary phase diagrams
3. Recorgnize the property requirements of a given application and suggest suitable ferrous & nonferrous alloys
4. Analyze the property requirements of a given application and suggest appropriate heat treatment
5. Identified the property requirements of a given application and suggest a suitable ceramic, composite materials

Text Books:

1. Introduction to Physical Metallurgy - Sidney H. Avener - McGrawHill
2. Essential of Materials science and engineering - Donald R.Askeland – Thomson

Reference Books:

1. Material Science and Metallurgy – V.D.Kodgire and S.V.Kodgire
2. Materials Science and engineering - Callister & Baalasubrahmanyam
3. Material Science for Engineering students – Fischer – Elsevier Publishers.
4. Material science and Engineering - V. Rahghavan
5. Introduction to Material Science and Engineering – Yip-Wah Chung CRC Press.
6. Material Science and Metallurgy – A V K Suryanarayana – B S Publications.
7. Material Science and Metallurgy – U. C. Jindal – Pearson Publication

Web Source References:

1. https://www.iitm.ac.in/mmresearch
2. http://nptel.ac.in/courses/113106032/3
3. https://en.wikipedia.org/wiki/Materials_science

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each

3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
1	2	1	2									1		
2	2	1	2									1		
3	2		2									2		
4	2		2									1		
5	2		2									2		
6	2		2									1		
Course	**3**	**1**	**2**									**2**		

INTRODUCTION TO MATERIAL HANDLING SEMESTER - XX			
Subject Code	21XXMEOX0XE	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

COURSE OBJECTIVES:

Students should be able

1. To understand the classification of material handling equipment.
2. To explain the usage of different material handling equipment in industry.
3. To know how to connect loading stations to the different discharge conditions.
4. To explain the usage of cranes at industries.
5. To explain the usage of hoists and monorails at industries.

Unit -1	**Hours**
Introduction to materials handling, examples of materials equipment, examples of materials handling equipment, continuous conveying, intermittent conveying, examples, lifting, hoisting, handling of bulk goods and piece goods, cranes and conveyors, principles of calculation of conveying equipment, cycle time, bulk materials and bulk density, angle of repose, example for a belt conveyor and a simple hoist.	**10**
Unit -2	
Belt conveyors, constructional details, toughing angle, idlers, belt specifications, chutes, skirt boards, ploughs, belt conveyor layouts, belt trippers and typical examples, roller conveyors, overhead conveyors, apron conveyors, component parts and operational details and applications with typical layouts.	**10**
Unit – 3	
Unit materials handling and storage: Unit load concept (platform sheet industrial hand trucks, self-contained unit load, pallet less handling, introduction only), industrial hand trucks, powered industrial trucks, automated guided vehicles, basic storage and equipment system, Automated storage and retrieval systems (AS/RS), carosel storage system and its applications.	**10**
Unit – 4	
Cranes Jib cranes like wall mounted and travelling type, stability criteria, wheel loads, wheel trucks and bogeys, number of mechanisms in jib cranes, jib construction. Harbour cranes, luffing and level luffing cranes, shipyard gantry cranes,	**10**
Unit – 5	
Hoists and monorails Portal frames and slewing rings and bearings typical stability, calculations of portal cranes, types of hoists	**10**

Course outcomes:

1. Classify the material handling equipment
2. Explain the usage of different material handling equipment in industry
3. Discuss how to connect loading stations to the different discharge conditions
4. Associate the usage of cranes at industries
5. Associate the usage of hoists and monorails at industries

TEXT BOOKS

1. Material handling handbook, 2nd edition, ASME, 1985
2. Automation production systems and computer integrated manufacturing, Mikell P Groover, Prentice Hall of India, 2002.
3. Plant Layout and Materials Handling, Dr R B Choudary and G R N Tagore, Khanna Publishers

REFERENCE BOOK

1. R.O. Bailey, "Bulk material handling by conveyor belt I and II" M.A. Al
2. Frutchbaum, "Bulk solids handling

Question paper pattern:

1. Question paper contains 12 Questions, 2 from each course outcome. The student must answer 6 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 12 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	1	1	3									1	3	
2	1	1	3									1	3	
3	1	2	3									2	3	
4	1	2	3									1	3	
5	1	2	3									2	3	
6	1	2	3									1	3	
Course	**1**	**2**	**3**									**2**	**3**	

PRODUCTION PLANNING AND CONTROL SEMESTER - XX			
Subject Code	21XXMEOX0XF	**IA Marks**	30
Number of Lecture Hours/Week	3(L)	**Exam Marks**	70
Total Number of Lecture Hours	50	**Exam**	03
Credits – 03			

COURSE OBJECTIVES: Students should be able to:

4. Understand the concepts of production and service systems
5. Apply forecasting techniques for various firms, namely qualitative & quantitative methods to optimize/make best use of resources in achieving their objectives.
6. Identify different strategies employed in manufacturing and service industries to plan inventory and Impart knowledge on the Materials Requirement Planning and Kanban, LOB and JIT Methods.
7. Determine the exact routing and scheduling which will be followed in production. And apply different scheduling policies in planning and control and make best use of resources.
8. Measure the effectiveness, identify likely areas for improvement, develop and implement improved planning and control methods for production systems.

Unit -1	**Teaching Hours**
Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department – internal organization of department.	**Hours – 08**
Unit -2	
Forecasting – importance of forecasting – types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitative methods.	**Hours – 10**
Unit – 3	
Inventory management – functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems Introduction to MRP I, MRP II, ERP, LOB (Line of Balance), JIT and KANBAN system.	**Hours – 10**
Unit – 4	
Routing & Scheduling– definition – routing procedure –route sheets – bill of material – factors affecting routing procedure, schedule –definition – difference with loading, Scheduling policies – techniques, standard scheduling methods, line balancing,	**Hours – 12**

aggregate planning.	
Unit-5	
Dispatching– activities of dispatcher – dispatching procedure – follow up – definition – reason for existence of functions – types of follow up, expediting, controlling aspects. Applications of computer in production planning and control.	**Hours – 10**

COURSE OUTCOMES

On completion of this course, students will be able to:

1. Illustrate the systems concept for the design of production and service systems.
2. Develop forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques
3. Discuss the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances.
4. Select and use an appropriate principles/methods/ techniques/ modern concept with reference to given application/situation in the preparation of route sheets with scheduling and loading in manufacturing systems.
5. Create and engage in life-long learning in the context of technological change in Operations Management and also able to identify dispatching, follow-up activities in the system

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. CO1- CO5 questions carries 14 marks each.
3. Each full question will have a sub question covering all topics under a course outcome.

Text Books

1. Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
2. Manufacturing, Planning and Control/PartikJonssonStig-Arne

Reference Books

1. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller/Prentice-Hall
2. Production Planning and Control/Mukhopadyay/PHI
3. Production Control A Quantitative Approach / John E. Biegel/Prentice-Hall

Web references

1. http://nptel.ac.in/courses/112102106/
2. http://nptel.ac.in/courses/112107143/
3. http://nptel.ac.in/courses/112107142/33
4. http://nptel.ac.in/courses/112107142/31
5. https://nptel.ac.in/courses/112107142/36

Course Outcomes to Program Outcomes mapping:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1		2	1						1		1		1	
2		2	1								3		1	
3		2									3		2	
4			1	1	1		3						1	
5				1	1		3				2	2	1	
Course		**1**	**1**	**1**	**1**		**3**		**1**		**2**	**1**	**2**	

NON-CONVENTIONAL SOURCES OF ENERGY SEMESTER-XX			
Subject code	21XXMEOX0XG	**Internal marks**	30
Number of lecture hours/Week	3(L)	**External marks**	70
Total No of lecture hours	50	**Exam hours**	03
Credits-03			

Course Objectives:

Enable the students to:

1. Understand the principles and working of solar and solar energy collection.
2. Apply the principles of solar energy storage, applications in generation of electric power.
3. Apply the knowledge of Wind energy and Biomass, in generation of electric power production.
4. Apply the Principles and working of Geothermal energy power plant, OTEC plants, tidal, wave energy and Mini hydel power plants in generation of the electric power
5. Apply the principles of direct energy conversion systems like Thermoelectric generators, MHD generators and fuel cells, in generation of electric power production

Unit-1	**Hours**
Principles of Solar Radiation: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power - the solar constant, extra-terrestrial and terrestrial solar radiation, Solar radiation on titled surface, Instruments for measuring solar radiation and sun shine, solar radiation data. **Solar Energy Collection:** Flat plate and concentrating collectors, classification of concentrating collectors, advanced collectors.	**8**
Unit-2	
Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications - solar heating/cooling techniques, solar distillation and drying, photovoltaic energy conversion.	**6**
Unit-3	
Wind Energy: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria **Bio-Mass:** Principles of Bio-Conversion, Anaerobic /aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of biogas, utilization for cooking, I.C. Engine operation, and economic aspects.	**10**
Unit-4	
Geothermal Energy: Resources, types of wells, methods of harnessing the energy, potential in India. Ocean Energy – OTEC, Principles, utilization, setting of OTEC plants, thermodynamic	**10**

cycles. **Tidal and Wave energy:** Potential and conversion techniques, mini-hydel power plants, their economics.	
Unit-5	
Direct Energy Conversion: Need for DEC, Carnot cycle, limitations, Principles of DEC. Thermoelectric generators, Seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principle, faraday's laws, thermodynamic aspects, selection of fuels and operating conditions.	**16**

Course outcomes:

1. The student understands the principles and working of solar and solar energy collection.
2. The students apply the principles of solar energy storage, applications in power generation.
3. The students Apply the knowledge of Wind energy and Biomass, in generation of power
4. The students Apply the Principles and working of Geothermal energy power plant, OTEC plants, tidal, wave energy and Mini hydel power plants in generation of the electric power.
5. Apply the principles of direct energy conversion systems like Thermoelectric generators, MHD generators and fuel cells, in generation of electric power.

Text books:

1. Renewable Energy Resources / Tiwari and Ghosal / Narosa
2. Non- conventional Energy Sources / G.D. Rai/ Khanna Publishers
3. Biological Energy Resources/ Malcolm Fleischer & Chris Lawis/ E&FN Spon

Reference books:

1. Renewable Energy Sources / Twidell& Weir
2. Solar Power Engineering / B.S. Magal Frank Kreith& J.F. Kreith
3. Principles of Solar Energy / Frank Krieth& John F Kreider
4. Non-Conventional Energy / Ashok V Desai / Wiley Eastern

Question paper pattern:

1. Question paper contains 10 questions,2 from each course outcomes, the student must answer 5 full questions by selecting one question from each course outcome (Internal choice)
2. All question carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3	2			2	2					3	3	
2	3	3	2			2	2					3	3	
3	3	3	2			2	2					3	3	
4	3	3	2			2	2					3	3	
5	3	3	2			2	2					3	3	
Course	**3**	**3**	**2**			**2**	**2**					**3**	**3**	

FLUID MECHANICS AND FLUID MACHINERY SEMESTER -XX			
Subject Code	21XXMEOX0XH	**Internal Marks**	30
Number of Lecture Hours/Week	3(L)	**External Marks**	70
Total Number of Lecture Hours	50	**Exam Hours**	03
Credits – 03			

Course Objectives:

Enable the students to:

1. Understand the fundamental properties of fluid and calculate fluid pressure using the manometer.
2. Apply the differential conservation equations of mass, momentum, and energy to fluid flow problems.
3. Evaluate major and minor losses in pipes and also discuss boundary layer concepts.
4. Solve problems on the turbo machines like turbines using analytical method and velocity triangles.
5. Discuss the Classification and working principles of pumps and evaluate the performance of hydraulic machines.

Unit -1	**Hours**
Fluids: Definition of fluid, Fluid properties, Atmospheric gauge and vacuum pressure – measurement of pressure. Manometers- Piezometer, U-tube, inverted and differential manometers. Hydraulics: Pascal's law, hydrostatic law. Buoyancy, forces on submerged bodies, stability of floating bodies.	**10**
Unit -2	
Fluid Kinematics: Introduction, flow types. Equation of continuity for one dimensional flow. Stream line, path line and streak lines and stream tube. Stream function and velocity potential function. **Fluid Dynamics:** surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its applications, force on pipe bend.	**10**
Unit – 3	
Closed Conduit Flow: Reynold's experiment- Darcy Weisbach equation, Minor losses in pipes- pipes in series and pipes in parallel- total energy line hydraulic gradient line.	**10**

Basics of Turbo Machinery: Hydrodynamic force of jets on stationery and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.	
Unit – 4	
Turbines: Hydraulic Turbines: classification of turbines, Working and efficiencies of Pelton wheel, Francis and Kaplan turbines. Importance of Draft Tube. **Hydraulic Quantities:** Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.	**10**
Unit – 5	
Pumps: Centrifugal Pumps: Classification, working, work done – manometric head losses and efficiencies- specific speed- pumps in series and parallel performance characteristic curves, cavitation & NPSH. **Reciprocating Pumps:** Working, Discharge, slip, indicator diagrams.	**10**

Course outcomes:

1. Demonstrate various properties of fluids, pressure measurement devices and their applications.
2. Identify the kinematics and dynamics properties of fluids flowing in different conditions and its effects on the bodies.
3. Estimate the effect of various losses in fluids due to flowing and obstructions and understand using the concepts of pipe losses and Boundary layer theory.
4. Analyze the performance of hydraulic turbines, units and specific quantities based on the design by applying the knowledge of turbo-machinery using analytical methods and velocity triangles.
5. Analyze the performance of various hydraulic pumps based on workings and design.

TEXT BOOKS

1. Hydraulics, fluid mechanics and Hydraulic machinery Modi and Seth
2. Fluid Mechanics and Hydraulic Machines/ RK Bansal/Laxmi Publications

REFERENCE BOOKS

1. Fluid Mechanics and Hydraulic Machines by Rajput
2. Fluid Mechanics & Turbo machinery by Dixon, 7th Edn, Elesvier
3. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International
4. Fluid Mechanics- Fundementals and Applications by Y.A. Cengel, J.M.Cimbala, 6th Edn, McGrawHill
5. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, Kotaria& Sons.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
2. All questions carries 14 marks each
3. Each full question will have sub question covering all topics under a course outcome

Course Outcomes to Program Outcomes mapping:

CO /PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	3				3							3	
2	3	3				3							3	
3	3	3				2							3	
4	3	2				3							3	
5	3	3				3							3	
Course	**3**	**3**				**3**							**3**	

SYLLABUS
SITE-21 REGULATIONS

For
HONORS/MINOR COURSES

Offered by
Mechanical Engineering

B. Tech (Mechanical Engineering)

Regulation SITE 21

IV- SEMSTER

HONORS/MINOR COURSES

Honors Courses

S. No.	Course Code	Course Title	Prerequisite
1.	21MEMEH401A	Advanced Strength of Materials	• Mechanics of Solids
2.	21MEMEH401B	Advanced Materials	• Materials Engineering
3.	21MEMEH401C	Advanced Welding Technology	• Production Technology
4.	21MEMEH401D	Waste to Energy	• Thermodynamics • Engineering Chemistry

Minor Courses

S. No.	Course Code	Course Title	Prerequisite
1.	21XXMEM401A	Engineering Mechanics	• Engineering Physics
2.	21XXMEM401B	Thermodynamics	• Engineering Physics • Engineering Chemistry
3.	21XXMEM401C	Materials Engineering	• Engineering Physics • Engineering Chemistry
4.	21XXMEM401D	Production Technology	• Engineering Physics

ADVANCED STRENGTH OF MATERIALS SEMESTER - IV			
Subject Code	21MEMEH401A	Internal Marks	30
Number of Lecture Hours/Week	3(L)	External Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 04			

Course Objectives: Students should be able to

1. Know the method of calculating stress and strain in a member subjected to principal stress and strain and relation between them.
2. Understand the relation between elastic constants and material symmetry.
3. Analyze the theories of failures and bending of beams
4. Calculate the torsion of a circular, elliptical, triangular, rectangular bars, and Rolled sections.
5. Calculate the stress energy stored by using different energy methods.

Unit -1	**Hours**
Stress: derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions. **Strains:** concept of strain. Derivation of small strain tensor and compatibility. strain theory, principal strains, strain of a volume element, small displacement theory, Stress-strain relations for isotropic materials	**10**
Unit -2	
Constitutive Equations: Generalized Hooke's law, linear elasticity, Material symmetry: Boundary value problems: Principal planes, cubic equations, the state of stress referred to principal axes, Plane stress and plane strain problems	**10**
Unit – 3	
Theories of Failure: Significance of the theories of failure, Factor of safety in design, ideally plastic solid **Bending of Beams**: Straight beams and asymmetrical bending, Bending of curved beams	**10**
Unit – 4	
Torsion & Axisymmetric Problems: Torsion of general prismatic bars - solid sections, Torsion of circular, elliptical, triangular and rectangular bars, Torsion of rolled sections, Thick-walled cylinder subjected to internal and external pressures -lame's-problems, Stresses in composite tubes, Thermal stresses.	**10**
Unit – 5	
Energy Methods Solutions using potentials, Energy methods, Work done by forces and elastic strain energy stored, Maxwell-Betti-Rayleigh Reciprocal theorem, Beggs Deformeter, First theorem of Castigliano, Theorem of virtual work, Kirchhoff's theorem.	**10**

Course outcomes: Students will be able to

1. Learn the method of calculating stress and strain in a member subjected to principal stress and strain and relation between them.
2. Understand the relation between elastic constants and material symmetry.
3. Analyze the theories of failures and bending of beams
4. Calculate the torsion of a circular, elliptical, triangular, rectangular bars, and Rolled sections.
5. Calculate the stress energy stored by using different energy methods

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries14 marks each
4. Each full question will have sub question covering all topics under a course outcome

Text Books:

1. Boresi & Sidebottom, Advanced Mechanics of Materials, Wiely International
2. L.S. Srinath, Advanced Mechanics of Solids, 3rd Edition, TMH, 2009

References:

1. Timoshenko, Theory of plates
2. B.C.Punmia, Strength of materials & Theory od Structures (V0l I & II)
3. Sadhu Singh, Strength of Materials

ADVANCED MATERIALS SEMESTER - IV			
Subject Code	21MEMEH401B	Internal Marks	30
Number of Lecture Hours/Week	3(L)	External Marks	70
Total Number of Lecture Hours	50	Exam Hours	03

Credits – 04

Course Objectives :

Enable the students to

1. Classify composites, introduce common types of fibers and matrices and applications of composites.
2. Underlying the applications of aerospace materials.
3. Illuminate the knowledge and analysis skills in applying hooke's laws in mechanics to the composite materials.
4. Understanding the key characteristics and applications of functionally graded materials, characteristics and applications of shape memory alloys.
5. Acquire different classes of nanomaterials that have been developed in recent years in light of various technological applications and properties.

Unit -1	**Hours**
Introduction to Composite Materials: Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber reinforced composites and nature-made composites, and applications **Reinforcements:** Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and born carbide fibres.	**10**
Unit -2	
Aerospace Materials: Metallic materials- super alloys, Aluminium, Magnesium, titanium and Nickel based alloys and intermetallics, High temperature polymers, Materials for cryogenic application, Materials for space environment, Evaluation of materials for extreme environment, Materials processing and manufacturing in zero gravity.	**10**
Unit – 3	
Macro mechanical Analysis of a Lamina: Introduction, generalized Hooke's law, reduction of Hooke's law in three dimensions to two dimensions, relationship of compliance and stiffness matrix to engineering elastic constants of an orthotropic lamina, laminate-laminate code.	**10**
Unit – 4	
Functionally Graded Materials: Types of functionally graded materials-classification, different systems - preparation - properties and applications of functionally graded materials. **Shape Memory Alloys:** Introduction-shape memory effect-classification	**10**

of shape memory alloys composition- properties and applications of shape memory alloys.	
Unit – 5	
Nano Materials: Introduction-properties at nano scales-advantages & disadvantages applications in comparison with bulk materials (nano – structure, wires, tubes, composites). state of art nano advanced- topic delivered by student.	**10**

Course outcomes:

1. Identify, describe and evaluate the properties and applications of fibre reinforcements and types of composite materials.
2. Identify the aerospace materials and their applications
3. Ability to obtain lamina and laminate behavior by using hooke's law and relationship of compliance and stiffness matrix for composite materials
4. Demonstrate awareness of recent scientific and technological developments in the field of aerospace materials, and assess their potential to enhance the performance of aircraft in the near future for functionally graded materials, properties and applications on shape memory alloys.
5. Impart knowledge on different types of Nano materials.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries14 marks each
4. Each full question will have sub question covering all topics under a course outcome

Text Books:

1. Nano material, A.K. Bandyopadyay, New age Publishers
2. Material science and Technology: A comprehensive treatment, Robert W.Cahn, VCH
3. Engineering Mechanics of Composite Materials, Isaac and M Daniel, Oxford University Press

References Books:

1. Mechanics of Composite Materials R. M. Jones, McGraw Hill Company, New York, 1975.
2. Analysis of Laminated Composite Structures, L. R. Calcote/Van NostrandRainfold, New York 1969
3. Analysis and performance of fibre Composites, B. D. Agarwal and L. J. Broutman, Wiley

ADVANCED WELDING TECHNOLOGY SEMESTER - IV			
Subject Code	21MEMEH401C	Internal Marks	30
Number of Lecture Hours/Week	3(L)	External Marks	70
Total Number of Lecture Hours	50	Exam Hours	03

Credits – 04

Course Objectives

1. Study the different types of welding processes and its application in various fields
2. Design and fabricate welded joints using cold metal transfer welding process
3. Employ appropriate welding processes for making welded joints with different materials
4. Analyze the welded joints fabricated through hybrid welding processes
5. Perform friction welding processes for making welded joints

Unit -1	**Hours**
Introduction: Classification of welding processes, heat sources, Weld joint design - Weldability of steels and other materials - Weld defects. Cold Metal Transfer welding process, advantages, limitations and applications.	**10**
Unit -2	
Classification of welding processes: TIG / A-TIG Welding, gas metal arc welding, Submerged arc welding, Plasma arc welding Adhesive bonding, vacuum brazing, Explosive welding: Process description, process parameters, joint design, advantages and limitations applications.	**10**
Unit – 3	
Laser Beam welding: Laser Beam welding, - advantages, limitations and applications, process variables and their effects.	**10**
Unit – 4	
Electron beam welding: Electron beam welding, - advantages, limitations and applications, process variables and their effects.	**10**
Unit – 5	
Friction stir welding: Friction & Friction stir welding, tool design, Fixture design, modification of tool and features, modeling of friction stir welding, submerged friction stir welding. Friction stir processing, Process variables, Surface modification by friction stir processing, Production of composite by friction stir processing.	**10**

Course outcomes:

1. Study the welded joints fabricated through cold metal transfer welding process
2. Select appropriate welding processes for making welded joints with different

materials
3. Analyze the welded joints fabricated through Laser Beam welding processes
4. Analyze the welded joints fabricated through Electron Beam welding processes
5. Employ friction welding processes for repair and reclamation work

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries14 marks each
4. Each full question will have sub question covering all topics under a course outcome

Text Books

1. Parmar R.S., "Welding Processes and Technology", Khanna Publishers, 2014.
2. Nadkarni S.V., 'Modern Arc Welding Technology', Oxford and IBH Publishing, 2015.

REFERENCE BOOKS

1. Lancaster J.F, 'The Physics of Welding', Pergamon Press, 1984
2. Weman K., "Welding Processes Hand Book", CRC Press, 2003.
3. Norrish J: Advanced Welding Processes, Woodhead publishing, 2006

WASTE TO ENERGY SEMESTER - IV			
Subject Code	21MEMEH401D	Internal Marks	30
Number of Lecture Hours/Week	3(L)	External Marks	70
Total Number of Lecture Hours	50	Exam Hours	03

Credits – 04

Course objectives:

Enable the students to

1. Understand the different types of wastes.
2. Understand various energy generation methods.
3. Identify sources of energy using bio-chemical conversion.
4. Apply the knowledge of waste to energy for extraction of fuel from waste.
5. Analyse the environmental effect of waste to energy conversion.

Unit -1	**Hours**
Characterization of wastes, agricultural residues and wastes including animal wastes; industrial wastes; municipal solid wastes. Waste processing types and composition of various types of wastes; Characterization of Municipal Solid Waste, Industrial waste and Biomedical Waste, waste collection and transportation; waste processing-size reduction, separation; waste management hierarchy, waste minimization and recycling of Municipal solid waste.	**10**
Unit -2	
Thermo chemical conversion: incineration, pyrolysis, gasification of waste using gasifiers, environmental and health impacts of incineration; strategies for reducing environmental impacts. Energy production from wastes through incineration, energy production through gasification of wastes. Energy production through pyrolysis and gasification of wastes, syngas utilization.	**10**
Unit – 3	
Bio-chemical Conversion: Anaerobic digestion of sewage and municipal wastes, direct combustion of MSW-refuse derived solid fuel, industrial waste, agro residues, anaerobic digestion biogas production, and present status of technologies for conversion of waste into energy, Design of waste to energy plants for cities, small townships and villages. Energy production from wastes through fermentation and trans esterification. Cultivation of algal biomass from wastewater and energy production from algae. Energy production from organic wastes through anaerobic digestion and fermentation.	**12**
Unit – 4	
Energy production from waste plastics, gas cleanup Waste, Heat Recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.	**10**

Unit – 5	
Environmental and health impacts-case studies: Environmental and health impacts of waste to energy conversion, case studies of commercial waste to energy plants, waste to energy- potentials and constraints in India, eco-technological alternatives for waste to energy conversions.	8
Course outcomes: 1. Understand the different types of waste. 2. Understand various energy generation methods. 3. Identify sources of energy from bio-chemical conversion. 4. Apply the knowledge of waste to energy for extraction of fuel from waste. 5. Analyse the environmental effect of waste to energy conversion.	
Question paper pattern: 1. Question paper contains 10 Questions, 2 from each course outcome. 2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice) 3. All questions carries14 marks each 4. Each full question will have sub question covering all topics under a course outcome	
TEXT BOOKS: 1. P.A.Vesilind and W.A.Worrell (2016) Solid Waste Engineering, 2nd Ed., Cengage India.Chemicals and Power, John Wiley and Sons, USA. 2. S. Capareda, (2013), Introduction to Biomass Energy Conversions, CRC Press, USA.	
REFERENCE BOOKS: 1. K.J. Ptasinski, (2016). Efficiency of Biomass Energy: An Energy Approach to Biofuels, Power, and Biorefineries, John Wiley & Sons, USA.	

MINOR COURSES under Mechanical Engineering

ENGINEERING MECHANICS SEMESTER - IV			
Subject Code	21XXMEM401A	Internal Marks	30
Number of Lecture Hours/Week	3(L)	External Marks	70
Total Number of Lecture Hours	50	Exam Hours	03

Credits – 04

Course Objectives

Students should be able to:

1. Gain knowledge on system of forces and moments and describe the various types of friction
2. Draw free-body diagrams and solve statics problems
3. Acquire knowledge on centre of gravity and moment of inertia for different sections.
4. Calculate velocity and acceleration of particles having rectilinear or curvilinear motion.
5. Analyze the problems on work energy method and impulse momentum method.

Unit -1	**Hours**
Introduction to Engg. Mechanics – Basic Concepts. **Systems of Forces:** Coplanar Concurrent Forces – Components in Space – Resultant – Moment of Force and its Application – Couples and Resultant of Force Systems. **Friction:** Introduction, limiting friction and impending motion, Coulomb's laws of dry friction, coefficient of friction, cone of friction	**10**
Unit -2	
Equilibrium of Systems of Forces: Free Body Diagrams, Equations of Equilibrium of Coplanar Systems, Spatial Systems for concurrent forces. LamisTheorm, graphical method for the equilibrium of coplanar forces, Converse of the law of Triangle of forces, converse of the law of polygon of forces, condition of equilibrium, analysis of plane trusses (Method of joints only)	**10**
Unit – 3	
entroid and Centre of Gravity: Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications. Area Moment of Inertia: Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections.	**10**
Unit – 4	
Kinematics: Rectilinear and Curvilinear motions – Velocity and Acceleration – Motion of Rigid Bodies – Types and their analysis in Planar Motion.	**10**

Kinetics: Analysis of a Particle and Rigid Body in Translation– Central Force Motion – Equations of Plane Motion – Fixed Axis Rotation – Rolling Bodies.	
Unit – 5	
Work – Energy Method: Equations for Translation, Work-Energy Application to Particle Motion, Connected System - Fixed Axis Rotation and Plane Motion, Impulse momentum method.	**10**

Course outcomes:

1. Determine the resultant force and moment for a given system of forces and Apply laws of friction to simple mechanisms with consideration of friction
2. Draw free-body diagrams and solve statics problems
3. Determine centroid and moment of inertia of simple and composite bodies
4. Calculate the motion characteristics of a body subjected to a given force system
5. Solve the problems using work energy method and impulse-momentum method.

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries14 marks each
4. Each full question will have sub question covering all topics under a course outcome

Text Books

1. Engineering Mechanics - S.Timoshenko&D.H.Young., 4th Edn - , Mc Graw Hill publications.
2. Engineering Mechanics-Statics and Dynamics by A Nelson, Tata McGraw Hill Education Private Ltd, New Delhi, 2009.

REFERENCE BOOKS

Engineering Mechanics statics and dynamics – R.C.Hibbeler, 11th Edn – Pearson Publ.

Engineering Mechanics, statics – J.L.Meriam, 6th Edn – Wiley India Pvt Ltd.

Engineering Mechanics, statics and dynamics – I.H.Shames, – Pearson Publ.

Mechanics For Engineers, statics - F.P.Beer&E.R.Johnston – 5th Edn Mc Graw Hill Publ.

Mechanics For Engineers, dynamics - F.P.Beer&E.R.Johnston –5th Edn Mc Graw Hill Publ.

Theory & Problems of engineering mechanics, statics & dynamics – E.W.Nelson, C.L.Best& W.G. McLean, 5th Edn – Schaum's outline series - Mc Graw Hill Publ.

Singer's Engineering Mechanics: Statics And Dynamics, K. Vijay Kumar Reddy, J. Suresh Kumar, BS Publications

THERMODYNAMICS SEMESTER - IV			
Subject Code	21XXMEM401B	IA Marks	30
Number of Lecture Hours/Week	3(L)	Exam Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits - 04			

COURSE OBJECTIVES:

Enable the students to

1. Gain the knowledge on the fundamentals of thermodynamics and temperature scales.
2. Apply First law of thermodynamics to various thermal engineering devices.
3. Understand the direction of second law of thermodynamics and concept of increase in entropy of universe.
4. Develop an idea on properties during various phases of pure substances using steam tables, Mollier chart and psychometric charts.
5. Acquire the knowledge of thermodynamics to air standard cycles, vapour power cycle and the properties of gas mixtures.

Unit -1	**Teaching Hours**
Introduction: Basic Concepts Fundamentals - System & Control volume; Property, State & Process; Exact & Inexact differentials; Work - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; various forms of work. Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers.	**10**
Unit -2	
First Law of Thermodynamics: Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy-Demonstration as a property; Various modes of energy, Internal energy and Enthalpy. First Law for Flow Processes - Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady, first law applications for system and control volume. Compressibility charts- Properties of two-phase systems.	**10**
Unit - 3	
Second law of Thermodynamics: Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle;	**12**

Absolute temperature scale. **Clausius inequality**: Definition of entropy; Demonstration that entropy is a property; Principle of increase of entropy; Illustration of processes in T-S coordinates; **Irreversibility and Availability**: Availability function for systems and Control volumes undergoing different processes, Second law analysis for a control volume and energy balance equation.	
Unit – 4	
Pure Substance: Definition of Pure substance, - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart. Determination of entropy from steam tables	**08**
Unit-5	
Mixtures of Perfect Gases: Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures and Basics of compressible flow. **Thermodynamic Cycles:** Otto, Diesel, Dual Combustion cycles, Sterling Cycle, Atkinson Cycle, Ericcson Cycle, Lenoir Cycle – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles. Brayton and Rankine cycles – Performance Evaluation-improving methods – combined cycles, Bell- Coleman Cycle, Vapour compression cycle-performance Evaluation.	**10**

COURSE OUTCOMES: On completion of this course, students should be able to:

1. Identify type of thermodynamic systems in the energy perspective.
2. Solve the practical thermodynamic problems by applying first law and steady flow energy equation.
3. Analyze the problems on heat engines, refrigeration and entropy by applying direction of second law and illustrate the concept of entropy by using second law of thermodynamics.
4. Calculate the thermodynamic properties of the pure substances.
5. Measure the performance of air standard cycles and vapor power cycle and analyze the properties of gas mixtures.

QUESTION PAPER PATTERN:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. CO1- CO5 questions carries 14 marks each.
4. Each full question will have sub question covering all topics under a course outcome.

TEXT BOOKS:

1. Engineering Thermodynamics, PK Nag 4thEdn, TMH.
2. Fundamentals of Thermodynamics- Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J, 2003, 6th Edition, John Wiley and Sons.

REFERENCE BOOKS:

1. Engineering Thermodynamics – Jones & Dugan PHI
2. Thermodynamics – An Engineering Approach with student resources DVD Y.A.Cengel & M.A.Boles, 6thEdn – McGraw Hill
3. Basic Engineering Thermodynamics – A.Venkatesh – Universities press.
4. An Introduction to Thermodynamics – Y.V.C.Rao – Universities press.
5. Engineering Thermodynamics – P.Chattopadhyay – Oxford Higher Edn Publ.
6. Engineering Thermodynamics – D.P.Misra, CengagePubl.

MATERIALS ENGINEERING SEMESTER - IV			
Subject code	21XXMEM401C	Internal	30
Number of lecture hours/Week	3(L)	External Marks	70
Total No Of lecture hours	50	Exam Hours	03

Credits-04

Course Objectives:

Enable the students to

1. Classify different bonds in solids and understand crystallization of the metals for the formation of the solid solutions and alloy phases.
2. Understand about phase diagrams to identify the number and their variations of phases in Metallographic Structure.
3. Recognize the property requirements of a given application and suggest a suitable ferrous and non-ferrous metal and their alloys.
4. Understand about various heat treatment processes and its microstructure formation.
5. Understand the need for different polymers, ceramics and composites and their uses in the engineering field.

Unit-1	**Hours**
Structure of metals: Bonds in Solids – Metallic bond - crystallization of metals, grain and grain boundaries, effect of grain boundaries on the properties of metal / alloys – determination of grain size. **Constitution of alloys:** Necessity of alloying, types of solid solutions, Hume Rothery's rules, intermediate alloy phases, ductility, resilience, toughness and elastic recovery	**8**
Unit-2	
Phase Diagrams: Methods of construction of equilibrium diagrams, Isomorpous alloy systems, equilibrium cooling and heating of alloys, lever rule, eutectic systems, congruent melting intermediate phases, peritectic reaction Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of important binary phase diagrams of $Fe\text{-}Fe_3C$.	**10**
Unit-3	
Cast Irons: Structure and properties of white cast iron, malleable cast iron, grey cast iron, spheroid graphite cast iron, alloy cast irons.**Non-ferrous metals and alloys:** Classification of steels, structure and properties of plain carbon steels, low alloy steels, Hadfield manganese steels, tool and die steels. Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys	12
Unit-4	

Heat Treatments: Annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface-hardening methods (carburizing, carbo-nitriding, cyaniding, induction hardening and flame hardening), age hardening treatment, and cryogenic treatment of alloys. vacuum and plasma hardening.	**10**
Unit-5	
Ceramics, Polymers and composites: Crystalline ceramics, glasses, cermets, abrasive materials, nano materials –properties and applications. Classification, properties and applications of composites, Reinforced materials, fiber reinforced materials, metal ceramic mixtures, metal matrix composites. Structure, properties, and applications of polymers.	**10**

Course outcomes:

1. Understand the basic crystal structures and their relationship with the properties
2. Identify the phases, present in different alloy systems by analyzing the phase diagrams
3. Understand the structure and properties of cast iron and nonferrous metals and alloys
4. Analyze various heat treatment process to change in physical properties in metals
5. Student is able to know the structure and properties of different polymers, ceramic and composite materials

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries14 marks each
4. Each full question will have sub question covering all topics under a course outcome

Text books:

1. Introduction to Physical Metallurgy, Sidney H. Avener, McGrawHill
2. Essential of Materials Science and Engineering, Donald R. Askeland, Thomson
3. Materials Science and Metallurgy, R.B.Choudary, Khanna Publishers

Reference books:

1. Material Science and Metallurgy – V.D.Kodgire and S.V.Kodgire, Everest PublishingHouse
2. Materials Science and Engineering - Callister &Baalasubrahmanyam, Willey publications
3. Material Science for Engineering Students, Fischer, Elsevier Publishers

PRODUCTION TECHNOLOGY SEMESTER - IV			
Subject Code	21XXMEM401D	Internal Marks	30
Number of Lecture Hours/Week	3(L)	External Marks	70
Total Number of Lecture Hours	50	Exam Hours	03
Credits – 04			

COURSE OBJECTIVES"

Enable the students:

1. To understand different casting techniques for product development.
2. To know about the applications of special casting processes
3. To understand basic manufacturing processes of welding
4. To understand the concepts of advanced welding processes for various applications.
5. To select appropriate metal forming and plastic working processes for a given application.

Unit -1	**Hours**
Introduction: Manufacturing processes and classification. **Casting:** Steps involved in making a casting. Patterns and Pattern making: Types of patterns, Materials used for patterns, Pattern allowances. Moulding sand: Molding sand composition, sand properties and Sand preparation. Core: Core sands, Types of cores, Core prints, Chaplets. Principles of Gating, Gating ratio and Design of Gating systems.	**10**
Unit -2	
elting and Solidification of casting: Cupola furnace, Solidification of pure metal and alloys, Short & long freezing range alloys. Risers: Types function and design, Casting designs. **pecial casting processes:** Centrifugal, Die and Investment casting. Casting defects-Causes and remedies. **Advanced Casting Techniques:** Stir Casting, Squeeze casting	**10**
Unit – 3	
elding: Introduction, classification of welding processes, types of welded joints and their characteristics. Gas welding: Different types of flames and uses, Oxy–Acetylene gas welding, metal arc welding, sub merged arc welding. **dvanced weldings:** TIG & MIG welding. Resistance welding: Spot welding, Seam welding, Projection welding, Upset welding, and Flash butt welding.	**10**
Unit – 4	
Special welding processes: Thermit welding, Friction welding, Friction stir welding, Electron beam welding, and Laser beam welding. Soldering and Brazing, Welding defects, causes and remedies.	**10**

Unit – 5	
Metal Forming: Nature of plastic deformation, Hot and cold working. Rolling: Principle, Types of rolling mills and products, Forces in rolling and power requirements. Extrusion process, Hot extrusion and cold extrusion, Impact extrusion. Forging, Tools and dies, Forging hammers, Rotary forging. Wire and tube drawings. **Sheet metal forming:** Blanking, Bending, Piercing, Stamping, Drawing, Coining, Embossing, Stretch forming, Hot and cold spinning. Blow and Injection moulding.	**10**

Course outcomes:

1. Students able to understand the knowledge of various casting processes
2. Students should be able to identify various casting technique parameters and their design effect on processes.
3. Students should be able to understand the equipment to complete specified welding processes efficiently and correctly
4. Students should be able to apply knowledge of welding safety standards to both field and factory environments.
5. Students should be able to understand the metal forming and sheet metal forming processes and their relevance in current manufacturing industry

Question paper pattern:

1. Question paper contains 10 Questions, 2 from each course outcome.
2. The student must answer 5 full questions by selecting one question from each course outcome (Internal Choice)
3. All questions carries 14 marks each
4. Each full question will have sub question covering all topics under a course outcome

TEXT BOOKS

1. P.N. Rao,Manufacturing Technology, Vol I, TMH
2. Kalpakjian S & Steven RSchmid, Manufacturing Processes for Engineering Materials, 5thEd.PearsonPubl.
3. B.S.Raghuwanshi, Workshop Technology, Vol I, Dhanpatrai& Co
4. Kalpakjain S.& Steven R Schmid,Manufacturing Engineering and Technology, 4th Ed., Pearson Publ.

REFERENCE BOOKS

1. P C Sharma,Production Technology, S. Chand
2. R.K. Jain and S.C. Gupta, Production Technology, Khanna Publishers
3. Production Technology, H.M.T. (Hindustan Machine Tools).