PRASAD V POTLURI SIDDHARTHA INSTITUTE OF TECHNOLOGY

(Autonomous)

ACADEMIC RULES &REGULATIONS (PVP20)

and

B. Tech Course Structure, Syllabus

Applicable for the batch of students admitted from the Academic Year 2020-2021

DEPARTMENT OF MECHANICAL ENGINEERING

PRASAD V. POTLURI SIDDHARTHA INSTITUTE OF TECHNOLOGY

(Autonomous)

AICTE approved, NBA & NAAC A^{+} Accredited, An ISO 9001:2015 certified Institution
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PREFACE

PVP Siddhartha Institute of technology, established in 1998, is one of the seventeen educational institutions sponsored and run by Siddhartha Academy of General & Technical Education. The 250 members of the Academy are a group of industrialists, educationists, auditors and philanthropists with vast experience in their respective fields and above all with an ardent desire to spread quality Education. All the academic organizations of Siddhartha Academy stand symbolic of the pragmatic vision of its founders. PVP Siddhartha Institute of Technology has the advantage of inheriting the higher academic standards. The college is approved by AICTE and is permanently affiliated to JNTUK. It is certified by ISO 9001-2015 for its quality standard. All the UG Programs are accredited by the National Board of Accreditation and NAAC with A^+ grade. It is an Autonomous institute.

The curriculum is revised continuously to address the challenges of industry and academia and to foster the global competencies among the students. The curriculum is revised thrice since 2012. The present curriculum(PVP20) is designed incorporating the features such as outcome based approach, encouraging self-learning through MOOCs platforms i.e., Swayam, COURSERA, EDX, NPTEL, etc., Transformation of creative ideas into a prototype through Internship & Project, enhancing depth & breadth by introducing more number of programs, open electives in core and multi-disciplinary areas, offering courses by industry experts to improve Industry Institute Interaction in addition to internships at industry and introduction of wide range of value added courses beyond curriculum to choose according to their interest to enhance their employability skills.

Institute Vision

To provide rich ambience for Academic and Professional Excellence, Research, Employability skills, Entrepreneurship and Social responsibility.

Institute Mission

To empower the students with Technical knowledge, Awareness of up-to-date technical trends, Inclination for research in the areas of human needs, Capacity building for Employment / Entrepreneurship, Application of technology for societal needs.

Quality Policy

At PVPSIT, We commit ourselves to offer Quality professional education in engineering & Management by adhering to applicable statutory and regulatory requirements and through continuous improvement in the Quality of our services by,

- Regular up gradation of knowledge and skills of faculty
- Improving the teaching methods and strategies
- Providing state of art infrastructure
- Recruiting competent faculty and maintaining prescribed Teacher Student ratio
- Improving the employability of students
- Enhanced Collaboration with industry and institutions of National Repute

DEPARTMENT OF MECHANICAL ENGINEERING

VISION OF THE DEPARTMENT

The Department of Mechanical Engineering will enhance the capabilities of students and mould them into innovative, employable, entrepreneurial, socially responsible graduates successful in advanced fields of research.

MISSION OF THEDEPARTMENT

The Department of Mechanical Engineering will impart quality education, ethical values, social responsibility, employability, research and entrepreneur.

PROGRAM EDUCATIONAL OBJECTIVES	
PEO	**STATEMENTS**
PEO I	The graduates will progress in wide range of mechanical engineering fields with solid foundation in physical and engineering sciences.
PEO II	The graduates will contribute as members of multi-disciplinary engineering teams, solve mechanical engineering and allied field problems resulting in significant societal development.
PEO III	The graduates will achieve goals by pursuing higher studies / research, become entrepreneurs.
PEO IV	The graduates will become responsible citizens by undertaking active role in their community.

PROGRAM OUTCOMES (PO's)	
PO 1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 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.
PO 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.
PO 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
PO 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.
PO 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.
PO 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.
PO 8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 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
PO 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.
PO 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.
PROGRAM SPECIFIC OUTCOMES (PSOs)	
PSO1	**UNDERSTANDING:** Graduates shall Apply Engineering Principles for design, manufacturing and maintenance of mechanical systems
PSO2	**BROADNESS AND DIVERSITY:** Graduates will Execute multi-disciplinary projects and exhibit managerial, leadership and entrepreneurial skills

QUALITY POLICY
At PVPSIT, We commit ourselves to offer Quality professional education in engineering & Management by adhering to applicable statutory and regulatory requirements and through continuous improvement in the Quality of our services by, ➢ Regular up gradation of knowledge and skills of faculty ➢ Improving the teaching methods and strategies ➢ Providing state of art infrastructure ➢ Recruiting competent faculty and maintaining prescribed Teacher Student ratio ➢ Improving the employability of students ➢ Enhanced Collaboration with industry and institutions of National Repute

CONTENTS

Engineering UG Programmes

Introduction

The redesigned curriculum focused on up skilling the graduates on the skills relevant to the need and demands of the industry. The curriculum mandates students to take up five skill courses which are relevant to the industry from second year onwards, two basic level skill courses, one on soft skills and other two on advanced level skill courses. The students are also given the option of choosing between skill courses offered by the Institute and a certificate course offered by industry, a professional body, APSSDC or any other accredited body.

Another major change brought in the curriculum is the introduction of B.Tech. with Honors or a B.Tech with a Minor. This is to give an opportunity for the fast learners to earn additional credits either in the same domain or in a related domain, making them more proficient in their chosen field of discipline or be a graduate with multidisciplinary knowledge and job ready skills.

Mandatory Internship, both industry and social, is included in the revised curriculum that aims at making engineering graduates connect with the needs of the industry and society at large. It will be mandatory for the students to intern in the industry/field for four to six weeks during the summer vacation and also in the final semester to acquire the skills required for job.

The redesigned curriculum offers academic flexibility by introducing a pool of inter-disciplinary and job-oriented skill courses which are integrated in to the curriculum of each branch of engineering, from which a student can pick his choice. Flexibility is not only given to students in the choices of courses, but flexibility is given in choosing courses either from the pool of courses offered by the concerned department or in choosing the courses offered by APSSDC or by any other reputed organization/professional body which offers with certification, as decided by respective BoS. Hence, the students are given wide choice and flexibility to undertake courses, while at the same time offering relevance to the interest of individual student in their own context. The curriculum also gives flexibility to the institution in offering a variety of courses to the students of a particular discipline. The Board of Studies is empowered to identify as many tracks and pools as possible in emerging technologies and industrial relevance, and also in humanities and sciences.

1. SHORT TITLE AND COMMENCEMENT

a. The regulations listed under this head are common for all degree level undergraduate programmes (B.Tech.), offered by the college with effect from the academic year 2020-21 and they are called as "PVP20" regulations.

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

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 Prasad V Potluri Siddhartha Institute of Technology, Vijayawada;

e. An **Academic Programme** 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 a semester.

g. "**Degree**" means an academic degree conferred by the university upon those who complete the under graduate curriculum.

h. "**MOOC**" means Massive Open Online Course

i. "**Regular Students**" means students enrolled into the four year programme in the first year.

j. "**Lateral Entry Students**" means students enrolled into the four year programme in the second year.

3. ACADEMIC PROGRAMMES

3.1 Nomenclature of Programmes

3.1.1 The nomenclature and its abbreviation given below, shall continue to be used for the Degree programmes under the University, as required by the Council and the Commission:

Bachelor of Technology (B. Tech)

Besides, the name of specialization shall be indicated in brackets after the abbreviation, for example, engineering degree in Mechanical Engineering programme is abbreviated as B.Tech (Mechanical Engineering).

3.1.2 Bachelor of Technology (B. Tech.) degree programme is offered in:

1. Civil Engineering(CE)
2. Computer Science and Engineering(CSE)
3. Computer Science and Engineering(AI & ML)
4. Computer Science and Engineering(Data Science)
5. Electronics and Communication Engineering(ECE)
6. Electrical and Electronics Engineering(EEE)
7. Information Technology(IT)
8. Mechanical Engineering(ME)

4. DURATION OF THE PROGRAMMES

4.1 Normal Duration

4.1.1. The duration of an academic programme shall be four years consisting of eight semesters.

4.1.2. The duration of the programme for lateral entry students who are admitted in II year shall be three years that consists of six semesters.

4.2 Maximum Duration

4.2.1 The maximum period for which a student can take to complete a full-time academic programme shall be double the normal duration of the programme, i.e., for regular students eight years, for lateral entry students six years.

4.3 Minimum Duration of a Semester

Each semester consists of a minimum of 90 instruction days with about minimum 20 and maximum 33 contact hours per week.

5. ADMISSION CRITERIA

The eligibility criteria for admission into UG Engineering programmes are as per the norms approved by Government of Andhra Pradesh from time to time. The sanctioned seats in each programme in the college are classified into CATEGORY-A, and CATEGORY-B at I year level and only CATEGORY-A at Lateral Entry II year level.

The percentages of Category–A, Category-B and Lateral Entry Seats are decided from time to time by the Government of Andhra Pradesh.

5.1 CATEGORY – A Seats

Category - A seats are filled as per the norms approved by the Government of Andhra Pradesh.

5.2 CATEGORY – B Seats

Category - B seats are filled by the College as per the norms approved by the

Government of Andhra Pradesh.

5.3 CATEGORY - Lateral Entry Seats

Lateral entry candidates shall be admitted into the III semester directly as per the norms approved by Government of Andhra Pradesh.

6. CREDIT SYSTEM AND GRADE POINTS

6.1 Credit Definition

'Credit' means quantified and recognized learning. Credit is measured in terms of contact hours per week in a semester. Typically, one credit is given to:

(a) Theory/Tutorial course conducted for one contact period.

(b) Laboratory course conducted for two contact periods.

Each course is assigned a certain number of credits depending upon the number of contact hours (Lectures/Tutorials/Practical) per week.

The curriculum of the eight semesters B. Tech program is designed to have a total of 160 credits for the award of B. Tech degree.

For lateral entry students, the curriculum of six semesters B. Tech program is designed to have a total of 121 credits for the award of B. Tech degree.

6.2 Semester Course Load

The average course load shall be fixed at 20 credits per semester with its minimum and maximum limits being set at 12 and 23 credits.

6.3 Grade Points and Letter Grade for a Course

The grade points and letter grade will be awarded to each course based on student's performance as per the grading system shown in the Table.

Table: Grading System for B. Tech Programme (PVP20 Regulations)

Grades and Grade Points (PVP20 Regulations)

Theory / Drawing (Max-100)	Laboratory/ Mini Project/ Internship etc. (Max – 50)	Level	Grade Point	Letter Grade
≥ 90	≥ 45	Outstanding	10	A+
≥ 80 to ≤ 89	≥ 40 to ≤ 44	Excellent	9	A
≥ 70 to ≤ 79	≥ 35 to ≤ 39	Very Good	8	B
≥ 60 to ≤ 69	≥ 30 to ≤ 34	Good	7	C
≥ 50 to ≤ 59	≥ 25 to ≤ 29	Fair	6	D
≥ 40 to ≤ 49	≥ 20 to ≤ 24	Satisfactory	5	E
< 40	< 20	Fail	0	F (FAIL)
ABSENT	ABSENT	ABSENT	0	AB

* For Major Project same (%) percentages will be followed for grading

6.4 Semester Grade Points Average(SGPA)

The performance of each student at the end of each semester is indicated in terms of SGPA calculated as shown in equation (1)

$$SGPA = \frac{\sum (CR \times GP)}{\sum CR \text{ (for all courses offered in the semester)}} \quad \text{-- (1)}$$

Where CR= Credits of a course

GP = Grade points awarded for a course

$\sum CR$ = Summation of all the courses offered in the semester

6.5 Cumulative Grade Point Average (CGPA)

The Cumulative Performance of each student at the end of each semester is indicated in terms of CGPA which is calculated as shown in equation (2).

$$CGPA = \frac{\sum CR \; X \; GP}{\sum CR (for\ all\ courses\ offered\ upto\ that\ semester\ /entire\ program)} \text{-- (2)}$$

Where CR = Credits of a course

GP = Grade points awarded for a course

Percentage equivalent of CGPA = (CGPA – 0.75) * 10

7. CURRICULUM FRAMEWORK

7.1. Regular and Honors B.Tech Programmes of all Branches

1. Award of the Degree: A student will be declared eligible for the award of

B. Tech. degree if he/she fulfils the following:

i. Pursues a course of study in not less than four and not more than eight academic years.

ii. 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.

iii. Registers for 160 credits and must secure all the 160 credits.

iv. A student shall be eligible for the award of B.Tech degree with Honors or Minor if he / she earns 20 credits in addition to the 160 credits. A student shall be permitted to register either for Honors or for Minor and not for both simultaneously.

2. Structure of the Undergraduate Engineering program:

Every course of B.Tech. Program shall be placed in one of the nine categories as listed in table below:

S. No.	Category	Code	Suggested breakup of Credits (APSCHE)	Suggested breakup of Credits (AICTE)
1	Humanities and social science including Management courses	HSMC	10.5	12
2	Basic Science courses	BSC	21	25
3	Engineering Science courses	ESC	24	24
4	Professional core Courses	PCC	51	48
5	Open Elective Courses	OEC	12	18
6	Professional Courses Elective	PEC	15	18
7	Internship, project work seminar, Community Service Project	PROJ	16.5	15
8	Mandatory courses	MC	Non-credit	Non-credit
9	Skill Oriented Courses	SC	10	-
Total Credits			160	160

3. Assigning of Credits:

   1 Hr. Lecture (L) per week - 1 credit

   1 Hr. Tutorial (T) per week - 1 credit

   1 Hr. Practical (P) per week - 0.5 credits

   2 Hours Practical (Lab)/week - 1 credit

4. There shall be mandatory student induction program for fresher's, with a three-week duration before the commencement of first semester. Physical activity, Creative Arts, Universal Human Values, Literary, Proficiency Modules, Lectures by Eminent People, Visits to local Areas, Familiarization to Dept./Branch & Innovations etc., shall be included in the guidelines issued by AICTE

5. All undergraduate students shall register for NCC/NSS activities. A student will be required to participate in an activity for two hours in a week during second and third semesters. Grade shall be awarded as Completed or Not Completed in the mark sheet on the basis of participation, attendance, performance and behavior, and it is treated as student practice course . 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.

6. 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 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.

7. Institution may swap some of the courses between first and second semesters to balance the workload.

8. The concerned Board of studies can assign tutorial hours to such courses wherever it is necessary, but without change in the total number of credits already assigned for semester.

9. There shall be 05 Professional Elective courses and 04 Open Elective courses. All the Professional & Open Elective courses shall be offered for 03 credits, wherever lab component is involved it shall be (2-0-2) and without lab component it shall be (3-0- 0). If a course comes with a lab component, that component has to be cleared separately. The concerned BOS shall explore the possibility of introducing virtual labs for such courses with lab component.

10. All Open Electives are offered to students of all branches in general. However, a student shall choose an Open Elective from the list in such a manner that he/she has not studied the same course in any form during the Programme.

11. A student shall be permitted to pursue up to a maximum of two elective courses under MOOCs during the Programme. Each of the courses must be of minimum 12 weeks in duration. Attendance will not be monitored for MOOC courses. Student has to pursue and acquire a certificate for a MOOC course only from the organizations/agencies approved by the BoS in order to earn the 3 credits. The Head of the department shall notify the list of such courses at the beginning of the semester.

12. The college shall invite registration forms from the students at the beginning of the semester for offering professional and open elective courses. There shall be a limit on the minimum and maximum number of registrations based on class/section strength.

13. Students shall undergo mandatory summer internships for a minimum of four to six weeks duration at the end of second and third year of the Programme. There shall also be mandatory full internship in the final semester of the Programme along with the project work.

14. There shall be 05 skill-oriented courses offered during III to VII semesters. Among the five skill courses, four courses shall focus on the basic and advanced skills related to the domain courses and the remaining one shall be a soft skills course.

15. Under graduate Degree with Honors / Minor shall be issued by the institute to the students who fulfil all the academic eligibility requirements for the B. Tech program and Honors / Minor program. The objective is to provide additional learning opportunities to academically motivated students.

16. Assessment: The performance of a student in each semester shall be evaluated subject wise with a maximum of 100 marks for theory and 50 marks for practical subject. The distribution shall be 30 marks for Internal Evaluation and 70 marks for the End Semester Theory Examinations. 15 marks for Internal Evaluation and 35 marks for the End Semester practical Examinations A student has to secure not less than 35% of marks in the end semester examination and minimum 40% of marks in the sum total of

internal and end semester examination marks to earn the credits allotted to each course. Detailed guidelines for continuous evaluation shall be planned by concerned combined BOS of the Universities.

17. **Attendance Requirements**:

i. A student shall be eligible to appear for end semester examinations if he/she acquires a minimum of 75% of attendance in aggregate of all the subjects in a semester.

ii. Shortage of Attendance below 65% in aggregate shall in NO case be condoned.

iii. Condonation for shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester may be granted by the College Academic Committee.

iv. Students whose shortage of attendance is not condoned in any semester are not eligible to take their end semester examination of that class and their registration shall stand cancelled.

v. A student will not be promoted to the next semester unless he satisfies the attendance requirements of the present semester, as applicable. They may seek readmission for that semester when offered next.

vi. A stipulated fee shall be payable towards condonation of shortage of attendance to the college. A student is eligible to write the semester end examinations if he acquires 75% of attendance in aggregate of all the subjects.

7.2 General Issues

7.2.1 Curriculum framework is important in setting the right direction for a degree programme as it takes into account the type and quantum of knowledge necessary to be acquired by a student in order to qualify for the award of degree in his/her chosen branch or specialization.

7.2.2 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 in fulfilling the requirements for conferment of degree.

7.2.3 Each theory course shall consist of five units.

7.3 Curriculum Structure

The curriculum is designed to facilitate B. Tech (Honors) and B.Tech (Major, Minor) incorporates courses required to attain the expected knowledge, skills and attitude by the time of graduation as per the needs of the stakeholders. The curriculum structure consists of various course categories (as described in 7.3.1 to7.3.5) to cover the depth and breadth required for the programme and for the attainment of programme outcomes of the corresponding programme.

7.3.1 Institutional Core

Institutional Core consists of the courses required for all UG Engineering Programmes offered in this college. The courses offered under this category cover the required knowledge in the following areas:

a Basic Sciences:

Basic Science courses include Engineering Physics, Applied Physics, Engineering Physics Lab, Applied Physics Lab Engineering Chemistry, Engineering Chemistry Lab, and Engineering Mathematics, etc.

b

Engineering Sciences:

Engineering Science courses include Problem Solving and Programming, AI Tools, Internet of Things, Design Thinking, Basic Electrical and Electronics Engineering, Engineering Graphics, Problem Solving & Programming Lab, Basic Electrical & Electronics Engineering Lab, AI Tools Lab, Internet of Things Lab, Design Thinking Lab and Basic Workshop, etc.

c

Humanities and Social Sciences:

Humanities and Social Science Courses consist of Communicative English I, Communicative English II, HS Elective, Communicative English-I Lab and Communicative English-II Lab, etc.

7.3.2 Elective Courses

Elective courses are offered across the programmes to enhance the knowledge breadth and professional competency of the students.

Courses	Branch Specific	Compulsory
Elective courses	Professional Electives	Supportive to the discipline courses with expanded scope in a chosen track of specialization or cross track courses
	HS Management Elective	Nurture the student interests in management courses.
	Open Electives	Common to all disciplines that helps general interest of a student

7.3.3 Professional Core

The Professional core consists of set of courses considered which are necessary for the students of the specific programme. The courses under this category satisfy the Programme Specific Criteria prescribed by the appropriate professional societies.

7.3.4 Project

In the final semester, the student should mandatorily undergo internship and in parallel he/she should work on a project with well-defined objectives.

7.3.5 Mandatory Learning Courses

According to the guidelines given by statutory bodies, Courses on Environmental Science, Constitution of India and Engineering Ethics, Life Sciences for Engineers and Life Sciences for Engineers Lab shall be offered. Induction program shall be offered in I semester for all the branches.

7.4 Honors Programme

In order to obtain honors degree students shall earn additional 20 credits in addition to the 160 credits for obtaining the UG degree. Students can register for additional courses by satisfying the pre-requisite course(s) to a maximum of 8 credits in each of the semesters from IV semester onwards along with the regular semester courses as prescribed. There is no minimum limit to the credits for taking additional courses.

1. 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 4th semester provided that the student must have acquired a minimum of 8.0 CGPA up to the end of 2nd 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 CGPA, his/her registration for Honors Programme stands cancelled and he/she shall continue with the regular Programme.
- An SGPA and CGPA of 8.0 and above has to be maintained in the subsequent semesters in major degree without any backlogs in order to keep the Honors degree registration active.
- Should both the SGPA and CGPA of major degree fall below 8.0 in major degree at any point after registering for the Honors; the Honors degree registration will cease to be active.

2. 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.
3. 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).
4. 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.
5. 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.
6. 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.
7. 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 explore the possibility of introducing virtual labs for such courses with lab component.
8. 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 Institute/academic council.
9. 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.
10. 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: The courses which were not done under the dropped Honors will not be shown in the transcript.

11. 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.
12. Honors must be completed simultaneously with a major degree program. A student cannot earn Honors after he/she has already earned bachelor's degree.

7.5 Minor Programme:

In order to obtain Minor degree students shall earn additional 20 credits in addition to the 160 credits for obtaining the UG degree. Students can register for additional courses by satisfying the pre-requisite course(s) to a maximum of 8 credits in each of the semesters from IV semester onwards along with the regular semester courses as prescribed. There is no minimum limit to the credits for taking additional courses.

A student shall be permitted to register for Minors program at the beginning of 4^{th} semester subject to a maximum of two additional courses per semester, provided that the student must have acquired 7.75 CGPA (Cumulative Grade point average) up to the end of 2^{nd} semester without any history of backlogs. It is expected that the 3^{rd} semester results may be announced after the commencement of the 4^{th} semester. If a student fails to acquire 7.75 CGPA up to 3^{rd} semester or failed in any of the courses, his registration for Minors program shall stand cancelled.

- An SGPA and CGPA of 7.75 and above has to be maintained in the subsequent semesters in major degree without any backlogs in order to keep the minor registration active.
- Should both the SGPA and CGPA fall below 7.75 in major degree at any point after registering for the minor; the minor registration will cease to be active.

1. 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.

2. 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 CE, EEE, ME, ECE, CSE, AND IT etc., or industry tracks such as Artificial Intelligence (AI), Machine Learning (ML), Data Science (DS), Robotics, Electric vehicles, VLSI etc.

3. The list of disciplines / branches eligible to opt for a particular industry relevant minor specialization shall be clearly mentioned by the respective

BOS.

4. There shall be no limit on the number of programs offered under Minor. The 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.

5. 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.

6. 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.

7. 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. 160credits).

8. 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 4credits.If the MOOC course is a pass/fail course without any grades, the grade to be assigned as decided by the Institute/academic council.

9. 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.

10. 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.

11. 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: The courses which were not done under the dropped Minors will not be shown in the transcript.

12. 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.

13. 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.

7.6 Industrial Collaboration (Case Study)

Institute - Industry linkages refer to the interaction between firms and universities or public research centers with the goal of solving technical problems, working on R&D, innovation projects and gathering scientific as well as technological knowledge. It involves the collaboration of Industries and Institutes in various areas that would foster the research ecosystem in the country and enhance growth of economy, industry and society at large.

The Institution is permitted to design any number of Industry oriented minor tracks as the respective BoS feels necessary. In this process the Institution can plan to have industrial collaborations in designing the minor tracks and to develop the content and certificate programs. Industry giants such as IBM, TCS, WIPRO etc., may be contacted to develop such collaborations. The Universities / Institutions shall also explore the possibilities of collaborations with major Industries in the core sectors and professional bodies to create specialized domain skills.

7.7 Mandatory Internships

1. 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.
2. A supervisor/mentor/advisor has to be allotted to guide the students for taking up the summer internship. The supervisor shall monitor the attendance of the students while taking up the internship. Attendance requirements are as per the norms of the Institute.
3. 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 consisting of an external examiner; Head of the Department; supervisor of the internship and a senior faculty member of the department. The report and the oral presentation shall carry 40% and 60% weightages respectively.
4. It shall be evaluated for 50 external marks at the end of the semester. There shall be no internal marks for Summer Internship.
5. In the final semester, the student should mandatorily 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.
6. 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.

7.8 Skill Oriented Courses

1. 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.
2. 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.
3. A pool of interdisciplinary skill oriented 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.
4. 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, COURSERA or any other accredited bodies as approved by the concerned BOS.
5. 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.
6. 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.
7. 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.
8. 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 Institute / Academic Council.
9. 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 skill-oriented courses.

7.9 Course Numbering Scheme

The Course code consists of Eight / Nine characters. The following is the structure of the course Code (Figure 1).

Course Numbering Scheme (PVP20)

2	0	C	S	3	2	0	1	A
Regulation		Course Category		Kind of course	Semester	Type	Course Number	[Elective code]
Last two digits of Regulation offered(i.e. 20 for PVP20 regulations)		HS-Humanities and Social Sciences including Management courses BS-Basic Science courses ES-Engineering Science MC- Mandatory Courses		1. Institutional Core(i.e. HS,BS,ES,MC)	1-First 2-Second 3-Third 4-Fourth 5- Fifth 6-Sixth 7-Seventh 8-Eigth	0-Theory 1-Theory studied in MOOCS Mode 2-Integrated Course (Theory+Lab) 4- NCC/NSS 5- Practical 6-Project Work 7-Seminar	i.e. Course sequence Number in that semester	In case if the course is Elective then this field will specify the elective code (i.e A,B,C…)
		Respective Handling department code is placed		2. Open Elective/ Job Oriented Elective				
		In case of Professional Core/ Professional Elective courses department code is placed: CE-Civil Engineering EE- Electrical & Electronics Engineering ME- Mechanical Engineering EC- Electronics and Communication Engineering CS- Computer Science & Engineering IT- Information Technology AM-CSE(Artificial Intelligence & Machine Learning) DS-CSE(Data Science)		3. Professional Core 4. Professional Elective				
		Respective chosen minor department code is placed		5. Minor Course				
		Respective department code is placed		6. Honors Course				
		Respective Handling department code is placed		7. Humanities and Social Science Elective				
		SO- Skill Oriented Course SA- Skill Advanced Course SS- Soft Skill Course		8. Skill Oriented/ Skill Advanced/ Soft Skill Course		8. Summer/ Industrial/ Research Internship		A - Summer B – Industrial C - Research
						9. Community Service Project		

Figure 1: Course numbering scheme

7.10 Medium of Instruction and Examination

The medium of instruction and examinations shall be English.

7.11 Registration

Every student has to register himself/herself for the courses in each semester individually at the time as specified in academic calendar.

8. Choice Based Credit System (CBCS)

Choice Based Credit System (CBCS) shall be introduced with effect from 2019-20 academic years, based on guidelines of the statutory bodies in order to promote:

- Activity based learning
- Student centered learning
- Students to choose courses of their choice
- Learning at their own pace

Flexibility is extended to the fast learning students to take the courses of higher semesters in advance as per their convenience to concentrate on their placement activity/ project work, etc., during the VII/VIII semesters.

8.1 CBCS Course Registration Policy

Fast learning students can register for additional courses from higher semesters by satisfying the pre-requisite course(s) to a maximum of 8 credits in each of the semesters from III semester onwards along with the regular semester courses as prescribed. There is no minimum limit to the credits for taking additional courses.

Eligibility for choosing CBCS flexibility:

- **Regular Students (4 Year duration),** entering the n^{th} semester with no backlog courses up to $(n-1)^{th}$ semester, are only eligible to opt for this flexibility.
- **Lateral entry students (3 year duration)** with 70% Marks in their Diploma are eligible to opt for this flexibility during III and IV Semesters. Those students entering into V/ VI /VII semester with no backlog courses up to $(n-1)^{th}$ semester, are only eligible to opt for this flexibility.

  The list of additional courses offered in the even & odd semesters, registration dates will be notified by the respective departments well in advance.

  A student can withdraw from the respective course within 15 days after the commencement of the course.

  The choice of utilizing this flexibility is purely optional to the students.

  A minimum number of students required to register for an additional course shall be twenty (20). In case, the registered strength for the additional course is less than twenty (20), the course may be offered on the recommendation of the Head of the Department and subsequent approval of the Principal.

8.2 Continuous Internal Evaluation (CIE) for CBCS opted Courses

The contact hours, continuous assessment pattern, eligibility criteria to write end semester examinations and revaluation scheme for these additional courses will be as per the current academic regulations [PVP20].

8.3 Eligibility to appear CBCS registered courses for Semester End Examinations

The registered additional courses will be dealt separately as individual courses for the calculation of attendance and continuous assessment of marks for assessing the eligibility to write the end semester examinations for these courses.

The performance of the student in the registered additional courses will be separately mentioned in the semester end grade card and it will not be taken into account for the calculation of the SGPA for that semester.

The performance of the student in the registered additional courses will be taken into account in the corresponding semesters.

8.4 CBCS Course Detention

8.4.1 In case, the student is detained for want of minimum specified attendance and continuous assessment marks criterion either in the regular semester or in the additional courses, he/she will forfeit the eligibility for registering additional courses from that semester onwards. However, the additional courses completed by the students in the earlier semesters will be valid and taken into consideration.

8.4.2 In case, the student is detained for want of minimum specified attendance and continuous assessment marks criterion in the regular semester but meets minimum specified attendance and continuous assessment marks criterion in the registered additional courses, he/she shall write the end semester examinations for these additional courses along with the regular students in the corresponding semester only.

8.4.3 In case, the student fails / is absent in the end semester examinations of the registered additional courses or in the regular semester courses in a particular semester, he will forfeit the eligibility for registering additional courses from that semester onwards. However, the additional courses completed by the students in the earlier semesters will be valid and taken into consideration. They can write the end semester examinations for additional courses in which they failed/were absent, along with regular students in the corresponding semesters only.

8.4.4 The criterion for the promotion to higher semesters will be as per PVP20 regulations, taking only the regular semester courses into consideration for the fast learners.

8.4.5 Additional courses, in which the fast learning student fails, will not be considered as backlogs for them.

8.4.6 The fast learning students shall register for all the courses of a regular semester excluding the courses completed in the previous semesters.

8.4.7 The credits scored by students through CBCS subjects shall not be considered for credit promotion from II year to III year or from III year to IV year B.Tech.

8.4.8 The student opting for the said flexibility will be considered for the award of the division on par with other regular students.

8.4.9 The students who have earlier history of indulging in malpractices in semester end examinations are not eligible for opting CBCS.

8.4.10 If the student fails to register for opted CBCS courses for semester end examination, he/she will forfeit the eligibility for registering additional courses from that semester onwards and marks secured through continuous assessment will not be considered.

8.4.11 The choice of utilizing this flexibility is purely optional to the students.

8.4.12 If a student fails/absent in a CBCS course, he/she is bound to appear in the same course when studied in regular semester.

9 EXAMINATIONS & SCHEME OF EVALUATION

9.1 Description of Evaluation

1. **Continuous Internal Evaluation (CIE):** The performance of the student in each course is evaluated by the faculty/course coordinator all through the semester; with mid-term tests (sessional-1and sessional-2), assignments, project reviews, viva-voce, laboratory assessment and other means covering the entire syllabus of the course.
2. **Semester End Examination (SEE):** It shall be conducted by chief controller of examinations at the end of each semester, as per the academic calendar and with a written examination for theory courses and practical/project examination with built-in oral part for laboratory/project.

9.2 Continuous Internal Evaluation (CIE)

9.2.1 Theory Courses

a) For theory subjects, during a semester, there shall be two mid-term examinations. Each mid-term examination consists of (i) one objective examination (20 multiple choice questions) for 10 marks for duration of 20 minutes (ii) one descriptive examination (3 full questions for 5 marks each) for 15 marks for duration of 90 minutes and (iii) one assignment for 5 marks. Mid-1 shall be conducted from first 50% of the syllabi.

b) In the similar lines, the second objective, 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 objective examination, descriptive examination and assignment shall be submitted by the concerned teacher to the department examination section within one week after completion of first mid examination.

d) The mid marks submitted to the department examination section shall be displayed in the concerned department 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 Head of the department within one week from the submission.

f) Second mid marks (Mid-2) consisting of marks of objective examination, descriptive Examination and assignment shall also be submitted by the concerned teacher to the department 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 Head of the department 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.

Example:

Mid-1 marks = Marks secured in (Objective-1+Descriptive examination-1 +Assignment-1)

Mid-2 marks = Marks secured in (Objective-2+Descriptive examination-2 +Assignment-2)

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, concerned departments have to display the consolidated marks obtained by the students in the department notice boards. If any discrepancy found, it shall be brought to the notice of Head of the department through proper channel within one week with all proofs.

9.2.2 Mandatory Learning Courses

Mandatory Course (M.C): Environmental Sciences, Universal Human Values, Ethics, Indian Constitution, Essence of Indian Traditional Knowledge, Life Sciences for Engineers, 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. 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.

9.2.3 Drawing Based Courses

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.

9.2.4 Laboratory Courses

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 today 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.

Table: Distribution of Marks (CIE)

S. No.	Criterion	Marks
1	Day to Day Evaluation	5
2	Record	5
3	Internal Examination	5

9.2.5 MOOCs Courses

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 pass.

9.3 Semester End Examination (SEE)

9.3.1 Theory Courses:

a) The semester end examinations will be for 70 marks consisting 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) 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.

9.3.2 Laboratory Courses: 35 marks

i. The Semester end examination for laboratory courses shall be conducted with three hour duration at the end of semester for 35 marks as given below:

Table: Distribution of Marks (SEE)

S.No.	Criterion	Marks
1	Procedure	5
2	Experiment / Programme Execution	15
3	Result	10
4	Viva-Voce	5

ii. Each Semester end Laboratory Examination shall be conducted by an External Examiner along with the Internal Examiner.

9.3.3 Internship: 50 Marks (Only External marks)

Evaluation of the summer internships: It shall be completed in collaboration with local industries, Govt. Organizations, construction agencies, Industries, Hydel and thermal power projects and also in software MNCs in the area of concerned specialization of the UG programme. Students shall pursue this course during summer vacation just before its offering as per course structure. The minimum duration of this course is at least 6 weeks. The student shall register for the course as per course structure after commencement of academic year. A supervisor / mentor / advisor have to be allotted to guide the students for taking up the summer internship. The supervisor shall monitor the attendance of the students while taking up the internship. Attendance requirements are as per the norms of the Institute. After successful completion, students shall submit a summer internship technical report to the concerned department and appear for an oral presentation before the departmental committee consists of an external examiner; Head of the Department; supervisor of the internship and a senior faculty member of the department. A certificate from industry / skill development center shall be included in the report. The report and the oral presentation shall carry 40% and 60% weightages respectively. 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. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the Institute.

9.3.4 Community Service Project (CSP): 100 Marks

Report on CSP should be submitted by each student. An internal Viva shall also be conducted by a Committee constituted by the Principal of the college. The assessment is to be conducted for **100 marks**. The number of credits assigned is 4. Later the marks are converted into grades and grade points to include finally in the SGPA and CGPA. A student shall secure minimum 40% of marks for successful completion. In case, if a student fails, he/she shall reappear as and when semester supplementary examinations are conducted by the Institute. The students must do the community service project in the vacation period after I-II .

The weightings shall be:

Activity Log 20% CSP Implementation 30% Report 25% Presentation 25%

For Complete details: https://www.jntuk.edu.in/jntuk-dap-community-service-project-guidelines-reg/

9.3.5 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 for **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.

9.4 Conditions for Pass Marks

I. Paper setting and evaluation of the answer scripts shall be done as per the procedures laid down by the Institution Examination section from time to time.

II. To maintain the quality, external examiners and question paper setters shall be selected from
premier institutes and Universities, NITs, Autonomous colleges.

For non-credit mandatory courses, like Life sciences for Engineers, 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.

III. 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.

Distribution and Weightage of marks:

The assessment of the student's performance in each course will be as per the details given

S.No	Component	Internal	External	Total
1	Theory	30	70	100
2	Lab	15	35	50
3	Mandatory	30	70	100
4	Drawing	30	70	100
5	Project	60	140	200
6	Mini Project/Internship/Industrial Training / Skill Development Programs/Research Project	-	50	50

9.5 Revaluation

9.5.1 Continuous Internal Evaluation

The continuous Evaluation scripts shall be shown to the students before finalizing the marks. However, if the student has any concern, not addressed before the finalization of marks, he/she may submit the application for revaluation to the concerned head of the department. The Head of the Department may constitute a two-member committee for re-evaluating the script. The evaluation of the committee is final and binding.

9.5.2 Semester End Examination

1. As per the notification issued by the Controller of Examinations, the students can submit the applications for revaluation, along with the requisite fee receipt for revaluation of his/her answer script(s) of theory course(s), if he/she is not satisfied with the marks obtained.
2. The Controller of Examinations shall arrange for re-evaluation of those answer script(s).
3. A new external examiner, other than the first examiner, shall re-evaluate the answer script(s).
4. Revaluation marks will be taken into consideration only if the difference between the two valuations is more than or equal to 15%. Better marks between the two shall be taken into consideration. However, if the revaluation marks facilitates passing of the candidate, then the revaluation marks will be considered even if the difference of marks is less than 15%.
5. If the difference of marks between the two valuations is more than 20%, the answer script will be referred to third valuation. The average of nearest two marks will be awarded.

9.6 Withholding of Results

If the student has not paid the dues to the college, or if any case of malpractice or indiscipline is pending against him, the result of the student will be kept as withheld and he/she will not be allowed to enter the next semester. His/her degree shall be considered as withheld in such cases.

10 CRITERIA TO ATTEND SEMESTER END EXAMINATION AND PROMOTION TO HIGHER SEMESTER

10.1 Eligibility for Semester End Examinations

10.1.1 Students shall put in a minimum average attendance of 75% in the courses. computed by totaling the number of periods of lectures, tutorials, drawing, practical and project work as the case may be, held in every course as the denominator and the total number of periods attended by the student in all the courses put together as the numerator, to be eligible to write semester end examinations.

10.1.2 Condonation of shortage in attendance may be recommended by respective Heads of Departments on genuine medical grounds, provided the student puts in at least 65% attendance as calculated above and provided the Principal is satisfied with the genuineness of the reasons and the conduct of the student.

10.1.3 Students, having more than 65% and less than 75% of attendance, shall have to pay requisite fee towards condonation.

10.2 Promotion Rules

1. A student shall be promoted from first year to second year if he fulfills the minimum attendance requirements.
2. 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.
3. 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.

11. SUPPLEMENTARY EXAMINATIONS

11.1 General

Semester end Supplementary examinations shall be conducted along with regular semester end examinations.

11.2 Advanced Supplementary Exams

Candidate(s), who fails in Theory or Laboratory courses of VIII semester, can appear for advanced supplementary examination conducted within one month after declaration of the revaluation results. However, those candidates who fail in the advanced supplementary examinations of VIII semester shall appear for subsequent examinations along with regular candidates conducted at the end of the respective academic year.

12. READMISSION CRITERIA

A candidate, who is detained in a semester due to lack of attendance/credits, has to obtain written permission from the Principal for readmission into the same semester after duly fulfilling all the required norms stipulated by the college in addition to paying an administrative fee of **Rs. 1,000/-**

Rules for calculation of attendance for readmitted students

a) Number of classes conducted shall be counted from the commencement day of the semester concerned, irrespective of the date of payment of tuition fee.

b) They shall submit a written request to the principal of the college, along with a challan paid towards tuition and other fee, for readmission before the commencement of the class work.

c) They can get the information regarding date of commencement of class work for each semester that will be made available in the college notice boards/website from time to time.

13. BREAK IN STUDY

Student, who discontinues the studies for valid reason permitted by the principal, shall get readmission into appropriate semester of B.Tech. programme after break-in study, with the prior permission of the Principal and following the transitory regulations applicable to such batch in which he/she joins. An administrative fee of **Rs**. 1**000/-**per each year of break in study, in addition to the prescribed tuition and special fee has to be paid by the candidate to condone his/her break in study.

14. 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 year/II year/III year to pursue entrepreneurship full time. This period shall be counted for the maximum time for graduation. An evaluation committee at Institution 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.

15. TRANSITORY REGULATIONS

A candidate, who is detained or discontinued in a semester, on re-admission, the academic regulations under which he/she has originally admitted will continue to be applicable to him/her on re-admission.

16. ELIGIBILITY FOR AWARD OF B.TECH DEGREE

1. The B.Tech. Degree shall be conferred on a candidate who satisfies the following requirements.

   a) A Regular student (four year programme) shall register and secure himself/herself for **160** Credits

   b) A Lateral Entry student (three year programme) shall register and secure himself/herself for**12**1 credits

2. **Award of Division**

   The criteria for award of division, after successful completion of programme are as shown in Table:

Table : Criteria for Award of Division

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	

- Awarded only if all the courses prescribed are cleared in single attempt within four years for regular candidates and three years for lateral entry candidates
- Detained and break-in study candidates are not eligible for the award of First Class with Distinction
- The cases of students who are absent for semester end examination only once in his/her

duration of B.Tech. Programme on valid medical grounds/humanitarian grounds shall also be considered for the award of First class with Distinction subject to the recommendations of the committee constituted by the Principal.

For the purpose of awarding First, Second and Pass Class CGPA obtained in the examinations appeared within the maximum period allowed for the completion of the programme shall be considered.

Consolidated Grade Card

A consolidated grade card containing credits & grades obtained by the students will be issued after successful completion of the four year B.Tech Programme.

17. CONDUCT AND DISCIPLINE

1. Students shall conduct themselves within and outside the premises of the Institute in a manner befitting the students of our Institution.
2. As per the order of Honorable Supreme Court of India and AICTE guidelines, ragging in any form is considered a criminal offence and is banned. Ragging within or outside any educational institution is prohibited. Ragging means doing an act, that causes or is likely to cause insult or annoyance or fear of apprehension or threat or intimidation or outrage of modesty or injury to a student. Any form of ragging will be severely dealt with as per AP Prohibition of Ragging Act-1997 section-4.

Table 9: Punishments for Ragging

Nature of ragging	Punishment
Teasing, embarrassing and humiliating	Imprisonment up to 6 months or fine up to Rs.1,000/- or both
Assaulting or using criminal force or criminal intimidation	Imprisonment up to 1 year or fine up to Rs.2,000/- or both
Wrongfully restraining or confining or causing hurt	Imprisonment up to 2 years or fine up to Rs.5,000/- or both
Causing grievous hurt kidnapping or raping or committing unnatural offence	Imprisonment up to 5 years and fine up to Rs.10,000/-
Causing death or abetting suicide	Imprisonment up to 10 years and fine up to Rs.50,000/-

3. A student who is convicted of an offence and punished with imprisonment for a term of more than six months shall not be admitted into the institution.
4. Whenever any student complains of ragging to the head or manager of an educational institution, such head or manager should inquire into the complaint and if the complaint is prima-facie found true, should suspend the student or students complained against.
5. If the head or manager of an educational institution fails or neglects to take action in the manner specified in the Act, the person shall be deemed to have abetted the offence and shall be punished with the punishment provided for the offence.
6. If a student commits suicide due to or in consequence of ragging, the person who commits such ragging shall be deemed to have abetted such suicide.
7. The following acts of omission and/or commission shall constitute gross

violation of the code of conduct and are liable to invoke disciplinary measures.

i. Lack of courtesy and decorum; indecent behaviour anywhere within or outside the campus

ii. Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.

The following activities are not allowed within the campus:

- Mutilation or unauthorized possession of library books.
- Noisy and unseemly behaviour, disturbing studies of fellow students.
- Hacking computer systems (such as entering into other person's areas without prior permission, manipulation and/or damage of computer hardware and software or any other cybercrime etc.)
- Use of mobile phones.
- Plagiarism of any nature.
- Any other act of gross indiscipline as decided by the Institute from time to time.
- Commensurate with the gravity of offense, the punishment may be reprimand, fine, expulsion from the institute/ hostel, debarment from a examination, disallowing the use of certain facilities of the Institute, rustication for a specified period or even outright expulsion from the Institute, or even handing over the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.
- For an offence committed in (i) a hostel, (ii) a department or in a class room and (iii) elsewhere, the Chief Warden, the Head of the Department and the Principal, respectively, shall have the authority to reprimand or impose fine.
- Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Principal for taking appropriate action.
- Unauthorized collection of money in any form is strictly prohibited.
- Detained and break-in-study candidates are allowed into the campus for academic purposes only with the permission from authorities.
- Misconduct committed by a student outside the Institute campus but having the effect of damaging, undermining & tarnishing the image & reputation of the institution will make the student concerned liable for disciplinary action commensurate with the nature and gravity of such misconduct.
- The disciplinary action committee constituted by the Principal, shall be the authority to investigate the details of the offence, and recommend disciplinary action based on the nature and extent of the offence committed.
- Grievance redressal committee, constituted by the Principal, shall deal with all grievances pertaining to the academic/ administrative and disciplinary matters.
- All the students must abide by the code and conduct rules of the Institute.

18. MALPRACTICES

The Principal shall refer the cases of malpractices by students in internal assessment tests and end semester examinations, to a malpractice enquiry committee constituted for the purpose. The committee shall follow the approved scales of punishment.
The committee consists of:

1. Heads of Department (Three)
2. Controller of Examinations
3. Assistant Controller of Examinations

Table – 10: Disciplinary action for malpractices/improper conduct in examinations

	Nature of Malpractices/Improper conduct	Punishment
1 (a)	If the candidate possesses or keeps accessible, any paper, note book, programmable calculators, mobile phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in the examination hall but has not made use of (material shall include any marks on the student's body that 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.
(b)	If the candidate gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through mobile 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	If the candidate 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 which the candidate is appearing.	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. He 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.
3	If the candidate 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	If the candidate smuggles in an 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 other examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5	If the candidate 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	If the candidate 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 results in damage to or destruction of property in the examination hall or any part of the Institute campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or	In case of students of the Institute, 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.

	misconduct or has the tendency to disrupt the orderly conduct of the examination.	
7	If the candidate 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 other examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8	If the candidate possesses 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 Institute, who is not a candidate for the particular examination or any person not connected with the Institute indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the Institute: 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. He 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 Institute: Will be handed over to police and a police case will be registered against them.
10	If the candidate 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. He 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 awarded suitable punishment.	

Note: Special squads may be formed to oversee the proper conduct of examinations.

19. OTHER MATTER

19.1 Scribe facility is extended to B Tech students strictly following the guidelines issued under F. No. 16-110/2003-DD.III Dt. 26-02-2013 by the Ministry of Social Justice and Empowerment, Department of Disability Affairs, Govt. of India.

19.2 Students who are suffering from contagious diseases are not allowed to appear either continuous internal assessment or semester end examinations

19.3 The students who participate in coaching/tournaments held at State/National/International levels through University/Indian Olympic Association during semester end examination period will be promoted to subsequent semesters till the entire programme is completed as per the guidelines of University Grants Commission Letter No. F.1-5/88 (SPE/PES), dated18-08-1994.

19.4 Based on the recommendations of HOD & Principal, exemption from attending the class work shall be given to those students who secure placement and intend to join as the employer in VIII semester of B.Tech. Special Continuous Internal Evaluation (Assignment Tests, Sessional, etc.,) will be arranged to such candidates separately if necessary. However, they shall appear for Semester End Examinations as per the Academic Calendar

19.5 The Principal shall deal with any academic problem, which is not covered under these rules and regulations, in consultation with the Heads of the Departments in an appropriate manner, and subsequently such actions shall be placed before the academic council for ratification. Any emergency modification of regulation, approved in the Heads of the Departments Meetings, shall be reported to the academic council for ratification.

20. GENERAL

1 Wherever the words “he”, “him”, “his”, occur in the regulations, they may include “she”, “her”, “hers”.

2 The academic regulations should be read as a whole for the purpose of any interpretation.

3 In case of any doubt or ambiguity in the interpretation of above rules, the decision of the principal is final.

21. INSTITUTE RULES AND REGULATIONS

1 Use of **Mobile phones** is strictly prohibited inside the Institute academic area.

2 Students should come to Institute in **proper dress**.

3 All students should wear **Identity cards** in the Institute premises.

4 Students should be present in their respective classrooms **before the commencement of class sharply**.

5 Students should not leave the Institute premises without prior permission of their respective Heads of the departments during Institute working hours.

6 Students should maintain silence in the class rooms during working periods.

7 Sitting / wandering of the students at the stair cases, corridors, cycle stands or the areas within the Institute premises is strictly prohibited.

8 Usage of Vehicle horn inside the Institute premises is prohibited.

22. AMENDMENTS TO REGULATIONS

The Academic Council may, from time to time, revise, amend or change the regulations, schemes of examination and/or syllabi.

Oratory
PRINCIPAL

PRASAD V POTLURI SIDDHARTHA INSTITUTE OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING
PVP 20 COURSE STRUCTURE

Semester I (First year)

S. No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1	20HS1101	Communicative English I	3	0	0	3
2	20BS1101	Calculus and Linear Algebra	3	0	0	3
3	20BS1105	Chemistry of Materials	3	0	0	3
4	20ES1102	Problem Solving & Programming with Python	3	0	0	3
5	20HS1151	Communicative English I Lab	0	0	3	1.5
6	20BS1154	Chemistry of Materials Lab	0	0	3	1.5
7	20ES1152	Problem Solving & Programming with Python Lab	0	0	3	1.5
8	20ES1153	Basic Workshop	1	0	4	3
	20MC1101	Life Sciences for Engineers	2	0	2	0
Total Credits			**19.5**			

Semester II (First year)

S. No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1	20HS1201	Communicative English II	3	0	0	3
2	20BS1201	Differential Equations and Vector Calculus	3	0	0	3
3	20BS1205	Applied Physics	3	0	0	3
4	20ES1201	Basic Electrical & Electronics Engineering	3	0	0	3
5	20ES1204	Engineering Graphics	1	0	4	3
6	20HS1251	Communicative English II Lab	0	0	3	1.5
7	20BS1253	Applied Physics Lab	0	0	3	1.5
8	20ES1251	Basic Electrical & Electronics Engineering Lab	0	0	3	1.5
9	20ME1291	Community Service Project	0	0	0	4
Total Credits			**19.5**			

Semester III (Second year)

S.No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1	20BS1301	Numerical and Statistical Methods	3	0	0	3
2	20BS1305	Mechanics	3	0	0	3
3	20ES1303	Material Science and Metallurgy	3	0	0	3
4	20ES1304	Basic Thermodynamics	3	0	0	3
5	20ME3301	Fluid Mechanics and Hydraulic Machines	3	0	0	3
6	20ES1353	Design Thinking Lab	0	0	3	1.5
7	20ES1354	CAMDP Lab	0	0	3	1.5
8	20ME3351	FM and HM Lab	0	0	3	1.5
9	20SO8353	Drafting and Modeling Lab	1	0	2	2
10	20MC1341A/ 20MC1341B	NSS/NCC	0	0	2	-
		Total Credits	**21.5**			

Semester IV (Second year)

S.No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1	20ME3401	Kinematics of Machinery	3	0	0	3
2	20ME3402	Strength of Materials	3	0	0	3
3	20ME3403	Applied Thermodynamics	3	0	0	3
4	20ME3404	Manufacturing Processes	3	0	0	3
5	20ME3405	Engineering Economics and Management	3	0	0	3
6	20ME3451	Fuels and IC Engines Lab	0	0	3	1.5
7	20ME3452	Manufacturing Processes Lab	0	0	3	1.5
8	20ME3453	Material Testing and Characterization Lab	0	0	3	1.5
9	20SO8453	AI Tools Lab	1	0	2	2
10	20MC1402	Environmental Science	2	0	0	0
		Total Credits	**21.5**			

Semester V (Third year)

S. No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1	20ME3501	Heat Transfer	3	0	0	3
2	20ME3502	Metal Cutting and Machine Tools	3	0	0	3
3	20ME3503	Design of Machine Elements	3	0	0	3
4	20ME4501	Professional Elective-I	3	0	0	3
5	20ME2501	Open Elective -I	3	0	0	3
6	20ME3551	Heat Transfer Lab	0	0	3	1.5
7	20ME3552	Machine Tools Lab	0	0	3	1.5
8	20SA8553	C Programming	1	0	2	2
9	20MC1502	Universal Human Values	2	0	0	0
10	20ME3581A	Summer Internship (2 Months)	0	0	0	1.5
		Total Credits	**21.5**			

Course Code	Professional Elective- I (V Sem)	Course Code	Open Elective-I (V Sem)
20ME4501A	Advanced Strength of Materials	20ME2501A	Design Thinking
20ME4501B	Operations Research	20ME2501B	Logistics and Supply Chain Management
20ME4501C	Modern Machining Methods		
20ME4501D	Composite Materials		
20ME4501E	Refrigeration and Air Conditioning		

Semester VI (Third year)

Sl. No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1	20ME3601	Dynamics of Machinery	3	0	0	3
2	20ME3602	Metrology and Measurements	3	0	0	3
3	20ME3603	Design of Transmission Elements	3	0	0	3
4	20ME4601	Professional Elective -II	3	0	0	3
5	20ME2601	Open Elective -II	3	0	0	3
6	20ME3651	CAE/CAM Lab	0	0	3	1.5
7	20ME3652	Metrology and Measurements Lab	0	0	3	1.5
8	20ME3653	Machine Dynamics Lab	0	0	3	1.5
9	20SS8651	Soft Skills	1	0	2	2
10	20MC1601	Constitution of India	2	0	0	0
		Total Credits	**21.5**			

Course Code	Professional Elective- II (VI Sem)	Course Code	Open Elective-II (VI Sem)
20ME4601A	Finite Element Method	20ME2601A	Value Engineering
20ME4601B	Production Planning and Control	20ME2601B	Human Factors in Engineering
20ME4601C	CAD/CAM		
20ME4601D	Material Characterization		
20ME4601E	Automobile Engineering		

Semester VII (Fourth year)

S.No.	Course Code	Course Title	Hours per week			Credits
			L	T	P	
1	20ME4701	Professional Elective III	3	0	0	3
2	20ME4702	Professional Elective IV	3	0	0	3
3	20ME4703	Professional Elective V	3	0	0	3
4	20ME2701	Open Elective III	3	0	0	3
5	20ME2702	Open Elective IV	3	0	0	3
6.	20HS7701	Humanities and Social Science Elective	3	0	0	3
7	20SA8753	Mechatronics Lab	1	0	2	2
8	20ME3781B/C	Industrial/ Research Internship	0	0	0	3
Honors/Minor courses (The hours distribution can be 3-0-2 or 3-1-0 also)						
Total Credits						**23**

Course Code	Professional Elective III	Course Code	Professional Elective IV	Course Code	Professional Elective V
20ME4701A	Mechanical Vibrations	20ME4702A	Artificial Intelligence and Machine Learning of Mechanical Systems	20ME4703A	Condition monitoring and Signal Processing
20ME4701B	Geometric Dimensioning and Tolerancing	20ME4702B	Mechatronics	20ME4703B	Additive Manufacturing
20ME4701C	Alternative Sources of Energy	20ME4702C	Gas Dynamics and jet Propulsion	20ME4703C	Power Plant Engineering
20ME4701D	Logistics and Supply Chain Management	20ME4702D	Non-Destructive Testing	20ME4703D	Materials Management
20ME4701E	Nano Technology	20ME4702E	Industrial Robotics	20ME4703E	Reliability Engineering

Course Code	Open Ele. III	Course Code	Open Ele. IV
20ME2701A	Operations Research (Except Mechanical)	20ME2702A	Mechatronics (Except Mechanical)
20ME2701B	Management Information Systems	20ME2702B	Robotics (Except Mechanical)

Course Code	Humanities and Social Science Elective
20HS7701A	Managerial Economics and Financial Analysis (Except Mechanical)
20HS7701B	Human Resources Management
20HS7701C	Entrepreneurship Management
20HS7701F	Industrial Engineering and Management
20HS7701G	Project Management

Semester VIII (Fourth year)

S. No.	Category	Course Title	Hours per week			Credits
			L	T	P	
1	20ME3861	Project work	0	0	0	8
		Total Credits	**8**			

GENERAL MINOR TRACKS

MINOR IN DIGITAL MANUFACTURING

S. No	CODE	Subject	L-T-P	Credit
1	20ME5401	Basic Manufacturing processes	3-1-0	4
2	20ME5501	Additive Manufacturing	3-1-0	4
3	20ME5601	Design for Additive Manufacturing	3-1-0	4
4	20ME5602	INDUSTRY 4.0 and IIoT	3-1-0	4
5	20ME5701	Intelligent Manufacturing Systems	3-1-0	4

MINOR IN AUTOBILE ENGINEERING

S. No	CODE	Subject	L-T-P	Credit
1	20ME5402	Automobile Engineering	3-1-0	4
2	20ME5502	Automotive Transmission System	3-1-0	4
3	20ME5603	Modern Technology in Automobile Engineering	3-1-0	4
4	20ME5604	Alternate Fuels and Emission control in Automotives	3-1-0	4
5	20ME5605	Autonomous Vehicles	3-1-0	4
6	20ME5702	Autotronics	3-1-0	4
7	20ME5703	Electric Vehicles	3-1-0	4

List of Proposed subjects for Honors

	DEPARTMENT OF MECHANICAL ENGINEERING				
S.NO.	**CODE**	**COURSE NAME**	**L-T-P**	**CR**	**PRE-REQ.**
POOL1					
1	20ME6401	Advanced Thermodynamics	**3-1-0**	4	ETD
2	20ME6402	Analysis and Synthesis of Mechanisms	**3-1-0**	4	KOM
3	20ME6403	Advanced Metal Casting	**3-1-0**	4	MP
4	20ME6404	Statistical Quality Control	**3-1-0**	4	NIL
5	20ME6405	Materials and Process Selection for Engineering Design	**3-1-0**	4	NIL
POOL2					
1	20ME6501	Advanced Mechanics of Fluids	**3-1-0**	4	FM
2	20ME6502	Gear Engineering	**3-1-0**	4	DME
3	20ME6503	Advanced Welding Technology	**3-1-0**	4	MP
4	20ME6504	Manufacturing Methods in Precession Engineering	**3-1-0**	4	MP
5	20ME6505	Design of Experiments			NIL
POOL3					
1	20ME6601	Advanced Heat and Mass Transfer	**3-1-0**	4	HT
2	20ME6602	Creep Fatigue and Fracture	**3-1-0**	4	MSM
3	20ME6603	Micro and Nano Manufacturing	**3-1-0**	4	MP
4	20ME6604	Optimization Techniques	**3-1-0**	4	CLA
5	20ME6605	Aerospace Propulsion	**3-1-0**	4	ETD
POOL4					
1	20ME6701	Computational Fluid Dynamics	**3-1-0**	4	FM
2	20ME6702	Mechanics of Composite Materials	**3-1-0**	4	MSM
3	20ME6703	Design for Manufacturing and Assembly	**3-1-0**	4	DME
4	20ME6704	Management Information Systems	**3-1-0**	4	NIL
5	20ME6705	Advanced Metal forming	**3-1-0**	4	MP

COMMUNICATIVE ENGLISH I

Course Code	20HS1101	Year	I	Semester	I
Course Category	Humanities	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the concept of LSRW and basic grammar.	Understand	L2	1,2,3,4,5
CO2	Apply grammar to various situations.	Apply	L3	2,4
CO3	Practice different styles of Reading and Comprehending.	Apply	L3	1,3,5
CO4	Illustrate the text to process the information for various purposes.	Analyze	L4	3,4
CO5	Reframe the text for effective communication.	Analyze	L4	1,2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														1
CO2										3		3		1
CO3									3	3		3		1
CO4										3		3		1
CO5									3	3		3		1

Syllabus

UNIT	Contents	Mapped COs
I	**Reading:** Skimming to get the main idea of a text; Scanning to look for specific pieces of information. **Reading for Writing:** Beginnings and endings of paragraphs - Introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph. **Grammar and Vocabulary:** Content words and function words; Word forms: Verbs, Nouns, Adjectives and Adverbs; Nouns: countable and uncountable; singular and plural; Basic sentence structures; Simple Question form - wh-questions; Word order in sentences.	CO1 CO3 CO5
II	**Reading:** Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together. **Writing:** Paragraph writing (specific topics) using suitable cohesive devices; Mechanics of writing - punctuation, capital letters. **Grammar and Vocabulary:** Cohesive devices - linkers, sign posts and transition signals; Use of articles and zero article; prepositions One word substitutes	CO1 CO2 CO5

III	**Reading:** Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension. **Writing:** Summarizing - identifying main idea/s and rephrasing what is read; avoiding redundancies and repetitions. **Grammar and Vocabulary:** Verbs - Tenses; Subject-verb agreement; Direct And Indirect speech, Reporting verbs for academic purposes. Idiomatic expressions	**CO1** **CO3** **CO4** **CO5**
IV	**Reading:** Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data. **Writing:** Information transfer; describe, compare, contrast, identify significance/trends based on information provided in figures/charts/graphs/tables. **Grammar and Vocabulary:** Quantifying expressions - adjectives and adverbs; comparing and contrasting; Degrees of comparison; Use of antonyms **Correction of sentences**	**CO1** **CO2** **CO4** **CO5**
V	**Reading:** Reading for comprehension. **Writing:** Writing structured essays on specific topics using suitable claims and evidences **Grammar and Vocabulary:** Editing short texts – Identifying and correcting common errors in grammar and usage (Articles, Prepositions, Tenses, Subject-verb agreement) **Prefixes/suffixes**	**CO1** **CO3** **CO5**

Learning Resources

Text Books

1. Prabhavathy Y, M.Lalitha Sridevi, Ruth Z. Hauzel, "English all Round 1: Communication skills for Undergraduate students", Orient Black Swan, 2019

Reference Books

1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. **Skillful** Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
3. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012

e- Resources & other digital material

Grammar/Listening/Writing:
1-language.com; http://www.5minuteenglish.com/
https://www.englishpractice.com/
Grammar/Vocabulary:
English Language Learning Online; http://www.bbc.co.uk/learningenglish/
http://www.better-english.com/; http://www.nonstopenglish.com/
https://www.vocabulary.com/; BBC Vocabulary Games
Free Rice Vocabulary Game
Reading:
https://www.usingenglish.com/comprehension/; https://www.englishclub.com/reading/short-stories.htm; https://www.english-online.at/
All Skills:
https://www.englishclub.com/; http://www.world-english.org/
http://learnenglish.britishcouncil.org/
Online Dictionaries:
Cambridge dictionary online; MacMillan dictionary; Oxford learner's dictionaries

CALCULUS AND LINEAR ALGEBRA

Course Code	20BS1101	Year	I	Semester	I
Course Category	Basic Science	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	**Understand** the basic concepts of calculus and linear algebra.	Understand	L2	1,2,3,4,5
CO2	**Apply** the echelon form to obtain the solution of system of linear equations and eigen vectors of a matrix.	Apply	L3	1,2,
CO3	**Apply** the concepts of calculus to find the series expansion and extremum of a given function ,area enclosed by plane curves and volume of the solids.	Apply	L3	3,4,5
CO4	**Analyse** the solution set of linear system of equations and nature of the quadratic forms.	Analyze	L4	1,2
CO5	**Analyse** the behaviour of functions using mean value theorems, extremum of the given function and limits of integration.	Analyze	L4	3,4,5
CO6	**Apply** the concepts of calculus and linear algebra to the given problem and **submit a report**	Apply	L3	1,2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1													1	
CO2	3								2	2			1	
CO3	3								2	2			1	
CO4		3											1	
CO5		3											1	
CO6	3								2	2			1	

Syllabus

UNIT	Contents	Mapped COs
I	**Matrices-Linear System of Equations:** Rank of a matrix by Echelon form, Normal form, PAQ form, solving system of homogeneous and non-homogeneous linear equations.	CO1 CO2 CO4 CO6
II	**Eigen values and Eigen Vectors:** Eigen values, Eigen vectors and their properties, Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem, diagonalization of a matrix, quadratic forms and nature of the quadratic forms.	CO1 CO2 CO4 CO6

III	**Mean Value Theorems:** Rolle's Theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin's theorems with remainders (without proofs).	**CO1** **CO3** **CO5** **CO6**
IV	**Multivariable Calculus:** Functions of several variables, Jacobian, Functional dependence, maxima and minima of functions of two variables, method of Lagrange's multipliers.	**CO1** **CO3** **CO5** **CO6**
V	**Multiple Integrals:** Double integrals, change of order of integration, double integration in polar coordinates, Triple integrals, change of variables between Cartesian, cylindrical and spherical polar co-ordinates, volume as triple integral. **Application-** Areas enclosed by plane curves.	**CO1** **CO3** **CO5** **CO6**

Learning Recourse(s)
Text Book(s)
1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44/e, 2019. 2. Erwin Kreyszig, Advanced Engineering Mathematics, 9/e, John Wiley & Sons, 2006
Reference Book(s)
1. N.P. Bali and Manish Goyal, A Text book of Engineering Mathematics, Laxmi Publications, 2008.
e- Resources & other digital material
1. https://nptel.ac.in/courses/111/108/111108157/ 2. https://www.nptel.ac.in/courses/111/104/111104125/ 3. https://youtu.be/xDSejIvZmg4 4. http://202.53.81.118/ -> PVPSIT FED-Moodle

CHEMISTRY OF MATERIALS

Course Code	20BS1105	Year	I	Semester	I
Course Category	Basic Science	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the basic principles related to water, energy sources, corrosion and engineering materials.	Understand	L2	1,2,3,4,5
CO2	Apply the knowledge of water treatment methods, corrosion technology and electrochemical energy systems to describe the functioning of water purifiers, methods for corrosion control and cells.	Apply	L3	1,2,3
CO3	Apply suitable methods and techniques for the characterization and manufacturing of various materials.	Apply	L3	4,5
CO4	Analyse the characteristics and performance of water, energy conversion systems, corrosion and materials in their respective applications.	Analyze	L4	1,2,3,4,5
CO5	Make an effective report on various concepts and technologies related to chemistry of materials.	Analyze	L4	1,2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2	3						1					1	1	
CO3	3						1					1	1	
CO4	3						1					1	1	
CO5	3						1			2		1	1	

Syllabus

UNIT	Contents	Mapped COs
I	**WATER TECHNOLOGY:** Introduction –Hard and Soft water, Estimation of hardness by EDTA Method - Boiler troubles- scale and sludge-priming and foaming, specifications for drinking water, Industrial water treatment – zeolite and ion- exchange processes- desalination of brackish water, reverse osmosis (RO) and electro dialysis.	CO1 CO2 CO4 CO5
II	**ENERGY SOURCES AND APPLICATIONS**: Electrode potential, determination of single electrode potential –Nernst's equation, reference electrodes, hydrogen and calomel electrodes – electrochemical series and its applications – primary cell, dry or Leclanche cell – secondary cell, lead acid storage cell – lithium batteries (Lithium-MnO2) – fuel cell, hydrogen-oxygen fuel cell, Solar energy- photovoltaic cell and applications.	CO1 CO2 CO4 CO5

III	**CORROSION ENGINEERING:** Corrosion: Definition – theories of corrosion, dry corrosion and electrochemical corrosion – factors affecting corrosion, nature of the metal and nature of the environment. Corrosion controlling methods: Sacrificial and Impressed current cathodic protection, Metallic coatings, anodic coatings, cathodic coating, galvanizing and tinning, anodic inhibitors and cathodic inhibitors – organic coatings, paints and varnishes (constituents and their functions).	**CO1** **CO2** **CO4** **CO5**
IV	**ENGINEERING MATERIALS AND POLYMERS** Steel – Types of Steel, chemical composition – applications of alloy steels Cement: Portland cement, constituents, Manufacture of Portland Cement, chemistry of setting and hardening of cement (hydration, hydrolysis, equations). Polymers: Introduction, differences between thermoplastic and thermo setting resins, Preparation, properties and uses of polystyrene and poly phosphazines.	**CO1** **CO3** **CO4** **CO5**
V	**NANO AND SMART MATERIALS:** Introduction to Nano materials, chemical synthesis of nanomaterials: Sol-gel method, characterization of nano materials by TEM (includes basic principle of TEM), Applications of nanomaterials in waste water treatment, lubricants and engines. **Smart Materials:** Introduction -Types of smart materials- self healing materials , Shape memory alloys and Uses of smart materials	**CO1** **CO3** **CO4** **CO5**

Learning Resources
Text Books
1. P.C. Jain and M. Jain, Engineering Chemistry, 15/e, DhanapatRai& Sons,(2014). 2. B.K. Sharma, Engineering Chemistry, Krishna Prakasham,(2014).
Reference Books
1. SashiChawla, A Textbook of Engineering Chemistry, Dhanapath Rai and sons,(2003) 2. B.S Murthy and P. Shankar, A Text Book of Nano Science and Nano Technology, University Press(2013). 3. S.S. Dara, A Textbook of Engineering Chemistry, S. Chand& Co,(2010) 4. V.Raghavan, A Material Science and Engineering, Prentice-Hall India Ltd,(2004). 5. N.Krishna Murthy and Anuradha, A text book of Engineering Chemistry, Murthy Publications(2014). 6. K. Sesha Maheshwaramma and Mridula Chugh, Engineering Chemistry, Pearson India Edn services,(2016).
e- Resources & other digital material
1. https://nptel.ac.in/courses/105105178/ 2. http://202.53.81.118/course/view.php?id=82

PROBLEM SOLVING AND PROGRAMMING WITH PYTHON

Course Code	20ES1102	Year	I	Semester	I
Course Category	Engineering Science	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the principles of structured programming and C constructs for solving problems.	Understand	L2	1,2,3,4,5
CO2	Apply suitable control constructs and array concepts to solve problems.	Apply	L3	1,2,
CO3	Apply the concept of pointers, user defined data types and files to solve problems.	Apply	L3	3,4,5
CO4	Analyze the given problem and use modular programming approach to develop solutions.	Analyze	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												2	
CO2	3												2	
CO3	3								3	3			2	
CO4		2											2	

Syllabus

UNIT	Contents	Mapped COs
I	**Computational Thinking and Visual Programming Concepts** Introduction to computational thinking. Visual programming concepts. Scratch environment: sprites -- appearance and motion, angles and directions, repetition and variation, changing costumes, adding background, Input/output, variables and operators. **Problems** - draw geometrical shapes such as Circle, Triangle, Square and Pentagon, Make a sprite to ask the user to enter two different numbers and an arithmetic operator and then calculate and display the result, make a sprite to ask the user to enter a number to display even and odd numbers.	**CO1 CO2**
II	**Algorithms and Flowchart design through Raptor** Introduction to the idea of an algorithm, Pseudo code and Flowcharts. Flowchart symbols, Input/output, Assignment, operators, conditional if, repetition, procedure and sub charts. **Problems** - Finding maximum of 3 numbers, Unit converters, Interest calculators, and multiplication tables, GCD of 2 numbers,	**CO1 CO2**

	Fibonacci number generation, and prime number generation. Minimum, Maximum and average of n numbers.	
III	**Introduction to Python** Features of Python, Writing and Executing First Python Program, Literal Constants, Variables and Identifiers, Reserved Words, Data Types, Input Operation, Operators and Expressions, Operations on Strings, Type Conversion, Conditional statements and iterative statements.	**CO1** **CO3**
IV	**Functions and Strings in Python** **Functions:** Introduction, Built-in Math Functions, User Defined Functions: Function Call, Variable Scope and Lifetime, The return statement, Lambda Functions, Packages in python. **Strings:** Introduction, Built-in String Functions, Slice Operation, Comparing Strings, Iterating String, Regular Expressions.	**CO1** **CO3**
V	**Files and Data Structures in Python** **File Handling:** open, close, read and write operations. **Data Structures:** **Lists:** Accessing values in lists, Nested Lists, Basic List Operations. **Tuples:** Creating Tuple, Accessing values in a tuple, Basic Tuple Operations. **Dictionaries**: Creating and Accessing Dictionaries, Built-in Dictionary functions, List Vs Tuple Vs Dictionary.	**CO1** **CO3** **CO4**

Learning Resources
Text Books
1. An introduction to programming and algorithmic reasoning using raptor, Weingart, Dr.Troy, Wayne, 2018, CreateSpace (an Amazon.com Company) 2. Core Python Programming, R. Nageswara Rao, 2018, Dreamtech press.
Reference Books
1. Python Programming: Using Problem Solving Approach, Reema Thareja, 2017, Oxford University Press. 2. Programming with python, T R Padmanabhan, 2017, Springer. 3. Python for Data Analysis, Wes McKinney, 2012, O.Reilly.
e- Resources & other digital material
1. http://fusecontent.education.vic.gov.au/9f79537a-66fc-4070-a5ce-e3aa315888a1/scratchreferenceguide14.pdf 2. https://raptor.martincarlisle.com/ 3. http://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf

COMMUNICATIVE ENGLISH-I LAB

Course Code	20HS1151	Year	I	Semester	I
Course Category	Humanities	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Expts.
CO1	Acquire communication skills through various language learning activities.	Apply	L3	1-10
CO2	Construct meaningful sentences and Paragraphs.	Apply	L3	3,4
CO3	Analyze the text to develop comprehensive ability.	Analyze	L4	5,6
CO4	Preparation of report based on the activity.	Analyze	L4	1-10

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2	3								2	2				
CO3	3								2	2				
CO4		3												

Syllabus

Expt. No.	Contents	Mapped CO's
1	Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.	CO1 CO4
2	Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.	
3	Answering a series of questions about main idea and supporting ideas after listening to audio texts.	CO1 CO2 CO4
4	Discussion in pairs/ small groups on specific topics followed by short structured talks.	
5	Listening for global comprehension and summarizing what is listened to.	CO1 CO3 CO4
6	Discussing specific topics in pairs or small groups and reporting what is discussed	
7	Making predictions while listening to conversations/transactional dialogues without video; listening with video	CO1 CO4
8	Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.	
9	Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.	CO1 CO4
10	Formal oral presentations on topics from academic contexts -without the use of PPT slides.	

Learning Resources
Text Books
1. Prabhavathy Y, M.Lalitha Sridevi, Ruth Z. Hauzel, "English all Round 1: Communication skills for Undergraduate students", Orient Black Swan, 2019
Reference Books
1. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT; 2nd Edition, 2018. 2. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational. 3. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012
e- Resources & other digital material
Grammar/Listening/Writing: 1-language.com http://www.5minuteenglish.com/ https://www.englishpractice.com/ **Listening:** https://learningenglish.voanews.com/z/3613; http://www.englishmedialab.com/listening.html **Speaking:** https://www.talkenglish.com/BBC; Learning English – Pronunciation tips Merriam-Webster – Perfect pronunciation Exercises All Skills: https://www.englishclub.com/; http://www.world-english.org/ http://learnenglish.britishcouncil.org/ **Online Dictionaries:** Cambridge dictionary online; MacMillan dictionary; Oxford learner's dictionaries

CHEMISTRY OF MATERIALS LAB

Course Code	20BS1154	Year	I	Semester	I
Course Category	Basic Science	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Expts.
CO1	Apply the acquired knowledge to estimate the amount of calcium, Chromium in a given sample.	Apply	L3	1,2
CO2	Analyze the quality of ground water sample, and active chlorine in bleaching powder.	Analyze	L4	6,7,8
CO3	Calculate the strength of an acid in lead-acid storage cell.	Apply	L3	5
CO4	Compare the viscosities and surface tension of different liquids.	Analyze	L4	3,4
CO5	Analyze the compounds and examine the Preparation of a polymer.	Analyze	L4	9,10
CO6	Make an effective report based on experiments	Apply	L3	1-10

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2				3					1		1
CO2	3		2				3					1		1
CO3	3		2				3					1		1
CO4	3		2				3					1	2	1
CO5	3		2				3					1		1
CO6	3		2				3			3		1		1

Syllabus

Expt. No.	Contents	Mapped CO's
1	Estimation of calcium in Portland cement	CO1, CO6
2	Determination of chromium (VI) in potassium dichromate	CO1, CO6
3	Determination of viscosity of a liquid	CO4, CO6
4	Determination of surface tension of a liquid	CO4, CO6
5	Determination of sulphuric acid in lead-acid storage cell	CO3, CO6
6	Determination of strength of an acid by pH metric method	CO2, CO6
7	Determination of Hardness of a ground water sample	CO2, CO6
8	Estimation of active chlorine content in Bleaching powder	CO2, CO6
9	Thin layer chromatography (paper chromatography)	CO5, CO6
10	Preparation of Phenol-formaldehyde resin	CO5, CO6

Learning Resources
Text Books
1. Mendham J, Denney RC, Barnes JD, Thosmas M and Sivasankar B Vogel's Quantitative Chemical Analysis 6/e, Pearson publishers(2000).
Reference Books
1. N.KBhasin and Sudha Rani Laboratory Manual on Engineering Chemistry 3/e, DhanpatRai Publishing Company(2007).
e- Resources & other digital material
1. https://nptel.ac.in/courses/105105178/ 2. http://202.53.81.118/course/view.php?id=82

PROBLEM SOLVING AND PROGRAMMING WITH PYTHON LAB

Course Code	20ES1152	Year	I	Semester	I
Course Category	Engineering Science	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Expts.
CO1	Apply visual programming concepts, flowchart design techniques and Python programming constructs for solving problems.	Apply	L3	1-10
CO2	Conduct experiments as an individual, or team member by using Scratch/Raptor tools and Python programming.	Apply	L3	1-10
CO3	Develop an effective report based on various programs implemented.	Apply	L3	1-10
CO4	Apply technical knowledge for a given problem and express with an effective oral communication.	Apply	L3	1-10
CO5	Analyze outputs generated through Scratch/Raptor tools and Python programming.	Analyze	L4	1-10

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											2	2	2
CO2					3				3				2	2
CO3										3				
CO4	3									3				
CO5		3												

Syllabus

Expt.No.	Contents	Mapped CO's
1	Apply Visual Programming Concepts using Scratch tool.	CO1, CO2, CO3, CO4, CO5
2	Solve various computational problems by designing flowcharts using Raptor tool.	CO1, CO2, CO3, CO4, CO5
3	Python programs on usage of operators.	CO1, CO2, CO3, CO4, CO5
4	Python Programs to demonstrate decision making and branching (Selection)	CO1, CO2, CO3, CO4, CO5
5	Python programs to demonstrate iterative statements.	CO1, CO2, CO3, CO4, CO5
6	Python programs to demonstrate functions	CO1, CO2, CO3, CO4, CO5
7	Python programs to perform operations on strings, regular expressions with built – in functions.	CO1, CO2, CO3, CO4, CO5
8	Python programs to handle file operations.	CO1, CO2, CO3, CO4, CO5

9	Python programs to apply various data structures.	CO1, CO2, CO3, CO4, CO5
10	Installing, importing and accessing numpy and pandas packages.	CO1, CO2, CO3, CO4, CO5

Learning Resources
Text Books
1. An introduction to programming and algorithmic reasoning using raptor, Weingart, 2. Dr. Troy, Brown, Dr. Wayne, 2018, CreateSpace (an Amazon.com Company) 3. Core Python Programming, R. Nageswara Rao, 2018, Dreamtech press.
Reference Books
1. Python Programming: Using Problem Solving Approach, Reema Thareja, 2017, Oxford University Press. 2. Programming with python, T R Padmanabhan, 2017, Springer. 3. Python for Data Analysis, Wes McKinney, 2012, O.Reilly.
e- Resources & other digital material
1. http://fusecontent.education.vic.gov.au/9f79537a-66fc-4070-a5ce-e3aa315888a1/scratchreferenceguide14.pdf 2. https://raptor.martincarlisle.com/ 3. http://www.ict.ru.ac.za/Resources/cspw/thinkcspy3/thinkcspy3.pdf

BASIC WORKSHOP

Course Code	20ES1153	Year	I	Semester	I
Course Category	Engineering Science	Branch	ME	Course Type	Lab
Credits	3	L-T-P	1-0-4	Prerequisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Expts.
CO1	Study and practice on basic hand tools and their operations.	Apply	L3	1-4
CO2	Practice on manufacturing of components using workshop trades including Tin smithy, fitting and carpentry.	Apply	L3	1-3
CO3	Apply basic electrical engineering knowledge for house wiring and soldering practice.	Apply	L3	4
CO4	Demonstrate basic concepts of software installations, operating systems and networking.	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	2			3		2	2	3	2
CO2	3	2				2			3		2	2	3	2
CO3	3	2				2			3		2	2	3	2
CO4	3	2	2	2	2	2			3		2	2	3	2

Syllabus

Expt. No.	Contents	Mapped CO's
1	Familiarity with different types of woods and tools used in wood working and make following joints 1. Half – Lap joint. 2. Mortise and Tenon joint. 3. Corner Dovetail joint or Bridle joint.	CO1, CO2
2	Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets 1. Tapered tray 2. Conical funnel 3. Elbow pipe	CO1, CO2
3	Familiarity with different types of tools used in fitting and do the following fitting exercises 1. V-fit 2. Dovetail fit 3. Semi-circular fit 4. Bicycle tire puncture and change of two wheeler tire	CO1, CO2
4	Familiarities with different types of basic electrical circuits and make the following connections 1. Preparation of a circuit for Parallel and series connection.	CO1, CO3

	2. Preparation of a circuit for Go down lighting using Two-way switch to connect tube light. 3. Soldering of wires	
5	1. Students have to be given a PC which does not boot due to improper assembly or defective peripherals. They should identify the problem and fix it to get the computer back to working condition. 2. Installation of MS-Windows and Linux. Connection of LAN and access the Internet, Configuration of TCP/IP setting and access of websites and email. 3. Exploring MS-Word and sample tasks. Document creation and editing text documents in your web browser using Google docs.	**CO4**

Learning Resources
Text Books
1. Work shop Manual - P.Kannaiah/ K.L.Narayana/ Scitech Publishers. 2. Workshop Manual / Venkat Reddy/ BS Publications/Sixth Edition.

LIFE SCIENCES FOR ENGINEERS

Course Code	20MC1101	Year	I	Semester	I
Course Category	Mandatory	Branch	ME	Course Type	Theory
Credits	0	L-T-P	2-0-2	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	**Apply** the concepts of biology to create tangible and economically viable engineering goods.	Apply	L3	1,2
CO2	**Analyse** new technologies in Genetics biotechnology, pharmaceutical, medical and agricultural fields from the knowledge gained from DNA technology.	Analyze	L4	2,5
CO3	**Apply** the knowledge of biology to improve the living standards of societies.	Apply	L3	3,4
CO4	**Apply** the basic knowledge of genetics and DNA technology for disease diagnostics and therapy.	Apply	L3	4
CO5	**Analyse** new technologies in biotechnology, pharmaceutical, medical and agricultural fields from the knowledge gained from DNA technology.	Analyze	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3									2				
CO2					3					2				
CO3					3					2				
CO4					3	3				2				
CO5	3					3				2				

Syllabus

Unit	Contents	Mapped CO's
1	**Introduction to Biology** Comparison of Biological organisms with manmade systems :Eye and Camera ,Flying bird and Aircraft Ultra structure of cell: Prokaryotes and Eukaryotes	**CO1**
2	**Bio-molecules** Structure and functions of proteins (antibodies) Structure and functions of nucleic acids Industrial applications- Enzymes and Fermentation	**CO1** **CO2**
3	**Bioenergetics and Cellular Respiration** Mechanism of photosynthesis Glycolysis TCA cycle Electron transport chain and Oxidative phosphorylation.	**CO3**
4	**Genetics** Mendel'slaws Gene mapping	**CO3** **CO4**

	Single gene disorders in humans	
5	**Recombinant DNA Technology** Recombinant vaccines, transgenic microbes, plants and animals. Animal cloning, biosensors, biochips.	**CO2** **CO5**

Expt. No.	Name of the experiment	Mapped CO's
1	Dissect & mount different parts of plants using Microscope	CO1
2	Estimation of Proteins by using Biuret method	CO2
3	Estimation of enzyme activity.	CO2
4	Estimation of chlorophyll content in some selected plants.	CO3
5	Nitrogen Cycle: Estimation of Nitrates /Nitrites in soil by using Spectrophotometer	CO3
6	Mendal's laws and gene mapping	CO4, CO5

Learning Resources

Text Books

1. Biology for Engineers-Wiley Editorial
2. N. A. Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2018.
3. Biotechnology by U.Satyanarayana, Alliedand books Pvt. ltd. Kolkata

Reference Books

1. Alberts et al., The molecular biology of the cell, 6/e, Garland Science, 2014.
2. John Enderle and Joseph Bronzino Introduction to Biomedical Engineering, 3/e, 2012

COMMUNICATIVE ENGLISH II

Course Code	20HS1201	Year	I	Semester	II
Course Category	Humanities	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand various Linguistic aspects.	Understand	L3	1,2,3,4,5
CO2	Apply language to draft letters for various business purposes.	Apply	L3	2,5
CO3	Interpret the text for information processing and effective communication.	Apply	L3	1,3,4
CO4	Analyze the data for report writing and précis writing.	Analyze	L4	2,4
CO5	Relate advanced writing skills for better employability.	Analyze	L4	1,2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														1
CO2									3	3		3		1
CO3									3	3		3		1
CO4									3	3		3		1
CO5									3	3		3		1

Syllabus

UNIT	Contents	Mapped COs
I	**Reading:** Reading for presenting - strategies to select, compile and synthesize information for presentation-Comprehending a wide range of texts -Reading to recognize academic style **Reading for Writing:** Paraphrasing - using quotations and in-text references; using academic style - avoiding colloquial words and phrases - Writing an essay after researching a topic - Citing the sources used **Grammar and Vocabulary:** Academic verbs in context; formal words and phrases-Awareness about Root words	CO1 CO3 CO5
II	**Reading:** Recognizing formal and informal styles -Recognizing the difference between facts and opinions - Identifying and understanding different perspectives **Writing:** Letter writing and e mail writing - Structure, Conventions and Etiquette – Informal, semi-formal and formal (enquiry, complaints, seeking permission, seeking internship - Re-draft a piece of text from a different perspective - Writing brief critical reviews of short texts. Communication skills-verbal /Non verbal **Grammar and Vocabulary:** Agreement: Subject-verb, Noun-	CO1 CO2 CO4 CO5

	pronoun; Editing short texts - Phrasal verbs - Phrasal prepositions - Avoiding clichés	
III	**Reading**: Identifying claims, evidences, views/opinions, purpose, and stance/position -Understand the correlation between a talk and a reading text based on inferences made. **Writing:** Writing structured analytical and argumentative essays on general topics using suitable claims and evidences with the sources cited-Peer review of the essays written **Grammar and Vocabulary:** Language for different functions such as stating a point, expressing opinion, Agreeing/disagreeing, Adding information to what someone has stated, and asking for clarification - Modifiers and misplaced modifiers. Corporate grooming	**CO1** **CO3** **CO5**
IV	**Reading:** Reading varied text types - Structure and contents of a formal report -Sections in a report and understanding the purpose of each section- Significance of references **Writing:** Writing reports **Grammar and Vocabulary:** Active and passive voice - Use of passive verbs in academic writing- Precis writing	**CO1** **CO3** **CO4** **CO5**
V	**Reading:** Reading for inferential comprehension **Writing:** Writing one's CV and cover letter - Applying for a job/internship **Grammar and Vocabulary:** Reinforcing learning - Edit one's writing to correct common errors in grammar and usage - Use appropriate vocabulary for speaking and writing – Various purposes, Jumbled sentences	**CO1** **CO2** **CO5**

Learning Resources

Text Books

1. Prabhavathy Y, M.Lalitha Sridevi "English all Round2: Communication skills for Undergraduate students", Orient Black Swan, 2020

Reference Books

1. Bailey, Stephen. Academic writing: A handbook for international students. Routledge, 2014.
2. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
3. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012(Student Book, Teacher Resource Book, CD & DVD)

e- Resources & other digital material

Grammar/Listening/Writing:
1-language.com; http://www.5minuteenglish.com/ https://www.englishpractice.com/
Grammar/Vocabulary:
English Language Learning Online; http://www.bbc.co.uk/learningenglish/
http://www.better-english.com/; http://www.nonstopenglish.com/
https://www.vocabulary.com/; BBC Vocabulary Games
Free Rice Vocabulary Game
Reading:
https://www.usingenglish.com/comprehension/; https://www.englishclub.com/reading/short-stories.htm; https://www.english-online.at/
All Skills:
https://www.englishclub.com/; http://www.world-english.org/
http://learnenglish.britishcouncil.org/
Online Dictionaries:
Cambridge dictionary online; MacMillan dictionary; Oxford learner's dictionaries

DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS

Course Code	20BS1201	Year	I	Semester	II
Course Category	Basic Science	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the basic concepts of differential equations and vector calculus.	Understand	L2	1,2,3,4,5
CO2	Apply different methods to solve differential equations.	Apply	L3	1,2,3
CO3	Apply the differential operator to calculate the divergence and flux of vector point functions.	Apply	L3	4,5
CO4	Analyse the given differential equation to find the solution.	Analyze	L4	1,2,3
CO5	Calculate work done and flux by applying vector integral theorems.	Analyze	L4	4,5
CO6	Apply the concepts of differential equations and vector calculus to the given problem and submit a report.	Apply	L3	1,2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1													1	
CO2	3								2	2			1	
CO3	3								2	2			1	
CO4		3											1	
CO5		3											1	
CO6	3								2	2			1	

Syllabus

UNIT	Contents	Mapped COs
I	**Ordinary Differential Equations Of First order and First degree**: Exact differential equations, Equations reducible to exact equations, orthogonal trajectories in Cartesian and polar coordinates. **Applications**: Newton's Law of cooling, Law of Natural growth and decay.	CO1, CO2, CO4, CO6
II	**Linear Differential Equations of Higher Order: O**perator D, rules for finding complementary function, inverse operator, rules for finding particular integral, method of variation of parameters.	CO1, CO2, CO4, CO6

III	**Partial Differential Equations:** Formation of partial differential equations, Linear equations of first order, Non-Linear equations of first order, Charpit's method.	**CO1, CO2, CO4, CO6**
IV	**Vector Differentiation:** Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, del applied to vector point functions- Divergence and Curl.	**CO1, CO3, CO5, CO6**
V	**Vector Integration:** Line integral, surface integral, volume integral, Green's theorem in the plane, Stoke's theorem, Divergence theorem (All theorems without proof). **Applications**: work done, flux.	**CO1, CO3, CO5, CO6**

Learning Resources
Text Books
1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44/e, 2019. 2. Erwin Kreyszig, Advanced Engineering Mathematics, 9/e, John Wiley & Sons, 2006.
Reference Books
1. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, 3/e, Alpha science International Ltd,2002
e- Resources & other digital material
1. https://nptel.ac.in/courses/111/105/111105121/ 2. https://nptel.ac.in/courses/111/105/111105122/ 3. https://nptel.ac.in/courses/111/107/111107108/ 4. http://202.53.81.118/ -> PVPSIT FED Moodle

APPLIED PHYSICS

Course Code	20BS1205	Year	I	Semester	II
Course Category	Basic Science	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	**Understand** the principles of Mechanics, Thermal, Optical and Acoustics in technical aspects.	Understand	L2	1,2,3,4,5
CO2	**Apply** the basic laws of Heat, Sound and mechanics for engineering applications**.**	Apply	L3	1,3,4
CO3	**Identify** the principles of forces and energy in mechanical system	Apply	L3	2,5
CO4	**Analyze** the mechanism of waves, thermal, accoustics and deduce different analytical parameters	Analyze	L4	1,3,4
CO5	**Examine** the different mechanical properties and their applications	Analyze	L4	2,5
CO6	**Study** the principles of Mechanics, Thermal energy, Acoustics, sensors and make a report	Apply	L3	1,2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2	3												3	2
CO3	3												3	2
CO4		3											3	2
CO5		3											3	2
CO6									2	2		2	3	2

Syllabus

UNIT	Contents	Mapped COs
I	**Mechanics** :Basic laws of vectors and scalars, Resolution of vectors, parallelogram law of vectors; Conservative and non-conservative forces; F = - grad V; Inertial & Non-inertial frames of reference **Wave mechanics:** wave, Characteristics of waves, Simple harmonic oscillator; Damped harmonic motion; Forced oscillations and resonance. Degrees of freedom.	CO1 CO2 CO4
II	**Elasticity:** Concepts of elasticity and plasticity, stress and strain, Hooke's law, different moduli of elasticity, Poisson's ratio, strain energy, stress-strain diagram, elastic behavior of a material, factors affecting elasticity.	CO1 CO3 CO5

III	**Thermal Properties**: Thermal expansion of solids and liquids; Thermal conduction, convection and radiation and their fundamental laws; Heat conductions in solids; Thermal conductivity - Forbe's and Lee's disc method: theory and experiment; Applications (qualitative only): heat exchangers, ovens and solar water heaters.	**CO1 CO2 CO4**
IV	**Acoustics:** Characteristics of sound waves; Weber-Fechner Law; Absorption coefficient, determination of absorption coefficient; Reverberation time; Sabine's formula, Intensity of sound; Acoustics of Buildings, Acoustic requirements of a good auditorium.	**CO1 CO2 CO4**
V	**Sensors:** Sensors (qualitative description only); Different types of sensors and applications; working and applications of Strain and pressure sensors magnetostrictive sensors, Fibre optic methods of pressure sensing; Temperature sensor - bimetallic strip, Hall-effect sensor	**CO1 CO3 CO5**

Learning Resources
Text Books
1. D. Kleppner and Robert Kolenkow "An Introduction to Mechanics– II" Cambridge University Press, 2015 2. M.N.Avadhanulu & P.G.Kshirsagar" A Text book of Engineering Physics"-S.Chand Publications,2017 3. Ian R Sinclair, Sensor and Transducers 3rd edition, 2001, Elsevier (Newnes)
Reference Books
1. M KVarma "Introduction to Mechanics" Universities Press,2015 2. Prithwiraj Purkait, Budhaditya Biswas and Chiranjib Koley, Chapter 11, Sensors and Transducers, Electrical and Electronics Measurements and Instrumentation, First edition., Mc-Graw Hill Education (India) Private Limited, 2013
e- Resources & other digital material
1. http://physicsforidiots.com/physics/electromagnetism/ 2. https://www.arcelect.com/fibercable.htm 3. http://freevideolectures.com/Course/3048/Physics-of-Materials/36 4. https://www.iitk.ac.in/mse/electronic-materials-and-devices 5. https://link.springer.com/chapter/10.1007/978-3-319-48933-9_35

BASIC ELECTRICAL & ELECTRONICS ENGINEERING

Course Code	20ES1201	Year	I	Semester	II
Course Category	Engineering Science	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	**Understand** the basic concepts of DC circuits, Electrical Machines, Concepts of Electronic Devices and Circuits and realize the Applications of Electrical & Electronics in Interdisciplinary Engineering Domains	Understand	L2	1,2,3,4,5
CO2	**Apply** the basic knowledge of mathematics, science and electrical engineering to obtain the desired parameters of Electric circuits and Machines.	Apply	L3	1,2,3
CO3	**Analyse** the behaviour of Electric circuits, transformers and Electrical machines.	Analyze	L3	1,2,3
CO4	**Apply** the basic principles of Electronics to solve Analog Circuits.	Apply	L4	4,5
CO5	**Analyse** the characteristics/ performance parameters of Electronic Circuits.	Analyze	L4	4,5
CO6	Ability to **investigate** various problems in DC circuits, Electrical Machines and Electronic Devices and Circuits and **submit a report.**	Apply	L3	1,2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2	3												1	2
CO3		3											1	2
CO4	3													1
CO5		3											1	1
CO6				3					2	2			1	2

Syllabus

UNIT	Contents	Mapped COs
I	**Basic laws and Theorems-DC Circuits**: Ohms law, Kirchhoff's Laws, series and parallel resistive circuits, source transformations, delta-wye conversion. Mesh analysis, nodal analysis. Superposition theorem, Thevenin's theorem, Norton's theorem and maximum power transfer theoremwith simple examples (**independent sources only**).	CO1 CO2 CO3 CO6
II	**DC Machines**: Construction, working principle, Voltage Build up, EMF equation, Torque expression, types of excitation, types of dc	CO1 CO2

	machines, necessity of Starter, losses and efficiency.	**CO3 CO6**
III	**Transformers**: Construction, working principle, EMF equation, open and short- circuit tests, voltage regulation definition, losses and efficiency. **Three Phase Induction Motors:** Construction, working principle of three phase induction motor.	**CO1 CO2 CO3, CO6**
IV	**Semiconductor Devices**: P-N Junction diode - Basic operating principle, current-voltage characteristics, half-wave rectifier, full-wave rectifier, rectifiers with filter capacitor, Zener diode as Voltage Regulator.	**CO1 CO4 CO5 CO6**
V	**Operational Amplifiers**: The Ideal Op Amp, The Inverting Configuration- The closed loop gain, Effect of Finite open-loop gain, The Non-inverting Configuration - The closed loop gain, Characteristics of Non-Inverting Configuration, Effect of finite open loop gain, The voltage follower.	**CO1 CO4 CO5 CO6**

Learning Resources

Text Books

1. D.P.Kothari, I.J.Nagrath, Basic Electrical and Electronics Engineering, 1st Edition, McGraw Hill Education (India) Private Limited, 2017.
2. B.L.Theraja, Fundamentals of Electrical Engineering and Electronics, 1st Edition, S.Chand Publishing, New Delhi, 2006.
3. Millman Jacob, Halkias C Christos, Electronic Devices and Circuits, 2nd Edition, Tata Mcgrawhill Publications, 2007.

Reference Books

1. S.K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Education, 2011.
2. Dharma Raj Cheruku, B T Krishna, Electronic Devices and Circuits, 2nd Edition, Pearson Education, 2008.
3. R.K.Rajput, Basic Electrical and Electronics Engineering, University Science Press, New Delhi, 2012.

e- Resources & other digital material

1. http://202.53.81.118/course/view.php?id=122
2. https://nptel.ac.in/courses/108105112/

ENGINEERING GRAPHICS

Course Code	20ES1204	Year	I	Semester	II
Course Category	Engineering Science	Branch	ME	Course Type	Theory
Credits	3	L-T-P	1-0-4	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Construct conic sections and curves used in Engineering practice. (L3)	Apply	L3	1,2,3,4,5
CO2	Construct orthographic projections of an object when its position is defined with respect to the reference planes. (L3)	Apply	L3	1,2,
CO3	Develop the isometric view for the given orthographic projections and vice versa. (L3)	Apply	L3	3,4,5
CO4	Develop the lateral surfaces of solids. (L3)	Apply	L3	1,2,5
CO5	Identify the appropriate commands that are used to prepare the given drawing in CAD environment. (L3)	Apply	L3	3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2							2	2	2		2	2
CO2	3	3							3	3	3		3	3
CO3	2	2							2	2	2		2	2
CO4	2	2							2	2	2		2	2
CO5	2				2				2	2	2		2	2

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction to Engineering Graphics**: Principles of Engineering Graphics and their significance- Conventions in drawing, lettering, dimensioning, BIS conventions. a) **Conic sections**: Construction of ellipse, parabola and hyperbola (general method only) b) **Cycloidal curves**: Cycloid, Epicycloid and Hypocycloid **Involutes**: Involute of regular polygons and Circle.	CO1
II	**Projection of points, lines and planes:** Projection of points in different quadrants, lines inclined to one and both the reference planes, finding true length and inclination made by the line. Projections of regular plane surfaces.	CO2
III	**Projections of solids:** Projections of regular solids such as cube, prism, pyramid, cylinder and cone (Treatment limited to solids inclined to one of the reference planes). **Sections of solids**: Section planes and sectional view of right regular Solids- cube, prism, cylinder, pyramid and cone. True shape	CO2

	of the section. (Treatment limited to the solids perpendicular to one of the principal planes)	
IV	**Orthographic View**s: Systems of projections, conversion of Isometric view to orthographic view. **Isometric Projections**: Principles of Isometric projection- Isometric scale; **Isometric views**: lines, planes and solids. (Treatment is limited to simple objects only)	**CO3**
V	**Development of surfaces:** Development of lateral surfaces of right regular solids-prism, cylinder, pyramid, cone and their sectional parts. (Treatment limited to solids perpendicular to one of the principal planes)	**CO4**
	Introduction to CAD: Basic drawing, editing and dimensioning commands: line, polyline, circle, arc, polygon, ellipse, rectangle, erase, undo, redo, snap, move, copy, rotate, scale, mirror, offset, layer, trim, extend, fillet, chamfer, array, linear and angular dimension.	**CO5**

Learning Resources

Text Books

1. N.D. Bhatt, Engineering Drawing, 53/e, Charotar Publishers,2016.
2. K.L. Narayana&P.Kannaiah,EngineeringDrawing,3/e,ScitechPublishers,2012

Reference Books

1. Dhanajay A Jolhe, Engineering Drawing, Tata McGraw-Hill,2009.
2. Shah and Rana, Engineering Drawing, 2/e, Pearson Education,2009.
3. K.Venugopal,EngineeringDrawingandGraphics,6/e,NewAgePublishers,2011.
4. K.C. John, Engineering Graphics, 2/e, PHI,2013.
5. Basant Agarwal and C.M. Agarwal, Engineering Drawing, TataMcGrawHill,2008.

e- Resources & other digital material

1. http://www.youtube.com/watch?v=XCWJ XrkWco, Accessed on 01-06-2017.
2. http://www.me.umn.edu/courses/me2011/handouts/drawing/blanco-tutorial.html#isodrawing, Accessed on 01-06-2017.
3. http://www.slideshare.net, Accessed on 01-06-2017.
4. http://edpstuff.blogspot.in, Accessed on 01-06-2017.

COMMUNICATIVE ENGLISH- II LAB

Course Code	20HS1251	Year	I	Semester	II
Course Category	Humanities	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Expt. No
CO1	Hone employability skills.	Apply	L3	1-10
CO2	Develop an ability of making discussions, inferences and presentations.	Apply	L3	1-4
CO3	Refine communication skills through various strategies.	Analyze	L4	5-10
CO4	Process the information in different contexts.	Analyze	L4	5-10

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1									3	3		3		1
CO2									3	3		3		1
CO3									3	3		3		1
CO4									3	3		3		1

Syllabus

Expt. No.	Contents	Mapped CO's
1	Listening for presentation strategies and answering questions on the speaker, audience, and key points	CO1, CO2, CO4
2	Formal presentations using PPT slides (individual)	
3	Relating a reading text to a talk/presentation – understanding different perspectives and drawing inferences	CO1, CO2, CO4
4	Formal team presentations using PPT slides/audio- visual aids	
5	Identifying views and opinions expressed by different speakers while listening to discussions	CO1, CO3, CO4
6	Group discussion on general topics	
7	Processing of information using context clues while listening to talks/lectures	CO1, CO3, CO4
8	Role plays – people from various fields of work	
9	Processing of explicit information presented in the text and implicit information inferable from the text or from previous/background knowledge	CO1, CO3, CO4
10	Mock interviews for jobs/internships	

Learning Resources

Text Books

1. Prabhavathy Y, M.Lalitha Sridevi. "English all Round 2: Communication skills for Undergraduate Learners", Orient Black Swan, 2020

Reference Books

1. Chase, Becky Tarver. Pathways: Listening, Speaking and Critical Thinking. Heinley ELT; 2nd

Edition, 2018.
2. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational.
3. Hewings, Martin. Cambridge Academic English (B2). CUP, 2012

e- Resources & other digital material

Grammar/Listening/Writing:
1-language.com
http://www.5minuteenglish.com/
https://www.englishpractice.com/
Listening:
https://learningenglish.voanews.com/z/3613;
http://www.englishmedialab.com/listening.html
Speaking:
https://www.talkenglish.com/BBC; Learning English – Pronunciation tips Merriam-Webster – Perfect pronunciation Exercises
All Skills:
https://www.englishclub.com/;
http://www.world-english.org/
http://learnenglish.britishcouncil.org/
Online Dictionaries:
Cambridge dictionary online; MacMillan dictionary; Oxford learner's dictionaries

APPLIED PHYSICS LAB

Course Code	20BS1253	Year	I	Semester	II
Course Category	Basic Science	Branch	ME	Course Type	Theory
Credits	1.5	L-T-P	0-0-3	Prerequisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Expt. No
CO1	Demonstrate elastic limit and stress-strain relationship using Hooke's law.	Apply	L3	1-10
CO2	Apply resonance to estimate the frequency of a tuning fork and examine the relation between frequency and volume of a cavity.	Apply	L3	2-5
CO3	Determine the rigidity modulus, and Poisson's ratio of a material.	Apply	L3	6,7
CO4	Examine the type of semiconductor and evaluate the acceptance angle, numerical Aperture an optical fiber.	Analyze	L4	8,9
CO5	Estimate thermal conductivity of bad and good conductors.	Analyze	L4	10
CO6	Summarize and tabulate the experimental observations and output.	Analyze	L4	1-10

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			2			2					2	3	2
CO2	3			2			2					2	3	2
CO3	3			2			2					2	3	2
CO4	3			2			2					2	3	2
CO5	3			2			2					2	3	2
CO6	3			2			2					2	3	2

Syllabus

Expt. No.	Contents	Mapped CO's
1	To Verify Hooke's Law.	CO1,CO6
2	To Verify the relation between Volume of the Air in the Resonator and Frequency of note.	CO2, CO6
3	To Study Resonance in an LCR Series & parallel Circuit.	
4	To verify the laws of transverse vibrations of a string using Sonometer.	
5	To Determine the Frequency of Electrically maintained Tuning Fork by Melde's method.	
6	To Determine The Rigidity Modulus of Material (Wire) -Dynamic Method (Torsional Pendulum)	CO3, CO6
7	To Determine The Poisson's Ratio of Rubber tube.	

8	To Determine the Hall Coefficient using Hall Effect Experiment.	**CO4, CO6**
9	To Determine the Numerical Aperture of a given Optical Fibre and hence to find its Acceptance Angle.	
10	To Determine The Thermal Conductivity of A Bad Conductor By Lee's Disc Method.	**CO5, CO6**

Learning Resources
Text Books
1. RamaraoSri, Choudary Nityanand and Prasad Daruka, "Lab Manual of Engineering Physics" Vth ed., Excell Books, 2010
Reference Books
1. Prithwiraj Purkait, Budhaditya Biswas and Chiranjib Koley, Chapter 11 Sensors and Transducers, Electrical and Electronics Measurements and Instrumentation, 1/e., 2013 McGraw Hill Education (India) Private Limited, 2013
e- Resources & other digital material
1. https://nptel.ac.in/courses/115/105/115105120/ 2. https://nptel.ac.in/courses/115/107/115107095/ 3. https://nptel.ac.in/courses/115/104/115104109/ 4. http://www.physicsclassroom.com/The-Laboratory 5. https://www.vlab.co.in/broad-area-physical-sciences

BASIC ELECTRICAL & ELECTRONICS ENGINEERING LAB

Course Code	20ES1251	Year	I	Semester	II
Course Category	Engineering Science	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Expt. No
CO1	**Apply** techniques/procedures of Electrical & Electronics Engineering to solve problems.	Apply	L3	1-14
CO2	Conduct experiments as a team / individual by using equipment available in the laboratory.	Apply	L3	1-14
CO3	**Examine** the network theorems and Kirchhoff's laws for DC electrical circuits.	Analyze	L4	1-3,12
CO4	**Analyse** the open circuit characteristic of DC shunt generator and efficiency of single phase transformer.	Analyze	L4	6-10
CO5	**Analyse** the characteristics/ performance parameters of Electronic and Analog Circuits.	Analyze	L4	6-9,13
CO6	make an effective report based on experiments	Analyze	L4	1-14

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3			3										1
CO2				3	3				3				1	1
CO3		3		3									1	1
CO4		3		3									1	1
CO5		3		3									1	1
CO6				3						3			1	1

Expt. No.	Contents	Mapped CO's
	Conduct any ten experiments	
1	Verification of Kirchhoff's Laws KVL and KCL.	CO1, CO2, CO3, CO6
2	Verification of DC Superposition Theorem.	CO1, CO2, CO3, CO6
3	Verification of Thevenin's Theorem and Norton's Theorem.	CO1, CO2, CO3, CO6
4	Open circuit characteristics/magnetization characteristics of DC shunt generator.	CO1, CO2, CO4, CO6
5	OC and SC Tests on single phase transformer.	CO1, CO2, CO4, CO6
6	Voltage Current Characteristics of a p-n Junction Diode.	CO1, CO2, CO5, CO6
7	Half wave rectifier with and without filter.	CO1, CO2, CO5,CO6

8	Full wave rectifier with and without filter.	CO1,CO2, CO5,CO6
9	Voltage Regulation with Zener Diode.	CO1,CO2, CO5,CO6
10	Inverting and Non-inverting Amplifier Design with Op-amp.	CO1,CO2, CO5,CO6
11	Verification of KCL and KVL using PSPICE.	CO1,CO2, CO3,CO6
12	Verification of Network Theorems using PSPICE.	CO1,CO2, CO3,CO6
13	Diode and Transistor Circuit Analysis using PSPICE.	CO1,CO2, CO5,CO6
14	Inverting and Non-inverting Amplifier Design with Op-ampusing PSPICE.	CO1,CO2, CO5,CO6

Learning Resources

Text Books

1. D.P.Kothari, I.J.Nagrath, Basic Electrical and Electronics Engineering, 1st Edition, McGraw Hill Education (India) Private Limited, 2017.
2. B.L.Theraja, Fundamentals of Electrical Engineering and Electronics, 1st Edition, S.Chand Publishing, New Delhi, 2006.
3. Millman Jacob, Halkias C Christos, Electronic Devices and Circuits, 2nd Edition, Tata Mcgrawhill Publications, 2007.

Reference Books

1. S.K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Education, 2011.
2. Dharma Raj Cheruku, B T Krishna, Electronic Devices and Circuits, 2nd Edition, Pearson Education, 2008.
3. R.K.Rajput, Basic Electrical and Electronics Engineering, University Science Press, New Delhi, 2012.

e- Resources & other digital material

1. http://202.53.81.118/course/view.php?id=122
2. https://nptel.ac.in/courses/108105112/

COMMUNITY SERVICE PROJECT

Course Code	20ME1291	**Year**	I	**Semester**	II
Course Category	Humanities	**Branch**	ME	**Course Type**	Practical
Credits	4	**L-T-P**	0-0-0	**Prerequisites**	Nil
Continuous Internal Evaluation	100	**Semester End Evaluation**	-	**Total Marks**	100

NUMERICAL & STATISTICAL METHODS

Course Code	20BS1301	Year	II	Semester	I
Course Category	Basic Sciences	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	**Understand** the basic concepts of Numerical and statistical Methods	Understand	L2	1,2,3,4,5
CO2	**Apply** different Numerical methods to solve the problems of numerical differentiation, integration, ordinary differential equations.	Apply	L3	1,2,
CO3	**Apply** concepts of probability and random variables to real life problems.	Apply	L3	3,4,5
CO4	**Estimate** the interpolated values, approximate roots, areas and derivatives.	Analyze	L4	1,2,5
CO5	**Analyse** the data to test of hypothesis corresponding to mean, proportions for large and small samples.	Analyze	L4	3,4,5
CO6	**Apply different methods to solve** Numerical and statistical problems and submit a report.	Apply	L3	1,2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1														
CO2	3								2	2				
CO3	3								2	2				
CO4		3												
CO5		3												
CO6	3								2	2				

Syllabus

UNIT	Contents	Mapped COs
I	**Solution to Algebraic and Transcendental Equations** Solution of algebraic and transcendental equations: Bisection method, method of false position and Newton-Raphson's method. Finite differences, relation between operators, interpolation using Newton's forward and backward difference formulae. Interpolation with unequal intervals: Lagrange's formula. (All theorems/properties without proofs)	CO1, CO2, CO4, CO6
II	**Numerical Differentiation and Integration** Numerical Differentiation- Newton's forward and backward difference formulae. Numerical integration- trapezoidal rule, Simpson's $\frac{1}{3}^{rd}$ and $\frac{3}{8}^{th}$ rules. Ordinary differential equations: Euler's,	CO1, CO2, CO4, CO6

	modified Euler's, Runge-Kutta method of fourth order for solving first order equations. (All theorems/properties without proofs)	
III	**Probability** Random variables (discrete and continuous), probability density functions, probability distribution: Binomial - Poisson - normal distribution and their properties (mathematical expectation and variance). (All theorems/properties without proofs)	**CO1, CO3, CO5, CO6**
IV	**Testing of Hypothesis** Formulation of null hypothesis, critical regions, level of significance. Large sample tests: Test for single proportion, difference of proportions, test for single mean and difference of means.	**CO1, CO3, CO5, CO6**
V	**Small Sample Tests** Student's t-distribution (single mean, two means and paired t-test), Testing of equality of variances (F-test)	**CO1, CO3, CO5, CO6**

Learning Resourse(s)
Text Book(s)
1. B.S. Grewal, *Higher Engineering Mathematics*, Khanna Publishers, 44/e, 2019. 2. T.K.V.Iyenger, Krishna Gandhi and others, *Probability & Statistics*, S.Chand.
Reference Book(s)
1. Erwin Kreyszig, *Advanced Engineering Mathematics*, 9/e, John Wiley & Sons, 2006. 2. Miller and Freund's, *Probability and Statistics for Engineers* , Pearson.
e- Resources & other digital material
1. https://www.nptel.ac.in/courses/111/107/111107105/ 2. https://www.nptel.ac.in/courses/111/105/111105041/ 3. https://www.nptel.ac.in/courses/111/106/111106112/ 4. https://www.nptel.ac.in/courses/111/105/111105090/ 5.FED Moodle

MECHANICS

Course Code	20BS1305	Year	II	Semester	I
Course Category	Basic Science	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Engineering Mathematics
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the principle of laws of mechanics involved in the resultant, moment, properties of areas static and dynamic equilibrium of rigid bodies and also in the practical applications like friction and trusses.	Understand	L2	1,2,3,4,5
CO2	Apply principles of mechanics and law of equilibrium to solve for the resultant, reaction due to supports, and problems related to friction and trusses.	Apply	L3	1,2
CO3	Apply first and second moments of an area to determine centroid and moment of inertia respectively.	Apply	L3	3
CO4	Analyse the dynamics of the rigid bodies using Equation of Motion, D'Alembert's principle and Work-Energy theorem.	Analyze	L4	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2						1	1		2	3	1
CO2	3	3	2						1	1		2	3	1
CO3	3	3	2						1	1		2	3	1
CO4	3	3	2						1	1		2	3	1

Syllabus

Unit	Contents	Mapped CO
I	**Introduction**: Significance of Engineering Mechanics, Composition and resolution of forces, parallelogram law, principle of transmissibility, types of force systems - concurrent and non-concurrent, coplanar forces, resultant of coplanar force systems, couple, moment of a force, Varignon's theorem, concept of free body diagrams, concept of equilibrium of coplanar force systems.	CO1, CO2
II	**Friction:** Laws of friction, types of friction, equilibrium of force systems involving frictional forces, ladder and wedge friction **Analysis of Structures:** Introduction to plane trusses, Types of trusses, Assumptions in analysis of truss, analysis of plane trusses by method of joints.	CO1, CO2
III	**Centroid:** Centroid and centre of gravity, derivation of centroids of rectangle, triangle, circle, semi-circle from first principles, centroid of composite areas. **Moment of Inertia:** Area moment of inertia of plane and composite	CO1, CO3

	figures, parallel axis theorem, perpendicular axis theorem, polar moment of inertia.	
IV	**Kinematics:** Equations of motion for rigid bodies under constant and variable acceleration, rectilinear and curvilinear motion, Rotation of a rigid body about a fixed axis.	**CO1, CO4**
V	**Kinetics:** Principles of dynamics - Newton's Laws of motion, D'Alembert's principle in rectilinear translation, Rotation under the action of constant moment, principle of work and energy.	**CO1, CO4**

Learning Resources
Text Book(s):
1.S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati, Engineering Mechanics (in SI units), 5/e, McGraw Hill, 2013. 2. Engineering Mechanics Statics and dynamics, by A.K.Tayal, Umesh Publication, Delhi, 14e, 2010.
References:
1. Irving Shames, G.K.M. Rao, Engineering Mechanics: Statics and Dynam-ics, 4/e, Pearson, 2009. 2. K.L. Kumar, Veenu Kumar, Engineering Mechanics, 4/e, Tata McGraw Hill, 2010. 3.N.H. Dubey, Engineering Mechanics: Statics and Dynamics,TataMcGrawHill,2014
E Resources:
1. https://nptel.ac.in/courses/112/103/112103108/ 2. https://www.coursera.org/learn/engineering-mechanics-statics

MATERIAL SCIENCE AND METALLURGY

Course Code	20ES1303	Year	II	Semester	I
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Chemistry of Materials
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand crystallography, constitution of alloys, Heat treatment Processes and properties of ferrous and non-ferrous metals.	Understand	L2	1,2,3,4,5
CO2	construct the phase diagrams of materials and illustrate the concept of Strengthening Mechanisms	Apply	L3	2
CO3	interpret heat treatment and surface hardening techniques	Apply	L3	3
CO4	Appraise properties of different stainless steels, tool steels, cast irons and non-ferrous materials	Analyze	L4	4
CO5	Establish features of ferrous, non-ferrous alloys and composite materials	Analyze	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	1		2					2			3	2
CO2	2	3	1		2					2			3	2
CO3	2	2	2	1	2					2			3	2
CO4	2	2	2	1	2		1			2			3	2
CO5	2	2	2	1	2		1			2			3	2

Syllabus

Unit	Contents	Mapped CO
I	**Materials Science and Engineering**: Introduction, Classification of Materials, Mechanical Properties of Materials, Case Study: Delhi Iron Pillar and Wootz Steel. **Crystallography:** Unit cell, Classification, Bravais Lattices, packing factor and coordination number in cubic systems, Miller Indices for Cubic systems, imperfections in solids: Point, Line and Volume, Slip and Twinning. Determination of grain size.	CO1
II	**Mechanism of Crystallization:** Nuclei Formation, crystal growth **Constitution of Alloys:** Types of solid solution- substitutional and interstitial solid solutions, Hume Rothery rules for solid solution. **Phase Diagrams:** Phase, Phase equilibrium, Gibbs Phase rule – one component system, two component system, Construction of binary phase diagram, Isomorphous, eutectic, eutectoid, peritectic and peritectoid systems, Fe-Fe_3C equilibrium diagram, Lever rule: Isomorphous. **Strengthening Mechanisms:** Grain Refinement, Strain hardening, solid solution strengthening, Dispersion strengthening.	CO1 CO2

III	**Heat Treatment Processes:** stages of heat treatment, TTT and CCT diagram of eutectoid steel, Annealing: Full Annealing, Spherodizing, Stress Relief Annealing, Process Annealing, Normalizing, Hardening, Tempering, Austempering, Martempering. **Case Hardening:** Flame hardening, Induction hardening, Carburizing, Cyaniding, Nitriding.	**CO1** **CO3**
IV	**Steels:** stainless steels, Ferritic, Martensitic, Austenitic, **Tool steels:** Water Hardened, Shock Resistance, Cold-Work, Hot-Work Tool Steels, Applications and Properties. **Cast Irons:** Structure, Properties and Applications of White Cast iron, Malleable Cast iron, Grey cast iron, Spheroidal graphite cast iron.	**CO1** **CO4**
V	**Radiation Heat Transfer:** Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann. Heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.	**CO1** **CO5**

Learning Resources

Text Book(s)

1. R.Balasubramaniam, Callister's, Material Science and Engineering, 2/e, WileyIndia,2014.
2. S.H. Avner, Introduction to Physical Metallurgy, 2/e, Tata McGrawHill, 1997.

Reference Books

1. Donald R. Askeland, "Essential of Materials Science and Engineering", Thomson Learning,
   5 th Edition – 2006
2. V.D. Kodgire, "Material Science and Metallurgy", Everest Publishing House - 25th Edition – 2009.
3. B.K.Agarwal, "Introduction to Engineering Materials", Tata McGraw Hill-1stEdition.
4. V. Raghavan, "Material Science and Engineering",-PHI Learning - 5th Edition.

E Resources & other Digital Material

1. http://materials.iisc.ernet.in/~wootz/heritage/WOOTZ.htm
2. http://met.iisc.ernet.in/~rangu/text.pdf
3. https://nptel.ac.in/courses/113106032/
4. https://nptel.ac.in/courses/113107078/
5. http://vvm.org.in/study_material/ENG%20-20Indian%20Contributions%20to%20Science.pdf

BASIC THERMODYNAMICS

Course code	20ES1304	Year	II	Semester	I
Course category	Engineering Science	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	**Understand** the fundamental laws of thermodynamics, concept of reversibility, phase transformation of materials and various thermal cycles.	Understand	L2	1,2,3,4,5
CO2	**Apply** the energy conservation for closed and open cycle systems.	Apply	L3	1,2
CO3	**Apply** the directional law for various cyclic devices named as Heat Engine, Heat Pump and Refrigerator.	Apply	L3	2,3
CO4	**Analyze** availability and entropy of various perfect gas as well as phase transforming thermodynamic processes.	Analyze	L4	3,4
CO5	**Analyze** the performance of different thermodynamic cycles.	Analyze	L4	5
CO6	**Analyze** the given scenario, use appropriate techniques and write an effective report.	Analyze	L4	2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	3												3	
CO2	3	3											3	
CO3	3	3				2						2	3	
CO4	3	3											3	
CO5	3	3				2						2	3	

Syllabus

Unit	Contents	COs
I	**Introduction:** Macroscopic and microscopic viewpoints, definitions of thermodynamic terms, quasi – static process, point and path function, forms of energy, ideal gas and real gas, Zeroth law of thermodynamics. **First Law of Thermodynamics (Closed System):** Joule's experiment - first law of thermodynamics, corollaries- perpetual motion machines of first kind, First law applied to non-flow process.	CO1, CO2
II	**First Law of Thermodynamics (Open System):** First law applied to flow process, Steady flow energy equation- limitations of first law of thermodynamics**.** **Second Law of Thermodynamics**: Kelvin - Planck statement and Clausius statement and their equivalence, corollaries - perpetual motion machines of second kind - reversibility and irreversibility, cause of irreversibility	CO1, CO2, CO3, CO6
III	**Engineering Devices:** Carnot cycle, heat engine, heat pump and refrigerator, Carnot theorem, Carnot efficiency. **Entropy:** Clausius inequality -Concept of Entropy- entropy equation for different processes and systems, Maxwell relations, TdS equations.	CO1, CO3, CO4, CO6

IV	**Availability and Irreversibility**: Definition of exergy and energy, expressions for availability and irreversibility. Availability in steady flow, non-flow processes, irreversibility. **Properties of Steam and Use of Steam Tables**: Pure Substances, P-V-T surfaces, T-s and h-s diagram, Mollier chart, dryness fraction, property tables, analysis of steam undergoing various thermodynamic processes using Mollier chart– steam calorimetry.	**CO1, CO4, CO6,**
V	**Gas Power Cycles:** Otto, Diesel, Dua Combustion cycles- Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles. **Thermodynamic Cycles**: Sterling Cycle, Atkinson Cycle, Ericsson Cycle, Lenoir Cycle, Brayton Cycle – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles.	**CO1, CO5, CO6**

Learning Resource
Text books
1. P.K.Nag, Engineering Thermodynamics, 5/e, Tata McGraw Hill, 2013. **2.** Yunus A. Cengel, Michaela A. Boles, Thermodynamics, 7/e, Tata McGraw Hill, 2011.
Reference books
1. J.B.Jones and G.A.Hawkins, Introduction to Thermodynamics, 2/e, John Wiley & Sons,2012. 2. Moran, Michael J. and Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, 3/e, Wiley, 2015 3. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley, 2009 4. R.K. Rajput, S.Chand& Co., Thermal Engineering, 6/e, Laxmi publications, 2010.
e- Resources & other digital material
1. https://nptel.ac.in/courses/112/105/112105266/ 2. https://nptel.ac.in/courses/103/103/103103144/ 3. https://nptel.ac.in/courses/112/105/112105220/ 4. https://nptel.ac.in/courses/101/104/101104067/ 5. https://nptel.ac.in/courses/101/104/101104063/ 6. https://nptel.ac.in/courses/103/104/103104151/

FLUID MECHANICS AND HYDRAULIC MACHINES

Course code	20ME3301	Year	II	Semester	I
Course category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	**Understand** the concepts of fluid properties, pressure measurement by manometers.	Understand	L2	1,2,3,4,5
CO2	**Apply** conservation laws to solve fluid flow problems in engineering applications.	Apply	L3	2
CO3	**Analyze** the various flow measuring devices and estimate the force exerted by the jet on vanes.	Analyze	L4	3
CO4	**Analyze** various hydraulic turbines and pumps with working proportions and efficiencies.	Analyze	L4	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											3	2
CO2	3	3											3	3
CO3	3	3											3	3
CO4	3	3											3	3

Course Content

Unit	Contents	Mapped CO
I	**Properties of Fluids:** Properties of fluids- Density, specific weight, specific volume, specific gravity, Viscosity-Dynamic viscosity, Kinematic Viscosity-Cohesion, Adhesion, surface tension, capillarity and vapor pressure, compressibility and elasticity. **Measurement of Pressure:** Pascal's law, Manometers–Simple Manometers-Piezometer, U-tube manometer, Single column manometers, Differential manometers-U-Tube differential manometers and inverted U-Tube differential manometers.	CO1
II	**Fluid Kinematics**: Classification of flows-steady and unsteady, uniform and non-uniform, laminar and turbulent, rotational and irrational, viscous and inviscid, continuity equation, Description of fluid flow, Stream line, path line, streak lines and stream tube **Fluid Dynamics**: Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend. **Closed Conduit Flow**: Reynolds's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line.	CO1, CO2
III	**Measurement of Flow**: Pitot tube, Venturimeter and orifice meter –flow over rectangular, triangular, trapezoidal and stepped notches.	CO1, CO3

	Impact of Jets: Hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes, jet striking centrally and at tip – velocity triangles at inlet and outlet – expressions for work done and efficiency - angular momentum principle	
IV	**Hydraulic Turbines:** Classification-Pelton wheel-Reaction Turbines-Inward and Outward radial flow reaction turbines-Francis Turbine- Axial flow reaction turbine - Kaplan turbine - Draft tube Types-Theory- and efficiency of draft tube. **Performance of Hydraulic Turbines:** Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine.	**CO1, CO4**
V	**Centrifugal Pumps:** Classification, working, work done – manomertic head - losses and efficiencies specific speed- pumps in series and parallel - performance characteristic curves, NPSH. **Reciprocating Pumps:** Main parts - Classification - Discharge - Slip - Velocity and acceleration variation in suction and delivery pipes due to piston acceleration- Effect of variation of velocity on friction in suction and delivery pipes- Effect of acceleration in suction and delivery pipes on indicator diagram- Effect of friction.	

Learning Resources
Text books
1. Hydraulics and Fluid Mechanics including hydraulic machines, by P.N.Modi and S.M.Seth, Standarard book house, 2000, New Delhi. 2. K.L.Kumar / Engineering Fluid Mechanics / S chand Publications.
Reference books
1. Fluid Mechanics and Hydraulic Machines, by R.K.Bansal, Laxmi publications (P) Ltd. 2011, New Delhi. 2. Hydraulics and Fluid Mechanics and fluid machines, by S Ramamrutham, Dhanapat rai publishing company,New Delhi 3. Fluid Mechanics and Hydraulic Machines, by R.K.Rajput, S.Chand limited publications, 2008, New Delhi. 4. Fluid Mechanics and Hydraulic Machines, by Sukumar Pati, Mc Graw Hill Education Private Limited, 2014, New Delhi. 5. Fluid Flow Machines by N.S.Govinda Rao, Tata Mc Graw Hill publishing company Ltd. 6. Fluid Mechanics and Hydraulic Machines by K.R.Arora, Standard Publishers Distributors
e- Resources & other digital material
1. https://nptel.ac.in/courses/112/105/112105171/ 2. https://nptel.ac.in/courses/112/105/112105183/ 3. https://nptel.ac.in/courses/105/101/105101082/ 4. https://nptel.ac.in/courses/105/103/105103095/

DESIGN THINKING LAB

Course Code	20ES1353	Year	II	Semester	I
Course Category	Engineering Science	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	NIL
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Experiment
CO1	Understand the stages of Design Thinking Process	Understand	L2	1,2,3,4
CO2	Apply Empathy, Ideation, and Art of Pitching tools for defined problems.	Apply	L3	5,6,7,8,9,10
CO3	Take apart to solve client problems	Analyze	L4	11,12

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3			3			3			3	3	
CO2	3		3			3			3			3	3	
CO3	3		3			3			3			3	3	

Expt. No	Name of Experiment	COs
	Introduction to Design Thinking	
1	LRI Assessment An Individual activity	CO1
2	Reflection - The Marshmallow Challenge	CO1
3	Round-Robin Brainstorming - Mind Tools	CO1
4	The Wallet Challenge -Team Activity	CO1
	Ideation Tools & Exercises	
5	Exercise - Thirty circle - Story Telling	CO2
6	Exercise - Framing the Design Challenge with mind mapping	CO2
	Analysis & Drawing Inferences - User research	
7	Exercise - Persona Creation & User Research	CO2
8	Exercise - Creating Empathy maps	CO2
9	Exercise - Creating Customer Journey maps	CO2
	The art of the pitch	
10	Exercise - Make a paper prototype for user testing (mock-up model)	CO2
11	Exercise - Develop & Present a 3-Minute Pitch (Sample Pitches)	CO3
12	The Design Challenge – Testing Documentation and Pitching	CO3

Learning Resources

Text Books

1. Change by design, Tim Brown, 2009, Harper Collins
2. Engineering design, George E Dieter,4th Revised edition, 2009 McGraw Hill

Reference Books

1. Design Thinking for Strategic Innovation, Idris Mootee, 2013, John Wiley & Son
2. Design Methods: A Structured Approach for Driving Innovation in Your Organization, Vijay Kumar, First Edition, 2012, Wiley
3. Human-Centered Design Toolkit: An Open-Source Toolkit to Inspire New Solutions in the

Developing World, IDEO, Second Edition, 2011, IDEO
E-Resources & other digital Material
1. https://www.interactiondesiqn.ora/literature/topics/desiqn-thinkinq 2.https://www.interactiondesiqn.prq/literature/article/how-tq-<eve'opanempath\capproach-in-design-thinking

COMPUTER AIDED MACHINE DRAWING PRACTICE LAB

Course Code	20ES1354	Year	II	Semester	I
Course Category	Engineering Science	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	Engineering Graphics
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Experiment Section
CO1	**Apply** the principles of engineering drawing to draw the machine components as per Indian Standard Code of practice using drafting software.	Apply	L3	A
CO2	**Develop** assembly drawings from part drawings using Modelling software.	Develop	L3	B

Contribution of Course outcomes towards achievement of programme outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		1		3					3			3	1
CO2	1		1		3					3			3	1

Syllabus

Section	Course Content	COs
A	**The following contents are to be done by any 2D software package** **Conventional representation of materials and machine components:** **Detachable joint:** Thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut. **Riveted joints**: Types of rivet heads, single riveted and double riveted lap joints, butt joint with single riveted, double riveted, single strap and double strap joints. **Keys:** Sunk key, round key, saddle key, woodruff key. **Cotter Joints:** Cotter joint with Socket and spigot ends, Knuckle Joint. **Shaft coupling**: bushed pin-type flanged coupling, Oldham's coupling.	**CO1**
B	**The following tasks to be done by any 3D software package** Solid modeling of machine components and their assembly. (Any two of the following) Screw jack, Stuffing box, Single tool post, Universal coupling.	**CO2**

Learning Resources

Text Books

1. Machine Drawing by K.L.Narayan, P.Kannaiah and K.Venkata Reddy, 5th edition, New Age Publications 2016.
2. Machine Drawing with Auto CAD, 1st edition, Gowtham Pohit and Goutam Ghosh, Pearson Education, Delhi, 2004.

Reference Books

1. Machine Drawing, by R.K.Dhawan, S. Chand Publications, New Delhi, 2016.
2. Text Book of Machine Drawing by K.C.John, PHI Learning Pvt.Ltd., New Delhi, 2010.

FLUID MECHANICS HYDRAULIC MACHINES LAB

Course Code	20ME3351	Year	II	Semester	I
Course Category	Professional Core	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Pre-requisites	NIL
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Experiment
CO1	**Apply** the knowledge to estimate losses in pipes and coefficient discharge of various flow measuring devices	Apply	L3	1,2,3,4,5
CO2	**Apply** the knowledge to estimate the coefficient of the impact of jet on vanes.	Apply	L3	6
CO3	**Analyze** Bernoulli's theorem.	Analyze	L4	7
CO4	**Evaluate** the performance of pumps and turbines.	Evaluate	L5	8,9,10,11,12

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3											3	3
CO2	3	3											3	3
CO3	3	3											3	3
CO4	3	3											3	3

Course Content

Expt No	Experiment	COs
1	Determination of loss of head due to the sudden contraction in a pipeline.	CO1
2	Determination of friction factor for a given pipeline.	CO1
3	Determination of coefficient of discharge of Triangular Notch	CO1
4	Determination of coefficient of discharge of Venturimeter.	CO1
5	Determination of coefficient of discharge of Orifice meter.	CO1
6	Determination of coefficient of Impact of jets on Stationary Vanes.	CO2
7	Verification of Bernoulli's equitation.	CO3
8	Performance Test on Single Stage Centrifugal Pump.	CO4
9	Performance Test on Multi Stage Centrifugal Pump.	CO4
10	Performance Test on Pelton Wheel.	CO4
11	Performance Test on Kaplan Turbine.	CO4
12	Performance Test on Francis Turbine.	CO4

Learning Resources

Text books

1. K.L.Kumar."Engineering Fluid Mechanics" Experiments, Eurasia Publishing House, 1997
2. Jagdish Lal, Hydraulic Machines, Metropolitan Book Co, Delhi, 1995

Reference books

1. Hydraulics and Fluid Mechanics, by P.N.Modi and S.M.Seth, Standarard book house, 2000, New Delhi.
2. Fluid Mechanics and Hydraulic Machines, by Sukumar Pati, Mc Graw Hill Education Private Limited, 2014, New Delhi.

DRAFTING AND MODELLING LAB

Course Code	20SO8353	Year	II	Semester	I
Course Category	Skill oriented course	Branch	ME	Course Type	Lab
Credits	2	L-T-P	1-0-2	Prerequisites	NIL
Continuous Internal Evaluation	0	Semester End Evaluation	50	Total Marks:	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Module
CO1	**Develop** 2D & 3D models.	Develop	L3	Sketcher, Part Design
CO2	**Prepare** 3D assembly from the part models.	Prepare	L3	Assembly

Syllabus		
Module	**Contents**	**COs**
SKETCHER	**The following tasks to be done by 3D software package - CATIA** : Introduction to CATIA Software, Workbench Introduction, Types of Sketches, Creating profiles, Practice of Profile tool bar with 3 to 4 Basic sketches. Sketcher constraints, sketcher operations, Practice 5 sketches with different Constraints. Transformation of profiles, Projection from 3D elements, Practice of transform tools with suitable sketches. Sketch analysis, Sketch modifications, Create 5 to 10 Sketches with Iso Constrain.	CO1
PART DESIGN	Workbench Introduction, Reference Elements, Practice of types of point, line and planes, Basic Solid Features, Practice of basic 2D to 3D parts, Advanced Solid Features, Practice of Ribs, Slots & Multi-sections. Dress up features, Practice of Fillets, chamfers, shell, Advanced Dress up features, Practice of Draft and other features. Transformation of solids, Practice of Pattern, mirror & Scaling. Introduction to Body concept, Explain the needs of Body concepts, Boolean operations, Practice 3D models using Booleans, Editing solid geometry, Editing & replacing of Bodies, sketches.	
ASSEMBLY	Introduction to Workbench, Importing of Parts & Products, Practice of Product structure tools with basic Assembly. Assembly Constraints, Practice of various Constraints tools. Types of Assembly – approach, Top Down Assembly, Creating 2 to 3 assemblies with top down approach. Bottom Up Assembly, Creating assemblies by importing parts.	CO2

Learning Resources
Text books
1. Machine Drawing by K.L.Narayan, P.Kannaiah and K.Venkata Reddy, 5th edition, New Age Publications 2016.
Reference books
1. Machine Drawing, by R.K.Dhawan, S. Chand Publications, New Delhi, 2016. 2. Text Book of Machine Drawing by K.C.John, PHI Learning Pvt.Ltd., New Delhi, 2010.

NSS/NCC

Course Code	20MC1341A/ 20MC1341B	**Year**	II	**Semester**	I
Course Category	Mandatory	**Branch**	ME	**Course Type**	Practical
Credits	-	**L-T-P**	0-0-2	**Prerequisites**	Nil
Continuous Internal Evaluation	-	**Semester End Evaluation**	-	**Total Marks**	-

KINEMATICS OF MACHINERY

Course Code	20ME3401	Year	II	Semester	II
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Mechanics
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the kinematic link, different types of kinematic pairs, mechanisms and their inversions, velocity, and acceleration of the mechanism, straight-line motion, steering mechanism, and the terminology related to cam, followers, gear, and gear trains	Understand	L2	1,2,3,4,5
CO2	Apply graphical and Instantaneous center methods for determining the velocity and acceleration of different mechanisms.	Apply	L3	2
CO3	Analyze the straight-line motion mechanisms, steering gear mechanisms, and velocity ratio of hook joints	Analyze	L4	3
CO4	Analyze the cam-follower mechanism for different motions of followers and generate cam profiles.	Analyze	L4	4
CO5	Analyze the gear and gear trains	Analyze	L4	5

Contribution of Course outcomes towards achievement of programme outcomes & Strength of correlations (High : 3, Medium :2, Low :1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO-1	PSO-2
CO1	3												3	
CO2	3	3	2		2					1			3	
CO3	3												3	
CO4	3	2	2		2					1			3	
CO5	3	2	2		2					1			3	

Syllabus

Unit	Contents	COs
I	**Introduction**: 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. **Machines**: Mechanism and machines – classification of mechanisms – kinematic chain – inversion of mechanism – inversions of quadric cycle chain – single and double slider crank chains.	CO1
II	**Kinematics**: Velocity – Motion of link in machine – Determination of Velocity diagrams – Graphical method –	CO1, CO2

	Application of relative velocity method four bar chain. Analysis of slider crank chain for displacement, velocity. **Acceleration Analysis**: Angular acceleration of Links, Acceleration of Intermediate and offset points- Four Link Mechanism- Slider Crank Mechanism, Corrilies component of acceleration. **Plane Motion of Body**: Instantaneous center of rotation, Three centres in line theorem – Graphical determination of instantaneous centre for Four Bar Mechanism.	
III	**Straight Line Motion Mechanisms**: Exact and approximate copiers and generated types –Peaucellier, Hart and Scott Russul – Grasshopper – Watt T. Chebicheff and Robert Mechanisms and Straight-line motion, Pantograph. **Steering Mechanisms**: Conditions for correct steering – Davis Steering gear, Ackermans steering gear. HOOKE'S JOINT: Single and double Hooke's joint – velocity ratio –application – simple problems.	**CO1, CO3**
IV	**Cams:** Definitions of cam and followers – their uses – Types of followers and cams – Terminology – Types of follower motion - Uniform velocity – Simple harmonic motion and uniform acceleration. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases.	**CO1, CO4**
V	**Gears**: Introduction, Classification of gear terminology, Law of Gearing, Velocity of Sliding, Forms of Teeth, Cycloidal Profile Teeth, Involute Profile Teeth, Path of contact, Arc of contact, Number of pairs of Teeth in contact, Interference in Involute Gears. **Gear trains**: Introduction, simple Gear Train, Compound Gear Train, Reverted Gear train, Planetary or Epicyclic Gear Train, Analysis of Epicyclic Gear Train, Torques in Epicyclic Trains. Tabular Method.	**CO1, CO4**

Learning Resources

Text Book(s)

1. Theory of Machines, (3rd Edition) by S.S.Rattan, Tata Mc-Graw Hill, New Delhi, 2012.
2. Theory of machine and Mechanisms, 2nd Edition by J.E. Shigley, Mc-Graw Hill, New Delhi, 1994.

References

1. Theory of Mechanisms and Machines, (I st Edition) by C S Sharma and Kamlesh Purohit, Prentice Hall of India Pvt. Ltd., New Delhi, 2006.
2. Theory of Machines, (3rd edition), by Ballaney, P.L, Khanna Publishers, New Delhi 2002.
3. Theory of Mechanisms and Machines, (2 nd Edition), by A. Ghosh and ak Mallik, East-West Press (P) Ltd., New Delhi, 1988.

E Resources

1. https://nptel.ac.in/courses/112/104/112104121/

STRENGTH OF MATERIALS

Course Code	20ME3402	**Year**	II	**Semester**	II
Course Category	Professional Core	**Branch**	ME	**Course Type**	Theory
Credits	3	**L-T-P**	3-0-0	**Prerequisites**	Mechanics
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

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

CO	**Statement**	**Skill**	**BTL**	**Units**
CO1	Understand the basic concepts of the stresses and strains for different materials and strength of structural elements.	L2	Understand	1,2,3,4,5
CO2	Apply the principles to determine the resistance and deformation in machine members subjected to axial, flexural and torsional loads.	L3	Apply	1,3,4,5
CO3	Analyze the basic mechanical principles underlying modern approaches for design of various types of structural members subjected to axial load, torsion, bending, transverse shear,	L4	Analyze	1,2,3,4,5
CO4	Analyze principal stresses, strains and buckling stresses for design.	L4	Analyze	4,5

Contribution of Course outcomes towards achievement of programme outcomes & Strength of correlations (High:3, Medium: 2, Low:1)														
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2				2			1		2	3	2
CO2	3	3	2				2			1		2	3	2
CO3	3	3	2				2			1		2	3	2
CO4	3	3	2				2			1		2	3	2

Syllabus		
Unit	**Contents**	**COs**
I	**Simple Stresses and Strains**: Types of stresses and strains - Hooke's law, stress- strain diagrams - Axially loaded bars of uniform and varying cross section, Compound bars, Relation between elastic moduli, Thermal stresses. **Torsion:** Torsion, Torsion Equation – Solid and Hollow circular shaft, Torsional rigidity, Power transmitted by shaft.	**CO1, CO2, CO3**
II	**Shear Force and Bending Moment Diagrams:** Types of beams and loads, Shear force and bending moment diagram for cantilever, simply supported and overhanging beams subjected to Point load, Moments and UDL, Point of contraflexure, Relation between load, shearing force and bending moment.	**CO1, CO3**
III	**Bending stresses in beams:** Introduction, pure or simple bending, distribution of bending stresses in symmetrical sections, section modulus, Strength of a section. **Shear stresses in beams:** Shear Stress at a section, Shear Stresses distribution in symmetrical sections.	**CO1, CO2, CO3**

IV	**Deflection of Beams**: Differential equations of the deflection curve, Slope and deflection of Cantilever beam, simply supported beam and overhanging beam using double integration method, Macaulay's method and Moment area method. **Thin Cylinders:** Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and Volumetric strains – changes in dia, and volume of thin cylinders.	**CO1, CO2, CO3, CO4**
V	**Complex stresses:** Stresses on inclined Sections, Plane Stress, Principal Stresses and Maximum Shear Stress. Mohr's Circle for Plane Stress. **Columns and Struts:** Buckling and stability of column, crippling load of columns with pinned ends, fixed-free, fixed –fixed and fixed-pinned, effective length of column ,limitations of Euler's formula.	**CO1, CO2, CO3, CO4**

Learning Resources

Text Book(s)

1. Stephen P. Timoshenko, James M. Gere "Mechanics of Materials", 2nd edition, C B S Publishers, 2011.
2. S.S. Rattan, "Strength of Materials", 2nd edition, Tata Mc-Graw Hill Private Limited, New Delhi, 2012.

References

1. James M. Gere, "Mechanics of Materials", 7th edition, Cengage learning India, 2010.
2. AdarshSwaroop, "Mechanics of Materials" 1st edition, New Age International Pvt. Ltd, 2012.
3. Popov, Mechanics of Solids, 2/e, New Pearson Education,2015.
4. B. Raghu Kumar, Strength of Materials, B S Publications.

APPLIED THERMODYNAMICS

Course code	20ME3403	Year	II	Semester	II
Course category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Basic Thermodynamics
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

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

CO	Statement	Skill	BTL	Units
CO1	**Understand** the basic concepts of IC engines, steam, gas power cycles and their components.	Understand	L2	1,2,3,4,5
CO2	**Apply** thermodynamic principles to calculate the engine performance**.**	Apply	L3	1,2
CO3	**Apply** steam cycles for performance calculation of steam power plant.	Apply	L3	3
CO4	**Analyse** the performance of steam nozzles, condensers and gas power cycles.	Analyze	L4	4, 5

Contribution of Course outcomes towards achievement of programme outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2					2						3	
CO2	3	2					2						3	
CO3	3	2					2						3	2
CO4	3	2					2						3	2

Syllabus

Unit	Contents	COs
I	**IC Engines:** Working and classification of IC engines, comparison of two stroke and four stroke engines, comparison of SI and CI Engines. **Testing and Performance of IC Engines:** Methods of testing IC Engines, performance analysis of IC Engines.	CO1, CO2
II	**Combustion in IC Engines: SI engine**: stages of combustion, normal combustion, abnormal combustion, variables affecting delay period and knocking, pre-ignition. S**tages of combustion in CI engine**: normal combustion, abnormal combustion, variables affecting delay period and knocking. Fuel requirements and fuel rating of SI and CI engines.	CO1, CO2
III	**Vapour Power Cycles:** Vapour power cycle, simple Rankine cycle, mean temp of heat addition thermodynamic variables affecting efficiency and output of Rankine cycle. **Methods to improve thermal efficiency of Rankine cycle:** Reheating, Regeneration, Factors affecting Rankine cycle, Adiabatic flame temperature.	CO1, CO3
IV	**Steam Nozzles**: Function of a nozzle – applications – types- velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity	CO1, CO4

	coefficient, condition for maximum discharge, critical pressure ratio. **Steam Condensers:** Requirements of steam condensing plant – classification of condensers – working principle of different types – vacuum efficiency and condenser efficiency.	
V	**Gas power Cycle:** Brayton cycle, Simple gas turbine plant, closed cycle and open cycle for gas turbines, condition for maximum pressure ratio and optimum pressure ratio, actual cycle, methods to improve the performance of the cycle- Inter cooling, reheating and regeneration.	**CO1, CO4**

Learning Resource
Text books:
1 Ganesan V/ Internal Combustion Engines / Tata McGraw Hill, 2017. 2 V.P.Vasandani and D.S.Kumar / Treatise on Heat Engineering / Metropoliton book Co. Pvt. Ltd. 3 Mahesh M Rathore, Thermal Engineering, McGraw Hill Publications - 2012.
Reference books
1 Cengal Y.A and Boles M.A,Thermodynamics: AnEngineeringApproach, 5/e, McGraw-Hill, 2006. 2 Yahya,S.M.,Turbines,CompressorsandFans,4/e,TataMcGrawHill,2010. 3 Nag P.K, Engineering Thermodynamics, 4/e, Tata McGraw-Hill, 2008. 4 Onkar Singh, Thermal Turbomachines, 3/e, Wiley India, 2014. 5 P.L.Ballaney, Thermal Engineering, 2/e, Khanna, 2005.

MANUFACTURING PROCESSES

Course code	20ME3404	Year	II	Semester	II
Course category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Material Science and Metallurgy
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

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

CO	Statement	Skill	BTL	Units
CO1	**Understand** the basic principles of manufacturing processes and non-destructive testing methods.	Understand	L2	1,2,3,4,5
CO2	**Apply** various casting, forming and metal joining processes with advantages, limitations, defects and applications.	Apply	L3	1,2,3
CO3	**Apply** suitable Non-destructive testing method to determine the defects in the given product.	Apply	L3	4
CO4	**Apply** the methods of manufacturing plastics, ceramics and powder metallurgy products.	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes (High :3, Medium :2, Low :1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2						2			3	2
CO2	3	3	2	2						2			3	2
CO3	3	3		2	2					2			3	2
CO4	3	3	2	2						2			3	2

Syllabus		
Unit	Contents	COs
I	**Introduction:** Importance and selection of manufacturing processes. **Casting Processes:** Introduction to casting, steps in casting process. **Pattern**: Types, materials and allowance. **Sand Molding**: Basic steps in mold preparation, materials used for mould, types of molds, cores. Principles and design of gating system. **Methods of Melting:** Crucible melting and cupola operation. **Special casting processes**: Shell casting, Investment casting, Die casting, Centrifugal casting, CO_2 Molding. Casting defects and remedies. Advantages and applications of casting.	**CO1, CO2**
II	**Metal Forming**: Introduction, hot and cold working of metals; **Rolling**: Principle, types of rolling mill and products, roll passes, forces in rolling and power requirements. **Extrusion**: Basic extrusion processes and its characteristics, wire drawing, tube drawing. **Forging**: Principle of forging. Tools and dies used in forging. **Types**: Smith forging, drop forging and rotary forging, forging defects. **Sheet metal forming**: Introduction, Blanking, Piercing, Bending, Stamping, Coining, Spinning and Stretch Forming. Clearance and shear as applied to Punching/Blanking operations.	**CO1, CO2**

III	**Metal Joining Processes:** Classification of welding processes, types of welds and welded joints, V-I characteristics, Arc Welding, Submerged Arc Welding, Gas Tungsten Arc Welding, Gas Metal Arc Welding, Electron Beam Welding, Laser Welding, Forge welding, Resistance welding, Friction welding, Explosive welding, Thermit welding and Plasma Arc welding. Heat affected zone in welding. **Welding defects**: causes and remedies. Soldering and brazing. Adhesive Bonding.	**CO1, CO2**
IV	**Non Destructive Testing:** Introduction to Non Destructive Testing, Industrial applications of Non destructive evaluation, Visual Optical testing, Dye penetrant testing, Magnetic particle testing, Eddy current testing, Ultrasonic testing, Acoustic emission testing, Radiography, Comparison and selection of NDT methods.	**CO1, CO3**
V	**Plastic Processing, Ceramics and Powder Metallurgy**: **Plastics**: Introduction to polymers, Processing of plastics, extrusion of plastics, transfer moulding, compression moulding, injection moulding, thermoforming, rotational moulding and blow moulding. **Ceramics**: Ceramic powder preparation; **Processing of ceramic parts**: Pressing, Casting, Sintering; **Secondary processing of** ceramics: Coatings and finishing. **Powder Metallurgy**: Manufacture of powders, steps involved in making a component using powder metallurgy.	**CO1, CO4**

Learning Resource

Text books:

1. P.N.Rao, Manufacturing Technology – Volume I, 5/e, McGraw-Hill Education, 2018.
2. S.Kalpakjain and S.R.Schmid, Manufacturing Engineering and Technology, 7/e, Pearson, 2018.
3. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

Reference books

1. Mikell. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes and Systems, 4/e, John Wiley and Sons Inc, 2013.
2. P.C.Sharma, A Text book of Production Technology, 8/e, S Chand Publishing, 2014.

E-Resources & other digital Material:

1. https://nptel.ac.in/courses/112107145/
2. https://www.nde-ed.org
3. https://nptel.ac.in/courses/113/106/113106070/

ENGINEERING ECONOMICS AND MANAGEMENT

Course Code	20ME3405	Year	II	Semester	II
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

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

CO	Statement	Skill	BTL	Units
CO1	Understand basics of managerial economics, Demand & demand forecasting, Industrial organization financial management, Depreciation Capital and capital budgeting, and Management.	Understand	L2	1,2,3,4,5
CO2	Apply the managerial economics, Demand & demand forecasting, Industrial organization in present scenario.	Apply	L3	1,2
CO3	Apply Business Cycles and Management tools in post-liberalization scenario	Analyze	L4	2,5
CO4	Analyze the Methods of evaluating alternatives in Financial Accounting and Capital Budgeting and depreciation	Analyze, communication	L4	3,4

Course outcomes towards achievement of programme outcomes &Strength of correlations (High :3, Medium :2, Low :1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					3		3			3		1	3
CO2	3					3		3			3		1	3
CO3	3					3		3			3		1	3
CO4	3					3		3			3		1	3

Syllabus

Unit	Contents	COs
I	**INTRODUCTION TO MANAGERIAL ECONOMICS**: Introduction to Managerial Economics & Demand Analysis: Definition of Managerial Economics, Characteristics and Scope – Managerial Economics and its relation with other subjects- Basic economic tools in Managerial Economics. Demand Analysis: Meaning- Demand distinctions- Demand determinants- Law of Demand and its exceptions. **ELASTICITY OF DEMAND & DEMAND FORECASTING**: Definition -Types of Elasticity of demand - Measurement of price elasticity of demand: Total outlay method, Point method and Arc method- Significance of Elasticity of Demand. **Demand Forecasting**: Meaning - Factors governing demand forecasting - Methods of demand forecasting (survey of buyers' Intentions, Delphi method, Collective opinion, Analysis of Time series and Trend projections, Economic Indicators, Controlled experiments and Judgmental approach) - Forecasting demand for new products- Criteria of a good forecasting method.	CO1 CO2

II	**TYPES OF INDUSTRIAL ORGANIZATION & INTRODUCTION TO BUSINESS CYCLES**: Characteristic features of Industrial organization, Features and evaluation of Sole Proprietorship, Partnership, Joint Stock Company, State/Public Enterprises and their types. Changing business environment in post-liberalization scenario.	**CO1 CO2 CO3**
III	**FINANCIAL MANAGEMENT AND INTRODUCTION TO FINANCIAL ACCOUNTING**: Functions of financial management, simple and compound interest, Methods of evaluating alternatives-Present Worth method. Future worth Method, Annual equivalent method. Introduction to double entry system (theory).	**CO1 CO4**
IV	**DEPRECIATION**: Introduction, common methods of depreciation: straight line method, Declining balance method, sum of year's digits method. **CAPITAL AND CAPITAL BUDGETING**: Meaning of capital budgeting, Need for capital budgeting – Capital budgeting decisions (Examples of capital budgeting) - Methods of Capital Budgeting: Payback Method, Accounting Rate of Return (ARR), IRR and Net Present Value Method (simple problems)	**CO1 CO4**
V	**MANAGEMENT:** Importance of management, definition of management, process of management, Functions of management, Management- science or art, Leadership: Difference between a leader and a manager, characteristics of a leader, types of leadership.	**CO1 CO3**

Learning Resources

Text Books

1. Engineering Economics, R. Panneerselvam,2nd Edition, PHI Learning Pvt. Ltd., 2013
2. Managerial Economics and Financial Analysis, by J.V.Prabhakar Rao, Maruthi Publications, 2011
3. Management, Koontz, H and Wihrich.H McGraw, New York, 10th Edition, 1995.
4. Principles of Management, Ramasamy.T Himalaya Publishing House, New Delhi, 2000.

Reference Books

1. Managerial Economics and Financial Analysis, by A R Aryasri, TMH 2011
2. Management-Aglobal entrepreneurial Perspective, Weihrich, Cannice, Koontz, 13th Edition, Tata McGraw Hill.2012.
3. Financial Accountings Maheswari,SK Maheswari, Vikas Publishing House Pvt Ltd., NewDelhi, 4th Edition,2006.
4. Entrepreneurship Narayana Reddy, Cengage learning, New Delhi, 2010
5. Entrepreneurship, Rajeev Roy, Oxford University Press, New Delhi, 2010
6. Projects, Prasanna Chandra, Tata McGraw-Hill Education, 2009.

E-Resources & other digital Material

1. www.tectime.com
2. www.exinfm.com
3. www.economywatch.com
4. https://nptel.ac.in/courses/110/101/110101149/
5. 5.https://nptel.ac.in/courses/109/107/109107119/

FUELS AND IC ENGINES LAB

Course code	20ME3451	Year	II	Semester	II
Course category	Professional Core	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	-
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course outcomes: At the end of the course, the student will be able to				
CO's	**Statement**	**Skill**	**BTL**	**Experiments**
CO1	**Analyze** the calorific values among different types of solid, liquid**,** and gaseous fuels.	Analyze	L3	E_1 To E_2
CO2	**Analyze** the components of Disassembly and assembly of the engine.	Analyze	L3	E_3
CO3	**Estimate** the residue percentage of **a** given fuel.	Estimate	L4	E_4
CO4	**Evaluate** the performance of the reciprocating air compressor.	Evaluate	L5	E_5
CO5	**Evaluate** the performance of different types of petrol engines and diesel engines.	Evaluate	L5	E_6To E_{12}

Course outcomes towards achievement of programme outcomes &Strength of correlations (High :3, Medium :2, Low :1)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2		2									3	3
CO2	3	2		2									3	3
CO3	3	2		2									3	3
CO4	3	2		2									3	3
CO5	3	2		2									3	3

Expt.	**contents**	**Mapped CO**
E1	Junker's gas calorimeter.	**CO 1**
E2	Bomb calorimeter	
E3	Assembly and disassembly of diesel and petrol engines	**CO 2**
E4	Canradson's carbon residue tester.	**CO 3**
E5	Performance of two stage reciprocating air compressor.	**CO4**
E6	Valve timing diagram of 4-stroke diesel engine	**CO5**
E7	Port timing diagram of 2-stroke petrol engine.	
E8	Performance of 4-stroke single cylinder diesel engine.	
E9	I.C. Engines Air/Fuel Ratio and Volumetric Efficiency.	
E10	I.C. Engines Heat Balance	
E11	Morse test on multi cylinder petrol engine	
E12	Retardation test	

MANUFACTURING PROCESS LAB

Course code	20ME3452	Year	II	Semester	II
Course category	Professional Core	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	-
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

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

CO's	Statement	Skill	BTL	Experiments
CO1	Demonstrate various processes used for casting, joining, sheetmetal and plastic processing.	Apply	L3	E_1 To E_{14}
CO2	Fabricate weldments using arc, gas, resistance and TIG welding.	Analyze	L4	E_1 To E_5
CO3	Analyze the properties of moulding sands, prepare pattern and mould cavity using sand casting.	Estimate	L4	E_6 To E_9
CO4	Experiment formability studies on sheet metal	Evaluate	L4	E_{10} , E_{11}
CO5	Analyse different moulding methods of manufacturing plasticscomponents.	Evaluate	L4	E_{11}To E_{14}

Course outcomes towards achievement of programme outcomes &Strength of correlations (High :3, Medium :2, Low :1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		2					3	3		2	3	3
CO2	3	2	2	2					3	3		2	3	3
CO3	3	2	2	2					3	3		2	3	3
CO4	3	2	2	2					3	3		2	3	3
CO5	3	2	2	2					3	3		2	3	3

Contents	Mapped CO
1. Fabricate the butt joint on the given work pieces using metal arc welding. 2. Fabricate the Lap joint on the given work pieces using metal arc welding. 3. Fabricate butt joint on the given work pieces using gas welding. 4. Fabricate butt joint on the given work pieces using TIG welding. 5. Join metal plates on the given work pieces using resistance spot welding.	**CO1, CO2**
6. Determine the grain fineness number of the given moulding sand. 7. Preparation of Pattern for sand casting of at least two products (i) Single Piece (ii) Split Piece 8. Preparation of mould cavity on sand casting using single and split piece pattern.	**CO1, CO3**
9. Perform formability studies on sheet metals. (i) Blanking and Piercing (ii) Bending	**CO1, CO4**
10. Develop plastic components using (i) Injection Moulding (Any Two Products)(ii) Blow Moulding.	**CO1, CO5**

MATERIAL TESTING AND CHARACTERIZATION LAB

Course code	20ME3453	Year	II	Semester	II
Course category	Professional Core	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	-
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

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

CO's	Statement	Skill	BTL	Experiments
CO1	Apply methods to determine Mechanical propertiesand Elastic Constants.	Apply	L3	Material Testing
CO2	Identify the microstructures of different ferrous andnon-ferrous metals.	Analyze	L3	Characterization
CO3	Appraise the students with the use of testing machines.	Analyze	L4	Material Testing
CO4	Discuss the effect of cold working, heat treatment, and cooling rates on the properties of steels.	Analyze	L4	Characterization

Course outcomes towards achievement of programme outcomes &Strength of correlations (High :3, Medium :2, Low :1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		1		3					3			3	1
CO2	1	2	3	3	3	2	3			3			3	1
CO3	1		1		3					3			3	1
CO4	1	2	3	3	2	2	3			3			3	1

Contents	Mapped CO
1. Determination of Tensile strength, percentage elongation and percentage reduction in area of the given Ferrous and non-Ferrous materials. 2. Determination of Young's modulus of given beam material (Deflection Teston beams). 3. Determination of modulus of rigidity of circular rod (Torsion Test). 4. Determination of Modulus of Rigidity of given Helical spring. 5. Determination of Hardness Number for given material. 6. Determination of impact strength of given material.	CO1, CO3
Out of the Ten Experiments ANY Six are to be performed 1. Preparation and study of microstructure of Iron, hypoeutectoid, eutectoidand hypereutectoid steels. 2. Study of microstructure of Cast Iron samples viz. Ductile, Malleable,Grey, White Cast Irons. 3. Preparation and study of microstructure of Aluminum and its alloy. 4. Study of microstructure of Copper and its alloy. 5. Study and quantification of micro phases in welded samples. 6. Study of microstructure of various treated and untreated steels. 7.Study of microstructure of 18/8 steel.	CO2, CO4

8. Hardness of various treated and untreated steels. 9. Hardenability of Steels by Jominy end Quench test. Comparison between annealing and normalizing of cold worked mild steel	

AI TOOLS LAB

Course code	20SO8453	Year	II	Semester	II
Course category	Skill Oriented Course	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	1-0-2	Prerequisites	Probability, Statistics
Continuous Internal Evaluation	-	Semester End Evaluation	50	Total Marks	50

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

CO's	Statement	Skill	BTL	Experiments
CO1	**Apply** various preprocessing techniques and Machine Learning/ Deep Learning methods on different datasets for a given problem.	Apply	L3	E1-E7
CO2	**Implement** various experiments in Jupiter Notebook Environment.	Apply	L3	E1-E7
CO3	**Develop** an effective report based on various learning methods implemented.	Apply	L3	E1-E7
CO4	**Apply** technical knowledge for a given scenario and express with an effective oral communication.	Apply	L3	E1-E7
CO5	**Analyze** the outputs and visualizations generated for different datasets.	Analyse	L4	E1-E7

Course outcomes towards achievement of programme outcomes &Strength of correlations (High :3, Medium :2, Low :1)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											2	1	
CO2					2				2			1	1	
CO3										2			2	
CO4	3									1			1	
CO5	3									1			1	

Any Ten Experiments (H/W or Simulation)		
Expt. No.	Contents	Mapped CO
1.	**Apply** Data pre-processing techniques.	CO1-CO5
2.	**Construct** a Machine Learning model using supervised learning method.	CO1-CO5
3.	**Construct** a Machine Learning model using Unsupervised learning method.	CO1-CO5
4.	**Construct** a Machine Learning model using Semi supervised learning method.	CO1-CO5
5.	**Develop** a Deep Learning model using supervised learning method.	CO1-CO5
6.	**Develop** a Deep Learning model using Unsupervised learning method.	CO1-CO5
7.	**Build** an AI application.	CO1-CO5

Learning Resources
Text Books
1. Artificial Intelligence: A Modern Approach, Stuart Russell and Norvig, Third Edition, 2015, **2.** Pearson Education. **3.** Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, 2012, MIT Press **4.** Deep Learning (Adaptive Computation and Machine Learning series), Ian Goodfellow , Yoshua Bengio, Aaron Courville, Francis Bach, 2017, MIT Press
e-Resources & other digital material
1. https://github.com/atinesh-s/Coursera-Machine-Learning-Stanford **2.** https://github.com/Kulbear/deep-learning-coursera

ENVIRONMENTAL SCIENCES

Course Code	20MC1402	Year	II	Semester	II
Course Category	Mandatory	Branch	ME	Course Type	Theory
Credits	0	L-T-P	2-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Apply advanced solutions to measure the threats and hazards in environment to link with human natural systems.	Apply	L3	1,2
CO2	Analyze the ethical, cultural and historical interactions between man and environment.	Analyze	L4	1, 2
CO3	Analyze various environmental assets and record for better management	Apply	L4	3
CO4	Analyze global issues to design and evaluate policies.	Apply	L4	4,5
CO5	Apply system concepts to methodological social and environmental issues.	Analyze	L3	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2						2							
CO2		2					3							
CO3		3					3							
CO4		2					3							
CO5	2						2							

Syllabus

Unit	Contents	Mapped CO's
I	**INTRODUCTION TO ENVIRONMENT AND NATURAL RESOURCES** Introduction to environment: Definition scope importance need for public awareness. Natural resources: Renewable and non renewable resources, natural resources and associated problems. Forest resources: Uses, Reasons for over-exploitation, deforestation effects case studies. Water resources: Use and over – utilization of surface and ground water, floods, drought, conflicts over water, dams- benefits and problems. Mineral resources: Uses, environmental effects of extracting and using mineral resources, case studies. Food resources: World food problems, Impacts of overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. Energy resources: Growing energy needs, use of renewable and non renewable energy sources, case studies	CO1,CO2
II	**ECOSYSTEMS AND BIODIVERSITY** Structure components of ecosystem: Biotic and Abiotic components. Functional components of an ecosystem: Food chains, Food webs,	CO1 CO2

	Ecological pyramids, Energy flow in the ecosystem, Ecological succession. Biogeochemical cycle: Nitrogen, carbon, Phosphorus cycle. Biodiversity: Definition, Levels of biodiversity: genetic, species andecosystem diversity. Bio-geographical classification of India, Values of biodiversity: consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega – diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Conservation of biodiversity: In– situ and Ex-situ conservation of biodiversity.	
III	**ENVIRONMENTAL POLLUTION AND CONTROL** Environmental Pollution: Definition, causes, effects and control measures: Air Pollution, Water pollution, Soil pollution, Marine pollution, Thermal pollution, Nuclear hazards, Solid waste Management, e-waste, Pollution case studies.	**CO3**
IV	**SOCIAL ISSUES AND GLOBAL ENVIRONMENT PROBLEMS AND EFFORTS** From Unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management, Remote sensing and GIS methods. Environmental ethics: Issues and possible solutions. Green building concept, Environmental Impact Assessment Environmental Management Plan, Climate change: global warming, acid rain, ozone layer depletion.	**CO4** **CO5**
V	**HUMAN POPULATION AND ENVIRONMENT LEGISLATION** Population growth, Environment and human health. HIV/AIDS,. Value Education. Women and Child Welfare. Role of Information Technologyin Environment and human health. Environment Legislation. Air (Prevention and Control of Pollution) Act. Water (Prevention and Control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Environmental Protection Act.	**CO4** **CO5**

Learning Resources

Text Books

1. Anubha Kaushik and C.P. Kaushik, Text book of environmental studies New AgeInternational Publisher (2014).
2. Erach Barucha, Text book of environmental studies for undergraduates courses,published by – University Grants Commission, University Press (2005)
3. Anindita Basak, Environmental Studies. Pearson (2009)

Reference Books

1. D.K. Asthana and Meera Asthana, A Text book of Environmental Studies, S. Chand(2010).
2. P.M Cherry Solid and Hazardous waste Management, CBS Publisher (2016).
3. Charles H. Ecclestion, Environmental Impact Assessment, CRC Press (2011).

HEAT TRANSFER

Course Code	20ME3501	Year	III	Semester	I
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	ATD, Differential Equations & Vector Calculus
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the basic concepts of heat transfer. Formulate one dimensional steady and transient conduction heat transfer problems and explain concept of fins	Understand	L2	1,2,3,4,5
CO2	Apply the concepts on solving forced convective heat transfer, significance of non-dimensional numbers and free convection heat transfer	Apply	L3	2,3
CO3	Apply the concepts on solving problems based on boiling, condensation, LMTD and NTU methods.	Apply	L3	4
CO4	Analyse the concepts of radiation heat transfer including both black body radiation and grey body radiation.	Analyze	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3				1							1	1
CO2	2	3				2							3	3
CO3	2	3				2							3	3
CO4	2	3				2							3	3

Syllabus

UNIT	Course Content	Mapped COs
I	**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.	CO1
II	**One Dimensional Steady State Conduction Heat Transfer:** steady, unsteady and periodic heat transfer – Initial and boundary conditions. Homogeneous slabs, hollow cylinders and spheres – overall heat transfer coefficient – electrical analogy – Critical radius of insulation - Variable Thermal conductivity – systems with and without heat generation. **Extended Surface (fins) Heat Transfer** – Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature. **One Dimensional Transient Conduction Heat Transfer:** Systems with negligible internal resistance – Significance of Biot and Fourier Numbers Chart solutions of transient conduction systems.	CO1, CO2
III	**Convective Heat Transfer:** Classification of systems based on causation of	CO1,

	flow, condition of flow, configuration of flow and medium of flow – Dimensional analysis as a tool for experimental investigation – Buckingham Pi Theorem and method, application for developing semi – empirical non-dimensional correlation for convection heat transfer – Significance of non-dimensional numbers – Concepts of Continuity, Momentum and Energy Equations. **Forced Convection: External Flows:** Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer Flat plates and Cylinders. **Free Convection:** Development of Hydrodynamic and thermal boundary layer along a vertical plate – Use of empirical relations for Vertical plates.	**CO2**
IV	**Heat Transfer with Phase Change:** 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. **Heat Exchangers:** Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.	**CO1, CO3**
V	**Radiation Heat Transfer:** Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann. Heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.	**CO1, CO4**

Learning Resources
Textbooks:
1. Heat and Mass Transfer by Y.A Cengel, A J Ghajar, Mc Graw Hill education,2011. 2. Heat transfer, by J.P.Holman, TMH publications, 2008 . 3. Heat and Mass Transfer, by Sachdeva, New age International.
Reference Books:
1. Engineering Heat & Mass transfer by Mahesh.M.Rathor ,University science press ,2006 2. Heat Transfer -A Basic Approach, by N.Ozisik , MC Grawhill,1985 3. Heat transfer, by S.P.Sukhatme , Orient longman Pvt. Ltd. 2005 4. Introduction to Heat Transfer, by lncropera and Dewitt, Wiley Publishers,2001 5. Heat Transfer, by D.S. Kumar, SK. Kataria & sons,2009.
E-Resources & other digital Material:
1.https://nptel.ac.in/courses/112/108/112108149/ 2.https://nptel.ac.in/courses/112/105/112105271/ 3.https://nptel.ac.in/courses/103/103/103103031/#

Data book to be allowed in examination:

- C.P.Kothandaraman & S. Subramanyam, Heat and Mass Transfer Data Book, New Age International Publishers – Sixth edition.

METAL CUTTING AND MACHINE TOOLS

Course Code	20ME3502	Year	III	Semester	I
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	MP
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: At the end of the course students will be able to

CO	Statement	Skill	BTL	Units
CO1	Discuss Geometry of single point single point cutting tool and Mechanics of machining.	Understand Communication	L2	1,2,3
CO2	Describe Tool reliability, materials and identify suitable cutting fluid for a machining operation.	Apply, Communication	L2	1,2,3,4,5
CO3	Illustrate working principle, mechanism and various operations performed on lathe, shaper and planner	Apply, Communication	L2	3
CO4	Discuss drilling machines, milling machines, and various operations performed.	Apply, Communication	L2	4
CO5	Specify suitable finishing process for a component.	Understand Communication	L2	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H:High, M: Medium, L:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2			2							2	3	1
CO2	3	2			2							2	3	1
CO3	3	2			2							2	3	1
CO4	3	2			2							2	3	1
CO5	3	2			2							2	3	1

Syllabus

Unit	Course Content	COs
I	**Geometry of Cutting Tools:** Geometry of single-point cutting tool: Tool-in hand system, ASA system, Significance of various angles of single point cutting tools, Orthogonal Rake System (ORS). **Mechanics of Machining Processes:** Orthogonal and Oblique cutting, Mechanics of Chip formation: Types of chips, chip-breakers, Chip reduction coefficient, shear angle, shear strain, Built-Up-Edge and its effect in metal cutting, Merchant's analysis of metal cutting process - Various forces, power and specific energy in cutting, Problems on Tool Geometry and Mechanics of Machining, Theories of Metal Cutting: Ernst & Merchant, theory, Modified Merchant's theory, Lee & Shaffer Theory, Stress distribution at Chip-Tool Interface.	CO1, CO2
II	**Tool wear, Tool life, Machinability and Machining Economics:** Wear Mechanisms, Types of tool wear, Tool Life and Machinability, Problems on Economics of Machining. **Cutting Tool Materials:** Desirable Properties of tool materials, Characteristics of Cutting Tool Materials, indexable inserts, coated tools. **Cutting Fluids:** Functions, characteristics and types, selection of cutting	CO1, CO2

	fluids.	
III	**Lathe:** Types, Parts, Feed Mechanisms, Specifications of lathe, Lathe Operations, Accessories and Attachments, Machining time estimation, Capstan and Turret Lathes. **SHAPER AND PLANER:** Types, Specifications, Crank and slotted link mechanism, Stroke length and position adjustments, Automatic feed mechanisms, Shaper Vs Planer, Machining time estimation	**CO1, CO2 CO3**
IV	**DRILLING:** Types, Operations, Nomenclature of a Twist drill, Machining time estimation. **Milling:** Types, Up Milling Vs Down Milling, Types of milling cutters, Operations, Dividing head, Types of Indexing and problems on indexing.	**CO2, CO4**
V	**GRINDING:** Specification and selection of grinding wheels, Truing, Dressing, Classification of Grinding wheels, Types of Grinding Machines. **FINISHING PROCESSES**: Lapping, Honing and Super-finishing processes.	**CO2, CO5**

Learning Resources
Text Books:
1.Manufacturing technology - Metal cutting and Machine tools, 2nd edition by P.N Rao, TMH publications, 2000. 2.Machining and machine tools, by A.B. Chattopadhyay, wiley india pvt. Limited, 2011.
Reference Books :
1. Metal cutting Principles, by M.C. Shaw, 3rd ed., Oxford, 1957. 2. Production Technology, by HMT, (Hindustan Machine Tools), TMH publications, 2001. 3. Workshop Technology Vol II, (10th edition), by B.S.Raghu Vamshi, Dhanpat Rai, & co (p) Ltd., 2009. 4. Manufacturing Science, by Amitabha Ghosh and Asok Kumar Mallik, East West, Press, 2nd Edition, 2010.
E- Resources & other digital material :
1. https://nptel.ac.in/courses/112105233

DESIGN OF MACHINE ELEMENTS

Course Code	20ME3503	Year	III	Semester	I
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Strength of Materials
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

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

CO	Statement	Skill	BTL	Units
CO1	Understand the Design Procedure and design considerations of various machine elements.	Understand	L2	1,2,3,4,5
CO2	Apply the principles of static and fatigue failure theories to estimate the size of machine elements	Apply	L3	2
CO3	Design the temporary and permanent joints required to assemble the machine elements	Analyze	L4	3,4
CO4	Design the required spring for the given application	Analyze	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H:High, M: Medium, L:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1						1		2	3	1
CO2	3	3	1	1						1		2	3	1
CO3	3	3	1	1						1		2	3	1
CO4	3	3	1	1						1		2	3	1

Syllabus

Unit	Contents	CO
I	**Mechanical Engineering Design:** Machine Design, Basic Procedure of Machine Design, Basic Requirements of Machine Elements, Design of Machine Elements, Traditional Design Methods, Design Synthesis, Use of Standards in Design, Selection of Preferred Sizes, Aesthetic Considerations in Design, Ergonomic Considerations in Design. Mechanical Properties of Engineering Materials, BIS System of Designation of Steels, Selection of Material, Selection of Manufacturing Method.	CO1
II	**Design Against Static Loads:** Modes of failure, Factor of Safety, design of components subjected to axial, bending, torsional loads. Theories of Elastic failure, Maximum Principal Stress theory, Maximum Shear Stress Theory, Distortion-Energy Theory **Design Against Fluctuating Load:** Stress Concentration, Stress Concentration Factors, Reduction of Stress Concentration, Fluctuating Stresses, Fatigue Failure, Endurance limit, Low-cycle and High-cycle Fatigue, Notch Sensitivity, Endurance Limit – Approximate Estimation, Reversed Stresses – Design for Finite and Infinite Life. Cumulative Damage in Fatigue, Soderberg and Goodman Lines and modified Goodman criterion for fatigue failure.	CO1, CO2
III	**Riveted Joints:** Types of riveted joints, Types of Failure, efficiency of riveted joint, Caulking and Fullering, Longitudinal Butt Joint for Boiler Shell, Circumferential Lap Joint for Boiler Shells, Eccentrically Loaded Riveted Joint.	CO1, CO3

	Welded Joints: Types of welded joints, Strength of Parallel Fillet welds, Strength of Transverse Fillet welds, Axially Loaded Unsymmetrical Welded Joints, Eccentric Load in the Plane of Welds, Welded Joint Subjected to Bending Moment, Welded Joint Subjected to Torsional Moment.	
IV	**Bolted Joints:** Load on bolt due to initial tightening, external loading, combined loading, eccentrically loaded bolted joints in shear, Eccentric load perpendicular to axis of bolt. **Cotter Joints:** Types of cotter joints, Design of Socket and Spigot Joint, Design of Sleeve and Cotter Joint, Design of Gib and Cotter Joint, knuckle joint	**CO1, CO3**
V	**Springs:** Types of springs, Terminology of Helical Springs, Styles of End, Stress and Deflection Equations, Series and parallel Connections, Design of Helical springs, Design against Fluctuating load, Concentric Springs Leaf springs, Design of Leaf spring, nipping of Leaf Spring	**CO1, CO4**

Learning Resources
Text Book(s):
1. V.B. Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.
References:
1. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986. 2. R.L. Norton, Machine Design an Integrated approach, 2/e, Pearson Education, 2004. 3. M.F.Spotts and T.E.Shoup, Design of Machine Elements, 3/e, Prentice Hall (Pearson education), 2013.

HEAT TRANSFER LAB

Course Code	20ME3551	Year	III	Semester	I
Course Category	Professional Core	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Pre-requisites	-
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

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

CO	Statement	Skill	BTL	Experiments
CO1	Determine Thermal conductivity of Insulating powder and for given metal Rod.	Apply	L3	1,2
CO2	Evaluate heat transfer through lagged pipe, Drop and Film wise condensation, Pin Fin, Forced convection, Natural Convection.	Apply	L3	3,4,5,6,7
CO3	Measure the Overall Heat transfer coefficient for Composite Wall and for Parallel and Counter Flow Heat Exchanger.	Apply	L3	8,9
CO4	Test Critical Heat flux, Stefan Boltzmann Constant and Emissivity Value	Apply	L3	10,11,12

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H:High, M: Medium, L:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2		3									3	3
CO2	1	2		3									3	3
CO3	1	2		3									3	3
CO4	1	2		3									3	3

LIST OF EXPERIMENTS

Expt No	Contents	COs
I	Determination of Thermal Conductivity for a given Asbestos Insulating powder	CO1
II	Determination of Thermal Conductivity for a Given Copper Metal Rod.	CO1
III	Determination of Heat Transfer through Lagged Pipe.	CO2
IV	Determination of Heat Transfer through Drop Wise and Film Wise Condensation.	CO2
V	Determination of Heat Transfer through Pin-Fin.	CO2
VI	Determination of Heat Transfer through Forced Convection	CO2
VII	Determination of Heat Transfer through Natural Convection.	CO2
VIII	Determination of Overall Heat Transfer Coefficient for Composite Wall.	CO3
IX	Determination of overall heat transfer coefficient for Parallel and Counter Flow Heat Exchanger.	CO3
X	Determination of Critical Heat Flux for a given Nichrome wire.	CO4
XI	Measurement of Stefan Boltzmann constant.	CO4
XII	Emissivity Measurement	CO4

Learning Resources
Text Books:
1. Heat and Mass Transfer by Y.A Cengel, A J Ghajar, Mc Graw Hill education,2011. 2. Heat transfer, by J.P.Holman, TMH publications, 2008 3. Heat and Mass Transfer, by Sachdeva, New age International.
Reference Books:
1. Engineering Heat & Mass transfer by Mahesh.M.Rathor ,University science press ,2006 2. Heat Transfer -A Basic Approach, by N.Ozisik , MC Grawhill,1985 3. Heat transfer, by S.P.Sukhatme , Orient longman Pvt. Ltd. 2005 4. Introduction to Heat Transfer, by lncropera and Dewitt, Wiley Publishers,2001 5. Heat Transfer, by D.S. Kumar, SK. Kataria & sons,2009.
E-Resources & other digital Material:
1.https://nptel.ac.in/courses/112/108/112108149/ 2.https://nptel.ac.in/courses/112/105/112105271/ 3.https://nptel.ac.in/courses/103/103/103103031/#

MACHINE TOOLS LAB

Course Code	20ME3552	Year	III	Semester	I
Course Category	Professional Core	Branch	ME	Course Type	Lab
Credits	1.5	L – T – P	0 – 0 – 3	Prerequisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

COs	Statement	Skill	BTL	Expts.
CO1	Perform various operations on Lathe machine.	Apply	L3	1-7
CO2	Perform Drilling, Reaming and Tapping operations using universal radial drilling machine	Apply	L3	8
CO3	Make plain and stepped surfaces using shaper, planner and surface grinder.	Apply	L3	9-11
CO4	Fabricate spur gear and splined shaft using milling machine and Slotting machine respectively.	Apply	L3	12,13
CO5	Prepare single point cutting tool using Tool and cutter grinding machine.	Apply	L3	14

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H:High, M: Medium, L:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3								3	2		1	3	1
CO2	3								3	2		1	3	1
CO3	3								3	2		1	3	1
CO4	3								3	2		1	3	1
CO5	3								3	2		1	3	1

LIST OF EXPERIMENTS

Syllabus

Exp.No.	Content	Mapped CO
EXPERIMENTS ON LATHE		
1.	Step turning	CO1
2.	Taper turning by swiveling compound rest	
3.	Taper turning by taper turning attachment	
4.	Knurling and Grooving	
5.	Thread cutting	
6.	Drilling and Boring	
7.	Form Turning	
EXPERIMENTS ON OTHER MACHINE TOOLS		
8.	Drilling, reaming and tapping operations	CO2
9.	Making a stepped surface using Shaper	CO3
10.	Machining flat surface using Planner	
11.	Surface grinding operation	
12.	Machining External Splines using slotting machine	CO4
13.	Machining Spur Gear using Milling machine	
14.	Grinding of single point cutting tool using Tool and cutter Grinding Machine	CO5

C PROGRAMMING LAB

Course Code	20SA8553	Year	III	Semester	I
Course Category	Skill Advanced Course	Branch	ME	Course Type	Theory+ Lab
Credits	2	L – T – P	1 – 0 – 2	Prerequisites	Nil
Continuous Internal Evaluation	-	Semester End Evaluation	50	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to		
COs	**Statement**	**BTL**
Course Outcomes (Theory Component)		
CO1	**Understand** the principles of structured programming and C constructs for solving problems.	L3
CO2	**Apply** suitable control constructs and array concepts to solve problems.	L3
CO3	**Apply** the concept of functions, pointers, and user defined data types to solve problems.	L3
Course Outcomes (Laboratory Component)		
CO1	**Apply** Structured Programming/C constructs for solving problems.	L3
CO2	**Implement** programs as an individual on different IDEs/ online platforms.	L3
CO3	**Develop** an effective report based on various programs implemented.	L6
CO4	**Apply** technical knowledge for a given problem and express with an effective oral communication.	L3
CO5	**Analyse** outputs using given constraints/test cases.	L4

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H:High, M: Medium, L:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3											3		
CO2					3				3					
CO3										3				
CO4	3									3				
CO5		3												

Syllabus		
UNIT	**Course Content (Theory Component)**	**Mapped CO**
I	**Introduction to C:** Introduction, Structure of C Program, A Simple C Program, C-Tokens, Basic Data types, Variables, Constants, Input / Output statements, Operators, Type conversion and Type casting	**CO1**
II	**Conditional Branching Statements:** if, if-else, if-else-if Statements and Switchcase **Iterative Statements:** while, do-while and for loops, break and continue statements.	**CO1, CO2**
III	**Arrays:** Declaration, accessing array elements, Storing values, Operations on arrays **Strings:** Introduction, String manipulation functions	**CO1, CO2**
IV	**Functions:** Introduction, Using Functions, Function declaration, Function definition and Function call, Parameter passing, Recursion, Storage classes. User defined data types: introduction to enum, introduction to	**CO1, CO3**

	typedef, introduction to structures, and introduction to union Declaration and Initialization of pointer variables, Pointer arithmetic, Pointers and arrays	
V	**User defined data types:** introduction to Enum, introduction to typedef, introduction to structures, and introduction to union	**CO1, CO3**

Course Content (Laboratory Component)		
Expt. No	**Contents**	**Mapped COs**
I	Write a program to print sample strings like "hello world", "Welcome to C Programming" with different formats. Write a Program to print different data types in 'C' and their ranges. Write a Program to initialize, assignment & printing variables of different data types.	**CO1, CO2, CO3, CO4, CO5**
II	Write a Program to demonstrate arithmetic operators. (+,-,*,/,%) Write a Program to demonstrate logical operators.(logical AND, logical OR) Write a Program to read radius value from the keyboard and calculate the area of circle and print the result in both floating and exponential notation. Write a Program to calculate simple interest. Write a Program to convert temperature. (Fahrenheit – Centigrade and vice-versa)	**CO1, CO2, CO3, CO4, CO5**
III	Write a Program to read marks of a student in six subjects and print whether pass or fail (using if-else). Write a Program to calculate roots of quadratic equation (using if-else). Write a Program to perform arithmetic operations using switch case. Write a Program to display vowels and consonants using switch case	**CO1, CO2, CO3, CO4, CO5**
IV	Do the Following Programs Using for, while, do-while loops. Write a program to calculate sum of individual digits of a given number. Write a program to check whether given number is palindrome or not. Write a program to print prime numbers in the given range. Write a program to display multiplication tables from 1 to 10 except 3 and 5	**CO1, CO2, CO3, CO4, CO5**
V	Write a program to print the Fibonacci series for given 'N' value. Write a program to check whether a given number is a Fibonacci number or not. Write a program to read 2 numbers x and n then compute the sum of the Geometric Progression. 1+x+ x2 +x3 + +x^n	**CO1, CO2, CO3, CO4, CO5**
VI	Write a program to store 10 elements in the 1-D array and print sum of the array. Write a program to print minimum and maximum elements in the 1-D array. Write a program to count no. of positive numbers, negative numbers and zeros in the array	**CO1, CO2, CO3, CO4, CO5**
VII	Write a program to perform various string manipulations using built-in functions. Write a program to verify the given string is palindrome or not(without built-in functions, with using built-in functions). Write a program to concatenate two strings using arrays.	**CO1, CO2, CO3, CO4, CO5**
VIII	Write a program to find sum of two numbers using functions. Write a program to swap two numbers using Call By Value	**CO1, CO2,**

	Write a program to calculate factorial using recursion and non- recursion functions.	**CO3, CO4, CO5**
IX	Write a program to swap two numbers using Call By Reference Write program to perform arithmetic operations using pointer. Write a program matrix addition using pointers	**CO1, CO2, CO3, CO4, CO5**
X	Write a program to display a day associated with a number using enum(assume Sunday=0 to Saturday=6). Write a program to create structure and union for an account holder in a bank with following Fields: name, account number,address, and balance and display the details of five account holders. Write a program to alias int with integer, char with character, float with flt and double with dbl using typedef.	**CO1, CO2, CO3, CO4, CO5**

Learning Resources
Text Books:
1. Programming in C, ReemaThareja, AICTE Edition, 2018, Oxford University Press.
Reference Books:
1. Computer Science: A Structured Programming Approach Using C, B. A.Forouzan and R.F. Gilberg, Third Edition, 2007, Cengage Learning. 2. Programming in C, PradipDey, ManasGhosh, AICTE Edition, OxfordUniversity Press. 3. Programming with C, B. Gottfried, Third Edition, 2017, Schaum'soutlines, McGraw Hill. 4. Problem Solving & Program Design in C,Jeri R. Hanly,Ellot B. Koffman,5th Edition, Pearson.
E-Resources & other digital Material:
1. http://cprogramminglanguage.net/ 2. https://www.geeksforgeeks.org/c-programming-language/ 3. https://www.greatlearning.in/academy/learn-for-free/courses/c- programming 4. https://www.udemy.com/course/the-complete-c-programming/ 5. https://nptel.ac.in/courses/106/105/106105171/

UNIVERSAL HUMAN VALUES

Course Code	20MC1502	Year	III	Semester	I
Course Category	Mandatory Course	Branch	ME	Course Type	Theory
Credits	0	L-T-P	2-0-0	Pre-requisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

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

CO	Statement	Skill	BTL	Units
CO1	**Describe** more aware of themselves, and their surroundings (family, society, nature)	Understand	L2	1
CO2	**Illustrate** more responsibility in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.	Understand	L2	2
CO3	**Show** better critical ability	Apply	L3	3
CO4	**Exhibit** sensitivity to their commitment towards what they have understood (human values, human relationship and human society)	Apply	L3	4
CO5	**Apply** what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H: High, M: Medium, L: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						2		2						2
CO2						2		2						2
CO3						2		2						2
CO4						2		2						2
CO5						2		2						2

Syllabus

UNIT	Course Content	Mapped COs
I	**Introduction - Need, Basic Guidelines, Content and Process for Value Education** Purpose and motivation for the course, recapitulation from Universal Human Values-I, Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario, Method to fulfil the above human aspirations: understanding and living in harmony at various levels.	CO1
II	**Understanding Harmony in the Human Being - Harmony in Myself!** Understanding human being as a co-existence of the sentient 'I' and the material 'Body', Understanding the needs of Self ('I') and 'Body' -	

	happiness and physical facility, Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer),Understanding the characteristics and activities of 'I' and harmony in 'I', Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Health.	**CO2**
III	**Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship** Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence, Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship, Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.	**CO3**
IV	**Understanding Harmony in the Nature and Existence - Whole existence as Coexistence** Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- pervasive space, Holistic perception of harmony at all levels of existence.	**CO4**
V	**Implications of the above Holistic Understanding of Harmony on Professional Ethics** Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations.	**CO5**

Learning Resources

Text Books:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010.

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi

ADVANCED STRENGTH OF MATERIALS

Course Code	20ME4501A	Year	III	Semester	I
Course Category	Professional Elective-I	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Strength of Materials
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the concepts of Strain energy and apply the energy methods on beams.	Understand	L2	1
CO2	Apply the concepts to find the deflections in fixed and continuous beams.	Apply	L3	2
CO3	Apply the principles to determine the stresses in thick cylinders, rotating elements and curved beams.	Apply	L3	3,4
CO4	Analyze 3D stresses at a point and yield criteria.	Analyze	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2				2			1		2	3	2
CO2	3	3	2				2			1		2	3	2
CO3	3	3	2				2			1		2	3	2
CO4	3	3	2				2			1		2	3	2

Syllabus

UNIT	Course Content	Mapped COs
I	**Strain Energy:** Resilience, Proof Resilience, Strain energy stored in a body when the load is applied gradually, Load is applied suddenly, Load is applied with impact, Strain energy stored in a body due to shear stress. **Application of energy methods:** Principle of stationary potential energy, Castigliano's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations, deflections of statically determinate structures.	CO1
II	**Fixed beams:** Introduction, bending moment diagram for fixed beam, Slope and deflection of fixed beam carrying point load and uniformly distributed load, Fixed end moments of fixed beam due to sinking of a support. **Continuous beams:** Bending moment diagram for Continuous beam, Clapeyron's theorem of three moments to continuous beam with Simply supported ends, Clapeyron's theorem of three moments to continuous beam with fixed supported ends, Beams with constant moment of inertia.	CO2
III	**Thick cylinders:** Introduction, Stresses in thick Cylindrical shell (Lame's theory), Radial Deflection, Stresses in Compound Cylinders. **Centrifugal Stresses:** Introduction, Rotating Ring, Rotating Disc, Rotating Disc of uniform strength.	CO3

IV	**Curved beams:** Stresses in Beams of small and large initial curvature, The Winkler-Bach theory, Assumptions for stresses in the bending of curved bars, Stresses in Crane Hook and C-Clamp with Rectangular, circular and trapezoidal cross sections.	**CO3**
V	**Analysis of stress:** Definition of stress at a point, stress notation, stress in arbitrary plane, stress transformation, principal stresses. **Yield Criteria:** General concepts, maximum Principal Stress Criterion, Maximum Principal Strain Criterion, Strain Energy Density Criterion, Maximum Shear Stress Criterion, Distortion Energy Density Criterion.	**CO4**

Learning Resource
Text books:
1. Stephen P. Timoshenko, James M. Gere "Mechanics of Materials", 2nd edition, C B S Publishers, 2011. 2. S.S. Rattan, "Strength of Materials", 2nd edition, Tata Mc-Graw Hill Private Limited, New Delhi, 2012.
Reference books:
1. James M. Gere, "Mechanics of Materials", 7th edition, Cengage learning India, 2010. 2. AdarshSwaroop, "Mechanics of Materials" 1st edition, New Age International Pvt. Ltd, 2012. 3. Popov, Mechanics of Solids, 2/e, New Pearson Education,2015. 4. B. Raghu Kumar, Strength of Materials, B S Publications, 2020.

OPERATIONS RESEARCH

Course code	20ME4501B	Year	III	Semester	I
Course category	Professional Elective-I	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to				
CO	**Statement**	**Skill**	**BTL**	**Units**
CO1	Understand the basics of linear programming, transportation, queueing, sequencing of jobs, replacement, inventory and simulation problems	Understand, Communication	L2	1,2,3,4,5
CO2	Apply linear programming, transportation and assignment models to solve real life problems	Apply, Communication	L3	1,2
CO3	Apply Sequencing, queueing, Game and Replacement theories to solve problems	Apply, Communication	L3	3,4
CO4	Apply knowledge of inventory control and simulation to solve practical industrial problems	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3								3	2		3	2
CO2	3	3								3	2		3	2
CO3	3	3								3	2		3	2
CO4	3	3								3	2		3	2

Syllabus		
UNIT	**Contents**	**Mapped CO**
I	**Introduction to Operations Research:** History, definition, operations research models, phases of implementing operations research in practice, applications. **Linear Programming**: Introduction, formulation, graphical solution, simplex method, artificial variable techniques – Big M and two-phase methods, duality principle.	**CO1 CO2**
II	**Transportation**: Formulation, initial feasible solution, optimal solution – MODI method, unbalanced transportation problems, degeneracy in transportation problems. **Assignment**: Formulation, optimal solution, Hungarian method, travelling salesman problem.	**CO1 CO2**
III	**Queuing theory**: Introduction, Kendall's notation, classification of queuing models, single server and multi-server models, Poisson arrival, exponential service, infinite population **Sequencing**: Introduction, assumptions, processing n-jobs through two machines, n-jobs through three machines, and graphic solution for processing 2 jobs through n machines with different order of sequence.	**CO1 CO3**
IV	**Game Theory**: Introduction, game with pure strategies, game with	**CO1**

	mixed strategies, dominance principle, graphical method for 2xn and mx2 games. **Replacement Theory**: Introduction, replacement of items that deteriorate with time - value of money unchanging and changing, simple probabilistic model for replacement of items that fail completely	**CO3**
V	**Inventory control**: Introduction, inventory costs, Economic Order Quantity (EOQ)Demand rate Uniform and replenishment rate infinite, demand rate non uniform replenishment rate infinite, Demand rate uniform, models with and without shortages, inventory model with single price break. **Simulation**: Definition, Types of simulation models, phases of simulation, applications of simulation	**CO1** **CO4**

Learning Resource
Text books:
1. Operations Research, by S.D.Sharma, Kedarnath & Ramnath publications (15th edition),2013. 2. Introduction to Operations Research, by Taha, Pearson Education,New Delhi, (8th edition), 2008
Reference books
1. Operations Research, (4th edition) by A.M .Natarajan, P. Balasubramani, ATamilarasi, Pearson Education, New Delhi, 2009. 2. Operations Research, (2nd edition) by R.Pannerselvam, 2009,PHI Publications, Noida 3. Operations Research, (2nd edition) by Wagner, 2007, PHI Publications, Noida 4. Operation Research, (4th edition) by J.K.Sharma, 2009, MacMilan publishers, india Ltd. New Delhi.
E-Resources & other digital Material:
1. http://nptel.ac.in/courses/112106134/ 2. http://nptel.ac.in/courses/112106131/

MODERN MACHINING METHODS

Course Code	20ME4501C	Year	III	Semester	I
Course Category	Professional Elective-I	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	MP
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Illustrate advanced machining processes, mechanism of Mechanical machining processes, its applications and limitations.	Understand Communication	L2	1,2,3,4,5
CO2	Classify the Electro Chemical machining process, economic aspects of ECM.	Apply, Communication	L3	3
CO3	Interpret Thermal Metal Removal Processes, characteristics of spark eroded surface & machine tool selection.	Apply, Communication	L3	4
CO4	Relate Generation and control of electron beam for machining and laser beam and Plasma Arc for machining.	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO	PO	PO	PO	PO1	PO11	PO12	PSO	PSO
CO1	2	2	2		2				2			2	2	1
CO2	3		2		2				2			2	2	2
CO3	3		2		2				2			2	2	1
CO4	2		2		2				2			2	2	1

Syllabus

UNIT	Course Content	Mapped COs
I	**INTRODUCTION:** Need for non-traditional machining methods, Classification of modern machining processes, considerations in process selection, Materials, Applications. **ULTRASONIC MACHINING-**Elements of the process, mechanics of metal removal, process parameters, economic considerations, applications and limitations, recent developments.	CO1
II	**ABRASIVE JET MACHINING, WATER JET MACHINING AND ABRASIVE WATERJET MACHINEING:** Basic principles, equipment's, process variables, mechanics of metal removal, MRR, application and limitations, Magnetic abrasive finishing, Abrasive flow finishing.	CO1
III	**ELECTRO–CHEMICAL PROCESSES**: 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. Electro stream drilling, Shaped tube electrolytic machining: Basic Principle of operation, advantages, disadvantages and applications. **CHEMICAL MACHINING:** Principle, maskants, etchants and applications.	CO1, CO2

IV	**THERMAL METAL REMOVAL PROCESSES:** General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting processes – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, methods, surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications. Comparison of thermal and non-thermal processes.	**CO1, CO3**
V	**ELECTRON BEAM MACHINING:** Generation and control of electron beam for machining, theory of electron beam machining. **LASER BEAM MACHINING:** General Principle and application of laser beam machining, thermal features, cutting speed, and accuracy of cut. **PLASMA ARC MACHINING**: Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish, other applications of plasma in manufacturing industries.	**CO1, CO4**

Learning Resource
Text books:
1. VK Jain, "Advanced machining processes", Allied publishers, New Delhi,2005. 2. Advanced Machining Processes by Hasan Abadel – Gawad El - Hofy , Mc Graw-Hill
Reference books
1. Pandey P.C. and Shah H.S, "Modern Machining Process", TataMcGraw-Hill Publishing.1984 2. McGeough, J. A, "Advanced Methods of Machining" Springer publisher; 1988
e- Resources & other digital material
1. https://nptel.ac.in/courses/112/104/112104204/

COMPOSITE MATERIALS

Course Code	20ME4501D	Year	III	Semester	I
Course Category	Professional Elective-I	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	AP,CM, MSM
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Explain the need for composite materials to fulfill the demand of various applications.	Understand, Communication	L2	1,2,3,4,5
CO2	Outline the fabrication techniques of different types of composite materials.	Understand, Communication	L2	3,4,5
CO3	Relate the construction, constituents & characteristics of the composite materials.	Apply, Communication	L3	1,2
CO4	Identify the strengthening mechanics adopted in a particular type of composite material.	Apply, Communication	L3	4

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1							2		1	3	1
CO2	3	1	1							2		1	3	1
CO3	3	1	1	2						2		1	3	1
CO4	3	1	1	2						2		1	3	1

Syllabus

UNIT	Contents	Mapped CO
I	**Introduction**: Definitions and classification, benefits of composites, Factors affecting properties of composites. **Fiber Reinforced Composites**: Short and Long Fiber, Influence of Fiber Length, Influence of Fiber orientation and concentration on Mechanical Properties.	CO1 CO3
II	**Matrix Materials:** Common matrix materials in Polymers, metals, ceramics and their applications. **Reinforcements:** Fabrication, Properties and applications of Glass fibers, Boron Fibers, Carbon Fibers. ceramic Fibers: Oxide fibers, Non oxide Fibers, Whiskers.	CO1 CO3
III	**Metal Matrix Composites (MMCs):** Types of Metal Matrix Composites, Important Metallic Matrices Processing: Stir casting, Spray deposition, Liquid Infiltration, squeeze casting, spray forming and diffusion bonding.	CO1 CO2
IV	**Strengthening Mechanisms in MMCs:** Dislocation Strengthening, Orowan Strengthening, grain size strengthening, Work hardening, Applications of MMCs. **Processing of MMCs by Friction Stir Processing:** Groove Filling Method, Drill Hole Method, Powder Metallurgy Route and In Situ Method.	CO1 CO2 CO4

V	**Ceramic Matrix Composites (CMCs):** Processing of CMCs-Cold Pressing, Hot Pressing, Chemical Vapour Deposition, Electrophoretic Deposition, Properties and applications of CMCs.	**CO1 CO2**

Learning Resource
Text books:
1. Chawla, Krishan K. Composite materials: science and engineering. Springer Science & Business Media, 2012. 2. Matthews, Frank L., and Rees D. Rawlings. Composite materials: engineering and science. CRC press, 1999.
Reference books
1. Donald R. Askeland, "Essential of Materials Science and Engineering", Thomson Learning, 5th Edition – 2006 2. R. Balasubramaniam, Callister's, Material Science and Engineering, 2/e, WileyIndia,2014.
E-Resources & other digital Material:
1. https://www.classcentral.com/course/swayam-introduction-to-composites-10005 2. https://nptel.ac.in/courses/112/104/112104229/ 3. https://nptel.ac.in/courses/112/104/112104168/ 4. https://nptel.ac.in/courses/101/106/101106038/ 5. https://nptel.ac.in/courses/112/104/112104249/ 6. https://nptel.ac.in/courses/112/104/112104161/

REFRIGERATION AND AIR CONDITIONING

Course Code	20ME4501E	Year	III	Semester	I
Course Category	Professional Elective-I	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	BTD, ATD
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the basic concepts of Refrigeration and Air Conditioning	Understand	L2	1,2,3,4,5
CO2	Apply the basic concepts on solving problems of various Refrigeration systems	Apply	L3	2,3
CO3	Analyze various Air conditioning systems	Analyze	L4	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO	PO	PO	PO	PO1	PO11	PO12	PSO	PSO2
CO1	3						2				3	1	3	1
CO2	2	2					2				2	1	3	1
CO3	2	3					2				2	1	3	1

Syllabus

UNIT	Contents	Mapped CO
I	**INTRODUCTION TO REFRIGERATION:** Necessity of refrigeration and air conditioning, applications, unit of refrigeration Refrigeration: Carnot cycle, Bell Coleman cycle and Brayton Cycle, Open and Dense air systems, Actual air refrigeration system –numerical problems. Refrigeration needs of aircraft's, methods of air refrigeration systems	CO1
II	**VAPOUR COMPRESSION REFRIGERATION SYSTEM:** Cycles and performance Simple Vapour compression refrigeration cycle -working principle, essential components, COP, representation of cycle on T–S and p-h charts, effect of sub cooling and super heating– cycle analysis. Actual cycle, Influence of various parameters on system performance - numerical Problems Components Compressors – classification –single stage reciprocating compressors-Working Principle, work done with and without clearance volume, capacity control. Condensers – classification–Working of evaporative condensers Evaporators– classification– Working of flooded and dry expansion evaporators Expansion devices–Types– capillary tube, automatic expansion valve, thermostatic expansion valve. Refrigerants: Desirable properties–classification refrigerants	CO1, CO2
III	**PERFORMANCE OF VAPOR ABSORPTION REFRIGERATION SYSTEM:** Calculation of max COP, description and working of NH3–water system and Li Br–water (Two shell & Four shell) System. Principle of operation of three fluid absorption system, salient features. Steam jet refrigeration system: Working Principle and Basic Components Nonconventional refrigeration methods: Principle and operation f(i) Thermoelectric refrigerator (ii) Vortex tube or Hilsch tube.	CO1, CO2
IV	**INTRODUCTION TO AIR CONDITIONING:** Psychometric Properties & Processes–Characterization of Sensible and latent heat loads. Need for Ventilation,	CO1, CO3

	Consideration of Infiltration, Load concepts of RSHF, GSHF, ESHF and ADP	
V	**HUMAN COMFORT AND LOAD CALCULATIONS** Requirements of human comfort and concept of effective temperature-Comfort chart– Com fort Air conditioning –Requirements of Industrial air-conditioning, Air-conditioning Load Calculations. Air Conditioning Systems Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers fans and blowers. Heat Pump –Heat sources– different heat pump circuits	**CO1, CO3**

Learning Resource
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 by R K Rajput, S K kataria & sons, 2010. 2. Refrigeration and Air Conditioning / Manohar Prasad / New Age. 3. Principles of Refrigeration, by Dossat ,Prentice Hall,1997. 4. Refrigeration and air conditioning, by Stoecker , Mc Graw hill Edu.,2004. 5. Basic refrigeration and air conditioning/PN Ananthanarayanan/Mc Graw hill education.
e- Resources & other digital material
1. https://nptel.ac.in/courses/112/105/112105129/ 2. https://nptel.ac.in/courses/112/107/112107208/ 3. https://nptel.ac.in/courses/112/105/112105128/
Data Books
1. Refrigeration and Air conditioning Data book, CP Kothandaraman /New age publishers. 2. Refrigeration and Air conditioning Data book-Domakundwar & Domakundwar / Dhanpathi rai &Co

DESIGN THINKING

Course Code	20ME2501A	Year	III	Semester	I
Course Category	Open Elective-I	Offering Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to				
CO	**Statement**	**Skill**	**BTS**	**Units**
CO1	Understand the principles of design thinking and its approaches	Understand	L2	1,2,3,4,5
CO2	Apply the empathy, the Define phase and develop an idea through ideation Techniques in human-centered design problems.	Apply	L3	1,2,3
CO3	Apply the design thinking techniques for innovation processes	Apply	L3	1,5
CO4	Analyze the prototype and test in a design thinking context.	Analyze	L4	1,4

Contribution of Course Outcomes towards achievement of Program Outcomes& Strength of correlations (3: High, 2: Moderate, 1: Low)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3			2	2		3	3	2	2	2	3	3	
CO2	3			2	2		3	3	2	2	1	3	3	
CO3	3			2	2		3	3	3	2	1	3	3	
CO4	3			2	2		3	3	2	2	1	3	3	

Syllabus		
Unit	**Contents**	**Mapped CO**
I	**Introduction to Design Thinking** An insight into Design, Design Methodology, the origin of Design thinking, Design thinking Vs Engineering thinking, the importance of Design Thinking, Design Vs Design thinking, understanding Design thinking and its various process models or frameworks, Stanford process models and its five stages, features of design thinking, application of Design thinking	**CO1 CO2 CO3 CO4**
II	**Empathize in Design Thinking:** Human-Centered Design (HCD) process, explanation of HCD design thinking with examples, Role of Empathy in design thinking, persona creation and its importance, tools of empathy: Empathy maps, advantages and disadvantages of empathy maps, Customer journey map and its advantages & disadvantages, Mind Maps, and its uses, understanding empathy tools.	**CO1 CO2**
III	**Define Phase and Ideation:** Explore define phase in Design Thinking, Methods of Define phase. Introduction to ideation Methods, convention methods for ideation, intuitive methods: Brainstorming, storyboard telling, select ideas from ideation Methods: Bingo Selection, Six Thinking Hats.	**CO1 CO2**
IV	**Prototyping and Testing**:	**CO1**

	Prototyping and methods of prototyping, Difference between low fidelity and high-fidelity prototypes, paper prototyping, techniques for implementing paper prototyping, Digital prototyping, user testing methods, Advantages, and disadvantages of user Testing/ Validation	**CO4**
V	**Design Thinking for Innovation**: Innovation in Design Thinking, Definition of innovation, the art of innovation, types of innovations, product innovation, process innovation, and organizational innovation, characteristics of innovation, levels of innovation, Innovation towards design, Case studies	**CO1** **CO3**

Learning Resources
Text books:
1. Changebydesign,Tim Brown,2009,HarperCollins 2. Engineering design, George E Dieter,4th R evised edition,2009 McGraw Hill.
Reference books
1. Design Thinking for Strategic Innovation, Idris Mootee,2013, JohnWiley&Sons 2. DesignThinking-TheGuidebook–FacilitatedbytheRoyalCivil serviceCommission, Bhutan 3. Design Methods: A Structured Approach for DrivingInnovation in Your Organization, Vijay Kumar, FirstEdition, 2012, Wiley 4. Human-Centered Design Toolkit: An Open-Source Toolkit to Inspire New Solutions in the Developing World, IDEO, Second Edition,2011, IDEO
e- Resources & other digital material
1. https://www.interaction-design.ora/literature/topics/design-thinking 2. https://www.interaction-design.prq/literature/article/how-tq-<eve'op-anempath\capproach-in-design-thinking

LOGISTICS & SUPPLY CHAIN MANAGEMENT

Course Code	20ME2501B	Year	III	Semester	I
Course Category	Open Elective-I	Offering Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to				
CO	**Statement**	**Skill**	**BTS**	**Units**
CO1	Explain the importance of Supply Chain Management	Understand	L2	1,2,3,4,5
CO2	Illustrate Inventory control techniques	Apply	L3	2
CO3	Illustrate various issues in Supply Chain Management	Apply	L3	5
CO4	Interpret supply chain strategies and procurement strategies	Apply	L3	4
CO5	Design Supply Chain Networks suitable for various market conditions	Analyse	L4	3

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Moderate, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2							2		3			1
CO2		2							2		3			1
CO3		2							2		3			1
CO4		2							2		3			1
CO5		2							2		3			1

Syllabus

UNIT	Content	Mapped CO
I	**Introduction to Supply Chain Management (SCM):** Concept of supply management and SCM, importance of supply chain flows, core competency, value chain, elements of supply chain efficiency, key issues in SCM, decision phases, supply chain integration, process view of a supply chain, competitive strategy and supply chain strategies, uncertainties in supply chain, supply chain drivers.	**CO1**
II	**Inventory Management**: Introduction, selective control techniques, cost involved in inventory system, single stage inventory control, economic lot size models, application to economic production quantity, effect of demand uncertainty, single period models, initial inventory, multiple order opportunities, deterministic models, quantity discounts. periodic and quantity review policies, mathematical modeling under known stock out costs and service levels, joint replenishment for multiple items, inventory system constraints, working capital restrictions, and storage space restrictions.	**CO1 CO2**

III	**Designing Supply Chain Network:** Introduction, network design, factors influencing network design, data collection, data aggregation, transportation rates, warehouse costs, capacities and locations, models and data validation, key features of a network configuration, impact of uncertainty on network design, network design in uncertain environment, value of information: Bullwhip effect, information sharing, information and supply chain trade-offs, distribution strategies, direct shipment distribution strategies, transshipment and selecting appropriate strategies.	**CO1 CO5**
IV	**Supply Chain Integration:** Introduction, push-pull supply chains, identifying appropriate supply chain strategy, Sourcing and procurement, outsourcing benefits, importance of suppliers, evaluating a potential supplier, supply contracts, competitive bidding and negotiation. Purchasing, objectives of purchasing, relations with other departments, centralized and decentralized purchasing, purchasing procedure, types of orders, e-procurement, tender buying, role of business in supply chains.	**CO1 CO4**
V	**Issues in Supply Chain Management:** Introduction, risk management, managing global risk, issues in international supply chain, regional differences in logistics. Local issues in supply chain, issues in natural disaster and other calamities, issues for SMEs, organized retail in India, reverse logistics.	**CO1 CO3**

Learning Resources
Text books:
1. Simchi-Levi, D. Kaminsky, P.Simchi-Levi, E. and Ravi Shankar, Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies, 3/e, Tata McGraw-Hill, 2008. 2. Chopra, S. and Meindl, Supply Chain Management: Strategy, Planning and Operations, 2/e, Pearson Education, 2004.
Reference books
1. Doebler, D.W. and Burt, D.N, Purchasing and Supply Management-Text and Cases, 6/e, McGraw- Hill, 1996. 2. Tersine, R.J, Principles of Inventory and Materials Management, 4/e, Prentice Hall, 1994.
E- Resources & other digital material
1. https://ocw.mit.edu/courses/engineering-systems-division/esd-273j-logistics-and-supply-chain management-fall-2009/lecture-notes/ 2. https://nptel.ac.in/courses/110/108/110108056/

DYNAMICS OF MACHINERY

Course Code	20ME3601	Year	III	Semester	II
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Kinematics of Machinery
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

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

CO	Statement	Skill	BTL	Units
CO1	Understand the functional details of balancing of rotating and reciprocating parts, gyroscope, flywheel, governors, and vibration phenomenon of single degree of freedom systems.	Understand	L2	1,2,3, 4,5
CO2	Compute natural frequencies of undamped free & forced vibrations for a single degree of freedom system.	Apply	L3	4,5
CO3	Perform balancing of rotating and reciprocating masses and analyze the gyroscopic effects in aero planes and	Analyse	L4	1,2
CO4	Analyze the forces acting on the slider-crank mechanism, governors, and flywheels.	Analyse	L4	2,3

Contribution of Course outcomes towards achievement of programme outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2				2			1		2	3	2
CO2	3	3	2				2			1		2	3	2
CO3	3	3	2				2			1		2	3	2
CO4	3	3	2				2			1		2	3	2

Syllabus

Unit	Contents	Mapped CO
I	**Balancing of Rotating Masses:** Introduction, Static balancing, Dynamic balancing, Balancing of single unbalanced rotating mass, Balancing of Several Masses in the same planes, Balancing of Several Masses in Different planes. **Balancing of Reciprocating Masses:** Introduction to Primary and Secondary balancing. Balancing of Multi cylinder in-line and radial engines	CO1, CO3
II	**Gyroscope:** Introduction to Precession, Gyroscopic Couple and its effect on an aero planes and Naval Ships **Dynamic Force Analysis:** Introduction, D-Alembert's Principle, Angular velocity and Angular acceleration of the Piston and Connecting rod, Forces on the Reciprocating parts of an Engine, Equivalent Dynamical system, Inertia force and Inertia Torque in a reciprocating Engine	CO1, CO3 CO4
III	**Turning Moment Diagram:** Introduction, Turning moment diagram for Multi cylinder Engine, Fluctuation of energy. Coefficient of fluctuation of Speed, Energy Stored in a Flywheel, Flywheel in Punching Press **Governors:** Introduction, Watt, Porter, Proell Governors, Hartnell, Hartung	CO1, CO4

	Governors, Sensitiveness of a Governor, Hunting, Isochronisms, Stability.	
IV	**Free Vibrations of Single Degree of Freedom Systems:** Introduction, Definitions, types of vibrations and causes of vibrations, Basic features of Vibrating system, Degree of freedom, D Alembert's Principle, Energy method, Un damped free longitudinal, transverse and torsional vibrations of single degree of freedom systems, equivalent stiffness	**CO1, CO2**
V	**Harmonically Excited Vibrations:** Introduction, equations of motion, response of undamped systems under harmonic excitation.	**CO1, CO2**

Learning Resources
Text Book(s):
1. Theory of Machines, (3rd Edition) by S.S.Rattan ,Tata Mc.Graw Hill, New Delhi, 2012
References:
1 Theory of Machines: Kinematics & Dynamics, by P.L. Ballaney, I.K.International Pvt. Ltd., New Delhi,2010 2. Theory of Machines, by B.V.R. Guptha, Khanna Publications, New Delhi,11th Edition,1980 3. Theory of Machines, (5th Edition) by R.K.Bansal, Laxmi Publications(p) ltd. New Delhi, 2010

METROLOGY AND MEASUREMENTS

Course Code	20ME3602	Year	III	Semester	II
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L – T – P	3 – 0 – 0	Pre-requisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Explain the basic concepts of Metrology and Measurements.	Understand, Communication	L2	1,2,3,4,5
CO2	Illustrate the construction and working of instruments used for linear and angular measurement.	Apply, Communication	L3	1,2,5
CO3	Discuss the methods/ devices used for the measurement of gear and screw thread parameters.	Apply, Communication	L3	3
CO4	Estimate the surface roughness and flatness of machined surfaces.	Apply, Communication	L3	4
CO5	Summarize the principles involved in the measurement of field quantities.	Apply, Communication	L3	2,5

Contribution of Course outcomes towards achievement of programme outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2								2		2	3	2
CO2	3	2								2		2	3	2
CO3	3	2								2		2	3	2
CO4	3	2			2					2		2	3	2
CO5	3	2			2					2		2	3	2

UNIT	Course Content	Mapped COs
I	**Concept of Measurement:** Generalized measurement system and its functional elements, classification of instruments. Basic standards, primary, secondary and working standards. Instrument characteristics (static and dynamic), errors in measurement, calibration. **Limits, Fits and Tolerances**: Terminology of limits, fits and tolerances. Hole basis and shaft basis system, interchangeability and selective assembly.	CO1 CO2
II	**Linear and Angular Measurement:** Vernier instruments, Micrometers, Slip gauges, Dial indicators, Tool maker's microscope, Profile projector. Bevel protractor, Sine bar, Spirit level, angle dekkor and use of rollers and spheres to determine taper. Limit gauges and Taylor's principle of gauge design. **Comparators**: **Mechanical**-Johansson, Mikrokator, sigma and reed type, **Pneumatic**-Solex and differential type, **Electrical**- visual gauging and multi gauging.	CO1 CO2
III	**Screw thread Metrology**: Screw thread terminology, errors in threads,	CO1

	measurement of pitch, thread angle, major diameter, minor diameter and effective diameter (two wire and three wire methods). **Gear Metrology:** Gear terminology, Gear measurement: runout, backlash, profile error, tooth thickness (chordal thickness, constant chord and base tangent methods) and Parkinson gear tester.	**CO3**
IV	**Surface Texture:** Orders of geometric irregularities**,** difference between surface roughness and surface waviness, Numerical assessment of surface finish - CLA, RMS and tenpoint height method. Measurement of surface finish- Profilometer, Tomlinson surface meter, Taylor Hobson Talysurf. **Flat surface Measurement:** Instruments used –straight edges, surface plates, Auto collimator and optical flats.	**CO1** **CO4**
V	**Stress and Strain Measurements:** Various types of stress and strain measurements- electrical strain gauge, gauge factor, usage of resistance strain gauge for determining bending, compressive and tensile strains, strain gauge rosettes. **Field Quantities Measurement: Displacement measurement:** Capacitive transducer, LVDT. **Temperature Measurement**: Thermometers, bimetallic strip, thermocouple and Pyrometers. **Force Measurement:** Elastic force meters, load cells, **Pressure Measurement**: Bourdon Tube Pressure Gauge, calibration of Bourdon Tube Pressure Gauge using dead weight pressure gauge tester**. Speed Measurement**: Tachometer, Photo and Magnetic pickup transducer, **Flow Measurement** using Rotameter.	**CO1** **CO2** **CO5**

Learning Resources
Text Books:
1. A Textbook of Engineering Metrology, I.C. Gupta, Dhanpat Rai Publications, 2018. 2. Mechanical Measurements, Thomas G Beckwith, Roy D. Marangoni, John H. Lienhard V., Pearson Education, 2020.
Reference Books:
1. A Textbook of Metrology, M. Mahajan, Danpath Rai & Co. (P), 2010. 2. Metrology for Engineers, by J.F.W. Galyer , Charles Reginald Shotbolt, Cengage Learning EMEA; 5th Edition. 3. Mechanical Measurements & control, Dr. D.S.Kumar, Metropolitan Book Co. Pvt. Ltd., 2015.
E-Resources & other digital Material:
1. https://nptel.ac.in/courses/112/104/112104250/

DESIGN OF TRANSMISSION ELEMENTS

Course Code	20ME3603	Year	III	Semester	II
Course Category	Professional Core	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Strength of Materials
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

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

CO	Statement	Skill	BTL	Units
CO1	Understand the operating principles and their merits and demerits of various transmission elements	Understand	L2	1,2,3,4,5
CO2	Select suitable belt drives, bearings and associated elements from manufacturers catalogues under given loading conditions	Apply	L3	2,3
CO3	Design of shafts, keys, couplings, power screws and Gear drives for the given loading conditions	Analyse	L4	1,4,5

Contribution of Course outcomes towards achievement of programme outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1									3	1
CO2	3	3	1	1									3	1
CO3	3	3	1	1									3	1

Syllabus

Unit	Contents	Mapped COs
I	**Shafts:** Transmission Shafts, Shaft Design on Strength Basis, Shaft Design on Torsional Rigidity Basis, ASME Code for Shaft Design, Design of solid and hollow shafts for strength – For Bending, Torsion, Combined bending and torsion and combined bending, torsion and axial loads **Keys & Couplings:** Types of keys, Design of square and flat keys, Rigid couplings – Muff, split muff and Flange couplings, Flexible coupling-Bushed-Pin Flexible coupling.	CO1, CO4
II	**Belt and Chain drives:** Belts and their construction. Geometrical Relationships, Analysis of Belt Tensions, Condition for Maximum Power, Selection of Flat-belts from Manufacturer's Catalogue, Pulleys for Flat Belts, V- belts, Selection of V-belts, **Chain Drives:** Roller chains, geometric relationships, polygonal effect of chain, power rating of Roller Chains, Sprocket Wheels, design of chain drives.	CO1, CO2
III	**Rolling Contact Bearings:** Bearings, Types of Rolling-contact Bearings, Selection of Bearing-type, Static Load Carrying Capacity, Stribeck's Equation, Dynamic Load Carrying Capacity, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue. Bearing with Probability of Survival other than 90 Per Cent	CO1, CO2, CO4

	Sliding Contact Bearings: Types of Bearings, bearing materials, Lubrication, types of lubricants, properties of lubricants, Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.	
IV	**Friction Clutches:** Clutches, Torque Transmitting Capacity, Multi-disk Clutches, Friction Materials, Cone Clutches, Centrifugal Clutches, Energy Equation, Thermal Considerations **Brakes:** Brakes, Energy Equations, Block Brake with Short Shoe, Block Brake with Long Shoe, Pivoted Block Brake with Long Shoe, Internal Expanding Brake, Band Brakes, Disk Brakes, Thermal Considerations	**CO1, CO3**
V	**Spur Gears:** Gear Terminology, Classification of Gears, Module and Face width-power rating calculations based on strength and wear considerations **Helical Gears** – Pressure angle in the normal and transverse plane Equivalent number of teeth-. Beam Strength of Helical Gears. Wear Strength of Helical Gear	**CO1, CO4**

Learning Resources
Text Book(s):
1. V.B. Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.
References:
1. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986. 2. R.L. Norton, Machine Design an Integrated approach, 2/e, Pearson Education, 2004. 3. M.F.Spotts and T.E.Shoup, Design of Machine Elements, 3/e, Prentice Hall (Pearson education), 2013.

FINITE ELEMENT METHODS

Course Code	20ME4601A	Year	III	Semester	II
Course Category	Professional Elective-II	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Strength of Materials
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the concepts of elasticity, Rayleigh-Ritz method and Galerkin's Approach	Understand	L2	1,2,3,4
CO2	Formulate finite element models to solve axially loaded bar, truss, beam and 2D problems	Apply	L3	2,3,4
CO3	Analyze heat transfer problems and solve eigen value problems	Analyze	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1			2			1		2	3	2
CO2	3	3	1	1			2			1		2	3	2
CO3	3	3	1	1			2			1		2	3	2

Syllabus

Unit	Contents	Mapped COs
I	**FUNDAMENTAL CONCEPTS**: Historical Background of FEM, Stress and Equilibrium, Boundary conditions, Strain displacement relations, stress-strain relations, Potential energy and equilibrium, The Rayleigh-Ritz method, Galerkin's Approach.	CO1
II	**AXIALLY LOADED BARS**: Finite Element Formulations, Fundamental concepts, Two node bar element, Shape functions, Formulation of stiffness matrix and Load Vectors, Assembly of element stiffness matrices and load vectors, Boundary conditions: Elimination method, Penalty Method, Temperature effects, Examples of Axially Loaded Members.	CO1 CO2
III	**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 nodes beam Element, shape functions, element stiffness matrix and load vectors, simple problems on beams with distributed and point loads.	CO1 CO2
IV	**TWO DIMENSIONAL CST PROBLEMS**: Finite Element Modeling, Constant Strain Triangle (CST) Element Stiffness, Force terms, Stress calculation, Problem modeling and boundary conditions, Plane Stress and plane Strain Problems using CST Element. **TWO DIMENSIONAL ISOPARAMETRIC PROBLEMS**: formulation of 4-noded quadrilateral element, Numerical integration – Gaussian Quadrature approach.	CO1, CO2

V	**FINITE ELEMENTS IN STRUCTURAL DYNAMICS**: Dynamic equations, eigen value problems, and their solution methods, simple problems on bar and beam. **ONE DIMENSIONAL HEAT TRANSFER**: Equilibrium equations, heat conduction in plane walls, convection heat transfer in fins, finite element formulation, simple problems.	**CO3**

Learning Resources
Text Book(s):
1. Introduction to Finite Elements in Engineering (revised 4th edition), by Tirupathi R. Chandrupatla, Ashok D. Belegundu, Pearson Education Limited, 2011
References: 1. Singiresu S.Rao, Finite element Method in Engineering, 5ed, Elsevier, 2012. 2. Reddy, J.N., Finite Element Method in Engineering, Tata McGraw Hill, 2017.

PRODUCTION PLANNING AND CONTROL

Course Code	20ME4601B	Year	III	Semester	II
Course Category	Professional Elective-II	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course outcomes At the end of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Explain basics concepts of Production planning functions, forecasting techniques, Inventory management, Routing, scheduling, Line balancing, aggregate planning, dispatching and follow-up	Understand, Communication	L2	1,2,3,4,5
CO2	Demonstrate dispatching and Follow-up techniques	Understand, Communication	L2	5
CO3	Apply forecasting Techniques, Inventory control Techniques, scheduling techniques	Apply, Communication	L3	1,2,3
CO4	Apply aggregate planning Line balancing techniques in production Planning	Apply, Communication	L3	4

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3-High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3	1		1					1		2	3
CO2	3		3	1		1					1		2	3
CO3	3		3	1		1					1		2	3
CO4	3		3	1		1					1		2	3

Syllabus

UNIT	Contents	Mapped CO
I	**INTRODUCTION:** Objectives of production planning and control, definitions, functions of production planning and control, organization of production planning and control department, internal organization of department. **FORECASTING:** Importance - Forecasting Techniques- qualitative methods: Jury/Expert Method, Survey method, Sales force composite method, Delphi method and quantitative methods: Simple average, moving average, smoothing coefficient, Least Square method.	CO1 CO3
II	**INVENTORY MANAGEMENT:** Functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems **INVENTORY CONTROL TECHNIQUES:** Introduction to MRP-I, MRP-II & ERP, JIT inventory, Kanban system	CO1 CO3
III	**ROUTING:** Definition – Routing procedure –Route sheets – Bill of material – Factors affecting routing procedure. **SCHEDULING:** Definition – Activities-Difference with loading, Scheduling types: Forward, Backward scheduling, Job shop scheduling – Arrival pattern, processing pattern, number of workers available,	CO1 CO3

	machine varieties available, Priority rules for job sequencing FIFO, FILO, SPT, SOT, EDD, STR, CR. **Johnson's job sequencing rules**- n jobs on 2machines, n jobs on 3 machines.	
IV	**AGGREGATE PLANNING:** Introduction, Inputs to aggregate planning, strategies- Line strategy, chase strategy, capacity options, demand options, Costs in Aggregate Planning. **LINE BALANCING**: Introduction, objectives, terms related to line balancing, procedures, simple problems	**CO1** **CO4**
V	**DISPATCHING:** Centralized and Decentralized Dispatching- Activities of dispatcher – Dispatching procedure **FOLLOW-UP** – definition – Reason for existence of functions – types of follow up - Application of computers in production planning and control.	**CO1** **CO2**

Learning Recourse(s)

Text Book(s)

1. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
2. James.B.Dilworth,"Operations management – Design, Planning and Control for manufacturing and services" McGraw Hill International edition 1992.

Reference books

1. MartandTelsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition, John Wiley and Sons, 2000.
3. KanishkaBedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
4. Melynk, Denzler, "Operations management – A value driven approach" Irwin McGraw hill.
5. Norman Gaither, G. Frazier, "Operations Management", 9th edition, Thomson learning IE, 2007

E- Resources & other digital material

1. https://www.tandfonline.com/toc/tppc20/current
2. https://www.managementstudyguide.com/production-planning-and-control.htm
3. https://nptel.ac.in/courses/112/107/112107143/

CAD/CAM

Course code	20ME4601C	Year	III	Semester	II
Course category	Professional Elective-II	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	MCMT
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: At the end of the course students will be able to

CO	Statement	Skill	BTL	Units
CO1	Discuss application of Computer in design and Manufacturing	Understand, Communication	L2	1,2,3,4,5
CO2	Apply raster scan graphic systems and knowledge of geometric modeling in design	Apply, Communication	L3	1,2
CO3	Employ suitable CNC machines and part programming techniques for various applications	Apply, Communication	L3	3
CO4	Summarize the concepts of Group Technology, Computer Aided Quality Control, Flexible Manufacturing Systems and Computer Integrated Manufacturing	Apply, Communication	L3	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		1					2		2	3	1
CO2	3	2	3		1					2		2	3	3
CO3	3		3		1					2		2	3	1
CO4	3				1					2		2	3	1

Syllabus

UNIT	Contents	Mapped CO
I	**INTRODUCTION:** Product cycle and CAD/CAM, applications and Benefits of CAD, Hardware in CAD: Design Workstation-Graphics Terminal-Input devices- output devices-Display devices- Flat panel Display-LCD, LED, Hard Copy Devices-Printers and Plotters, CPU, Secondary Storage, Image Generation Techniques. **RASTER SCAN GRAPHICS** -Line generation Algorithms-DDA, Bresenham's algorithm, Coordinate systems, 2D transformation of geometry, Homogeneous representation,3D transformations, Cohen Sutherland Line clipping Algorithm, Hidden surface removal- Back face detection algorithm, Depth buffer algorithms.	**CO1 CO2**
II	**GEOMETRIC MODELING**: Curve representation- Cubic, Bezier and B-spline curves parametric forms, Geometric Modeling of Surfaces: Basic surfaces entities, sweep surfaces, surface of revolution, Surface blending, Geometric Modeling of Solids: Solid entities, Boolean operations, B-rep, CSG **DRAFTING AND MODELING SYSTEMS:** Basic geometric commands, layers, display control commands, editing, dimensioning	**CO1 CO2**

III	**COMPUTER AIDED MANUFACTURING (CAM):** Basic Components of NC System, NC Procedure, NC motion control systems, problems with conventional NC, Direct Numerical control (DNC), Computer Numerical Control (CNC), Functions of CNC and DNC systems. **CNC PART PROGRAMMING:** fundamentals, manual part programming and Computer Assisted Part Programming-APT	**CO1** **CO3**
IV	**GROUP TECHNOLOGY (GT):** Part family, coding and classification, production flow analysis, advantages and limitations, Computer Aided Processes Planning- Retrieval type and Generative type. **COMPUTER AIDED QUALITY CONTROL (CAQC):** Coordinate Measuring Machine, Non-Contact Inspection and Machine Vision	**CO1** **CO4**
V	**FLEXIBLE MANUFACTURING SYSTEM (FMS):** Components of FMS, FMS equipment and control, FMS Layouts **COMPUTER INTEGRATED MANUFACTURING SYSTEM (CIMS):** CIM Wheel, Elements of CIMS, CIMS benefits.	**CO1** **CO4**

Learning Resource
Text books:
1. CAD / CAM A Zimmers & M.P.Groover/PE/PHI 2. CAD / CAM Theory and Practice / Ibrahim Zeid / TMH
Reference books
1. CAD/CAM by P.N. Rao/TMH. 2. Automation, Production systems & Computer integrated Manufacturing/ Groover /P.E 3. CAD / CAM / CIM / Radhakrishnan and Subramanian / New Age 4. Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson 5. CAD/CAM: Concepts and Applications/Alavala/ PHI 6. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson.
e- Resources & other digital material
1. https://nptel.ac.in/courses/112/102/112102101/ 2. https://nptel.ac.in/courses/112/104/112104289/ 3. https://nptel.ac.in/courses/112/104/112104188/

MATERIAL CHARACTERIZATION

Course Code	20ME4601D	Year	III	Semester	II
Course Category	Professional Elective-II	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	AP, CM, MSM
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course outcomes At the end of the course, the student will be able to

CO	Statement	Skill	Blooms	Units
CO1	Discuss the principle and operation of Light microscopy, Scanning Electron and Transmission Electron Microscopy	Understand, Communication	L2	1,2,3
CO2	Summarize the principle and operation of different characterization tools such as optical microscope, Scanning electron microscopes and transmission electron microscope	Understand, Communication	L2	1,2,3
CO3	Interpret changes in materials using X-ray and thermal analysis techniques.	Understand, Communication	L2	4,5
CO4	Select the characterization tool for specific application	Apply	L3	1,2,3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3-High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3					2		2	3	1
CO2	3	2	2	2	3					2		2	3	1
CO3	3	2	2	2	3					2		2	3	1
CO4	3	2	2	2	3					2		2	3	1

Syllabus

UNIT	Contents	Mapped CO
I	**Light Microscopy:** Optical Principles-Image Formation- Resolution, Effective Magnification, Brightness and Contrast, Depth of Field, Aberrations. **Instrumentation:** Illumination System- Objective Lens and Eyepiece, Specimen Preparation. **Imaging Modes:** Bright-Field and Dark-Field Imaging, Phase Contrast Microscopy, Polarized Light Microscopy, Nomarski Microscopy, Fluorescence Microscopy, Confocal Microscopy.	CO1 CO2 CO4
II	**Electron Microscopy:** Introduction, Need of electron microscopy, Key advantages and disadvantages of imaging with electrons, Interaction of electrons with materials, Elastic versus inelastic electron scattering, Signals from the specimen, material features analysis using electron microcopy. **Scanning Electron Microscopy (SEM):** Key features of the SEM microscope, SEM Specimen preparation, SEM detectors, Key microstructural features analyzed by SEM, Specimen shape, Specimen composition, Surface crystallography.	CO1 CO2 CO4

III	**Transmission Electron Microscopy:** Key features of the TEM microscope, TEM specimen preparation, TEM imaging modes- Bright-field (BF) imaging, Electron diffraction, High-resolution TEM (HRTEM), Scanning TEM (STEM), High angle annular dark field (HAADF), **TEM spectroscopy:** X-ray analysis in TEM (EDX), Electron energy loss spectrometry, Key applications of TEM. Specimen changes during imaging, Strategies for minimizing specimen damage: Outlook for SEM and TEM.	**CO1** **CO2** **CO4**
IV	**X-ray diffraction (XRD) techniques for materials characterization:** Introduction, Principles of X-ray diffraction techniques, Generation of X-ray radiation, Diffraction of X-ray by crystalline materials. **Special methods:** Energy-dispersive X-ray diffraction, Small angle scattering, In situ X-ray diffraction, Hardware for X-ray diffraction measurements with laboratory equipment: X-ray source, Goniometer, Primary optics, Secondary optics, Detectors. **Applications:** Measurement of diffraction patterns by X-ray diffraction, Qualitative phase analysis. Quantitative phase analysis: Method with external standard, Method with internal standard, Method of intensity ratio, Rietveld method.	**CO3** **CO4**
V	**Thermal Analysis:** Common Characteristics-Thermal Events, Instrumentation Experimental Parameters. **Differential Thermal Analysis and Differential Scanning Calorimetry:** Working Principles, Temperature-Modulated Differential Scanning Calorimetry Experimental Aspects, Measurement of Temperature and Enthalpy Change, Applications. **Thermogravimetry:** Instrumentation, Experimental Aspects Interpretation of Thermogravimetric Curves, Applications**.**	**CO3** **CO4**

Learning Recourse(s)

Text Book(s)

1. Materials Characterization Using Nondestructive Evaluation (NDE) Methods. (2016). Netherlands: Elsevier Science.
2. Mitra, P. K. Characterization of Materials. PHI Learning Pvt. Ltd., 2013.
3. Leng, Yang. Materials characterization: introduction to microscopic and spectroscopic methods. John Wiley & Sons, 2009.

Reference books

1. B.D.Cullity and S.R.Stock, "Elements of X-Ray Diffraction" Third edition, Prentice Hall,NJ, 2001.
2. David B. Williams, C. Barry Carter, " Transmission Electron Microscopy: A Textbook for Materials Science", Springer, pub. 2009.
3. Zhang, Sam, Lin Li, and Ashok Kumar. Materials characterization techniques. CRC press, 2008.

e- Resources & other digital material

1. https://nptel.ac.in/courses/115/103/115103030/
2. https://onlinecourses.nptel.ac.in/noc20_mm14/preview
3. https://www.classcentral.com/course/swayam-materials-characterization-7978

AUTOMOBILE ENGINEERING

Course code	20ME4601E	Year	III	Semester	II
Course category	Professional Elective-II	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Applied Thermodynamics
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: At the end of the course students will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand basic components of an Automobile.	Understand	L2	1,2,3,4,5
CO2	Illustrate the working of various systems of engines.	Apply	L3	1,2
CO3	Illustrate the working of various automobile systems.	Apply	L3	3,4,5
CO4	Illustrate various alternative energy resources, emissions standards and application of plastic in automobiles.	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1									1	3	1
CO2	3	1	1									1	3	1
CO3	3	1	1									1	3	1
CO4	3	1	1				2					1	3	1

Syllabus

UNIT	Contents	Mapped CO
I	**INTRODUCTION** Components of four-wheeler automobile – chassis and body – power unit –power transmission – rear wheel drive, front wheel drive, 4-wheel drive. Types of automobile engines, engine construction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps – crank case ventilation –engine service, reboring, decarburization, Nitriding of crank shaft. **INTRODUCTION TO NVH:** Definition of Noise, Vibrations & Harshness in reference to Vehicular application.	CO1, CO2
II	**FUEL SYSTEM** S.I. Engine: Fuel supply systems, Mechanical and electrical fuel pump – filters–carburetor – types – air filters – petrol injection. C.I. Engines: Requirements of diesel injection systems, types of injection systems, fuel pump, nozzle, spray formation, injection timing, testing of fuel pumps. **COOLING SYSTEM:** Cooling Requirements, Air Cooling, Liquid Cooling, Thermosyphon, Forced Circulation System, evaporating cooling and pressure sealed cooling – antifreeze solutions.	CO1, CO2

	IGNITION SYSTEM: Ignition System-, battery, magneto, Electronic ignition	
III	**TRANSMISSION SYSTEM:** Clutches: Principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel. Gear boxes, types, sliding mesh, construct mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. Propeller shaft – Hotch – Kiss drive, Torque tube drive, universal joint, differential rear axles – types – wheels and tyres. **SUSPENSION SYSTEM:** Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.	**CO1, CO3**
IV	**STEERING SYSTEM:** Steering geometry – camber, castor, king pin rake, combined angle toe-in, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages. **BRAKING SYSTEM:** Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder, tandem master cylinder, Requirement of brake fluid, Pneumatic and vacuum brakes.	**CO1, CO3**
V	**ELECTRICAL SYSTEM:** Charging circuit, generator, current – voltage regulator – starting system, Bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc. **EMISSION FROM AUTOMOBILES:** Pollution standards National and international – Pollution Control– Techniques – Multipoint fuel injection for SI Engines. Common rail diesel injection. Energy alternatives – Solar, Photo-voltaic, hydrogen, Biomass, alcohols, LPG ,CNG, liquid Fuels and gaseous fuels, electrical-their merits and demerits. **KEY AUTOMOTIVE PLASTICS APPLICATIONS:** Safety and Energy Management, Interiors and Occupant Safety. Glazing, Plastic-Metal Hybrid Structures, Headlamps, Body Panels, Under-the-Hood Components.	**CO1, CO3, CO4**

Learning Resource
Text books:
1. Automotive Mechanics-Vol.1 & Vol.2, by Kirpal sing, Standard Publishers, New Delhi 2008. 2. Automobile Engineering, (3rd edition), by William crouse, TMH Distributors, New Delhi. 3. Plastics Application Technology for Safe and Lightweight Automobiles,Sudhakar R Marur,SAE International (30 October 2013), USA
Reference books
1. Automobile Engineering Theory and Servicing, by James D. Halderman and Chase D. Mitchell, Pearson education inc, 2001. 2. Automobile Engineering, by Newton's steeds & Garrett Automotive Mechanics Heitner, Butterworth International, London.
e- Resources & other digital material
1. https://nptel.ac.in/courses/107/106/107106088/

VALUE ENGINEERING

Course Code	20ME2601A	Year	III	Semester	II
Course Category	Open Elective-II	Offering Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	UNIT
CO1	Understand the basic concepts, techniques and applications of value engineering	Understand	L2	1,2,3,4,5
CO2	Describe job plan of value engineering.	Understand	L2	2
CO3	Illustrate different value engineering techniques and versatility of value engineering.	Apply	L3	3,4
CO4	Illustrate the efforts of value engineering team during the process of value engineering	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H: High(3), M: Medium(2), L:Low(1))

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2			3			3		3			3
CO2	1	2	2			3			3		3			3
CO3	1	2	2			3			3		3			3
CO4	1	2	2			3			3		3			3

Syllabus

UNIT	Content	Mapped CO
I	**Introduction**: Value engineering (VE) concepts, advantages, applications, problem recognition, and role in productivity, criteria for comparison, element of choice. **Organization**: Level of value engineering in the organization, size and skill of VE staff, small plant, VE activity, unique and quantitative evaluation of ideas.	CO1
II	**Value engineering job plan**: Introduction, orientation, information phase, speculation phase, analysis phase. **Selection and Evaluation of value engineering Projects**, Project selection, methods selection, value standards, application of value engineering methodology.	CO1, CO2
III	**Value engineering techniques**: Selecting products and operation for value engineering action, value engineering programmes, determining and evaluating function(s) assigning rupee equivalents, developing alternate means to required functions, **Decision making for optimum alternative**, use of decision matrix, queuing theory and Monte Carlo method make or buy, measuring profits, reporting results, Follow up, Use of advanced technique like Function Analysis System.	CO1, CO3

IV	**Versatility of value engineering**: Value engineering operation in maintenance and repair activities, value engineering in non-hardware projects. **Initiating a value engineering programme**: Introduction, training plan, career development for value engineering specialties.	**CO1, CO3**
V	**Value engineering level of effort**: Value engineering team, co-coordinator, designer, different services, definitions, construction management contracts, value engineering case studies.	**CO1, CO4**

Learning Recourse(s)

Text Book(s)

1. Anil Kumar Mukhopadhyaya, "Value Engineering: Concepts Techniques and applications", SAGE Publications 2010.
2. Dr. M. H. Bulsara, Dr. H. R. Thakkar, "Product design and Value Engineering", Charotar Publishers,2009.

Reference books

1. Alphonse Dell'Isola, "Value Engineering: Practical Applications for Design, Construction, Maintenance & Operations", R S Means Co., 1997.
2. Richard Park, "Value Engineering: A Plan for Invention", St. Lucie Press, 1999.
3. Del L. Younker, "Value Engineering analysis and methodology", Marcel Dekker Inc, New York, 2004.
4. Miles, L.D., "Techniques of Value Analysis and Engineering", McGraw Hill, second Edition, 1989.
5. Khanna, O.P., "Industrial Engineering and Management", Dhanpat Rai & Sons, 1993.
6. Anil Kumar Mukhopadhyaya, "Value Engineering Mastermind: From concept to Value Engineering Certification", SAGE Publications, 2003

HUMAN FACTORS IN ENGINEERING

Course Code	20ME2601B	Year	III	Semester	II
Course Category	Open Elective-II	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Units
CO1	Understand the fundamentals of Human factors, Physical work, Anthropometry, Ergonomics, Machine controls, Seating design, Colour - Light, Temperature - Humidity –Illuminations and Measurement of sound.	Understand	L2	1,2,3,4,5
CO2	Identify the role of Anthropometry and Ergonomics in product design.	Apply	L3	2
CO3	Choose the effective seating design and Machine controls for improvement of human workplace.	Apply	L3	3
CO4	Represent the importance of colour and light, Temperature - Humidity – Illumination, Measurement of sound in human workplace.	Apply	L3	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H: High(3), M: Medium(2), L:Low(1))

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		2			3			1			1	3	1
CO2	1		2			3			1			1	3	1
CO3	1		2			3			1			1	3	1
CO4	1		2			3			1			1	3	1

Syllabus

UNIT	Content	Mapped CO
I	**Fundamentals of Human Factors Engineering**: Human Biological, Ergonomic and psychological capabilities and limitations, Concepts of human factors engineering and Ergonomics, Man-Machine system and Design philosophy. **Physical work and energy expenditure**: Manual lifting, Work posture, Repetitive motion, Provision of energy for muscular work, Heat stress, Role of oxygen physical exertion, Measurement of energy expenditure, Respiration, Pulse rate and blood pressure during physical work, Physical work capacity and its evaluation.	CO1

II	**Anthropometry**: Physical dimensions of the human body as a working machine, Motion size relationships, Static and dynamic anthropometry, Anthropometric design principles, Using anthropometric measures for industrial design. **Ergonomics and product design**: Ergonomics in automated systems, Expert systems for ergonomic design, Anthropometric data and its application in ergonomic design, Limitations of anthropometric data, Use of computerized database.	**CO1, CO2**
III	**Machine controls:** Improvement of human work place through controls, Displays and Controls, Shapes and sizes of various controls and displays, Multiple display and control situations, Design of major controls in automobiles and machine tools, Principles of hand tool design. **Work place and seating design**: Design of office furniture, Redesign of instruments, Work process: Duration of rest periods, Design of visual displays, Design for shift work.	**CO1, CO3**
IV	**Color and light:** Color and the eye, Color consistency, Color terms, Reactions to color and color continuation, Color on engineering equipments. **Temperature-Humidity-Illumination and Contrast**: Use of Photometers, Recommended illumination levels, the ageing eye, Use of indirect (Reflected) lighting, Cost efficiency of illumination. Special purpose lighting for illumination and quality control.	**CO1 CO4**
V	**Measurement of sound**: Noise exposure and hearing loss, Hearing protectors, Analysis and reduction of noise, Effects of noise, Performance annoyance of noise and interface with communication, Sources of vibration and performance effect of vibration.	**CO1 CO4**

Learning Recourse(s)

Text Book(s)

1. . M. S. Sanders and E. J. McCormick, Human Factors in Engineering Design, VII Edition, McGraw Hill International, 1993.

Reference books

1. P. V. Karpovich and W. E. Sinning, Physiology of Muscular Activity", VII Edition, Saunders (W.B.) Co Ltd., 1971.
2. Applied Ergonomics Handbook, I.P.C. Science and Technology Press Limited, 1974.
3. M. Helander, A Guide to the Ergonomics of Manufacturing, II Edition, CRC Press, 1997.
4. K. H. E. Kroemer, H. B. Kroemer, K. E. Kroemer Elbert, Ergonomics: How to design for ease and efficiency, II Edition, Pearson Publications, 2001.

CAE/CAM LAB

Course code	20ME3651	Year	III	Semester	II
Course category	Program Core	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Prerequisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

CO	Statement	Skill	BTL	Expts.
CO1	Demonstrate the main stages of Finite Element analysis.	Apply	L3	1-6
CO2	Perform modeling and analysis of structural and heat transfer problems.	Apply	L3	1-6
CO3	Use CAM software to generate NC code	Apply	L3	7, 8
CO4	Machine simple components on CNC machines	Apply	L3	9-12

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	3		2	3				1			2	2	3
CO2	1	3		2	3				1			2	2	3
CO3	1				3				1			2	2	3
CO4	1				3				1			2	2	3

Syllabus		
Expt. No	**Contents**	**Mapped CO**
	CAE LAB	
1.	Static analysis of indeterminate/ composite bars	CO1 CO2
2.	Shear force and bending moment diagrams of a beam	
3.	Thermal stress in bar.	
4.	static analysis of plane or 3-space truss/frame	
5.	Evaluation of Stress concentration factor in a rectangular plate with central hole	
6.	Stress distribution in thick a cylinder subjected to internal and/external pressures	
	CAM LAB	
7.	Rectangular and Arbitrary contouring NC code generation using ESPRIT	CO3
8.	Facing, Taper Turning and Arbitrary Profile Turning NC code generation using ESPRIT	
9.	Rectangular contouring on XL MILL	CO4
10.	Arbitrary contouring on XL MILL	
11.	Facing and Taper turning on XLTURN	
12.	Arbitrary Profile Turning on XLTURN	

METROLOGY AND MEASUREMENTS LAB

Course code	20ME3652	**Year**	III	**Semester**	II
Course category	Program Core	**Branch**	ME	**Course Type**	Lab
Credits	1.5	**L-T-P**	0-0-3	**Prerequisites**	Nil
Continuous Internal Evaluation	15	**Semester End Evaluation**	35	**Total Marks**	50

Course Outcomes: Upon successful completion of the course, the student will be able to

COs	Statement	Skill	BTL	Expt.No
CO1	Use instruments for measuring linear, angular dimensions and surface roughness.	Apply	L3	1-6
CO2	Perform alignment tests on various machine tools.	Apply	L3	7
CO3	Apply standard procedures to calibrate instruments for measuring field quantities.	Apply	L3	8-14

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3-High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1		2	2				2	3		1	3	2
CO2	3	1		2					2	3		1	3	2
CO3	3	1		2	2				2	3		1	3	2

Note: Any ***'SIX'*** experiments from Each Section are to be performed

Syllabus

Expt. No	Contents	Mapped COs
METROLOGY		
1.	Measurement of bore by internal micro metres and dial bore indicator / rollers and slip gauges.	**CO1**
2.	Use of gear teeth vernier callipers for checking the chordal addendum and chordal thickness of spur gear.	
3.	Measurement of linear and angular dimensions using Profile projector / Tool makers microscope.	
4.	Angle and taper measurements by Bevel protractor, Sine bars, spirit level etc.	
5.	Measurement of effective diameter of a thread using Two wire/ Three wire method.	
6.	Surface roughness measurement by Talysurf instrument	
7.	Alignment test on the lathe/milling machine using dial indicators.	**CO2**
MEASUREMENTS		
8.	Calibration of Pressure Gauge using dead weight pressure gauge tester.	**CO3**
9.	Calibration of thermocouple.	
10.	Calibration of LVDT.	
11.	Calibration of capacitive transducer.	
12.	Calibration of photo and magnetic speed pickup transducer.	
13.	Calibration of Strain gauge.	
14.	Measurement of flow using rotameter	

MACHINE DYNAMICS LAB

Course Code	20ME3653	Year	III	Semester	II
Course Category	Program Core	Branch	ME	Course Type	Lab
Credits	1.5	L-T-P	0-0-3	Pre-requisites	Nil
Continuous Internal Evaluation	15	Semester End Evaluation	35	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

COs	Statement	Skill	BTL	Expts.
CO1	Evaluate the natural frequencies in different vibrating systems and the effect of gyroscopic couple	Analyze	L4	1,2,3,12
CO2	Compute the radius of gyration & Moment of Inertia of the oscillating part in the vibration system	Analyze	L4	4,5
CO3	Test for amplitude and damping coefficient in damped and undamped vibrating systems	Analyze	L4	6,7,8
CO4	Verify the static and dynamic balancing and determination of whirling speeds of shaft	Analyze	L4	9,10,11

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3-High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3						1			3	2
CO2	3	3	2	3						1			3	2
CO3	3	3	2	3						1			3	2
CO4	3	3	2	3						1			3	2

Syllabus

Expt. No	Contents	Mapped CO
1.	Determination of Natural frequency of single mass, single helical spring system.	CO1
2.	Determination of Natural frequency of the combination of springs – springs in parallel or springs in series.	CO1
3.	Determination of Natural frequency of undamped torsional single rotor system.	CO1
4.	Determination of radius of gyration of a given compound pendulum.	CO2
5.	Determination of radius of gyration, a moment of inertia – bifilar suspension Method.	CO2
6.	To find the Damping coefficient of the torsional single rotor system.	CO3
7.	Determination of amplitude of vibration of a damped vibrating system.	CO3
8.	Determination of amplitude of vibration of an undamped vibrating system.	CO3
9.	Verify the Static balancing using a steel ball.	CO4
10.	Verify the Dynamic balancing using steel balls.	CO4
11.	Whirling of shafts/ determination of critical speed with Rotors.	CO4
12.	Gyroscopic couple verification.	CO1

Learning Resources
Text Books: Theory of Machines, (4th Edition) by S.S.Rattan ,Tata Mc.Graw Hill, New Delhi, 2014. Mechanical vibrations, (4th edition) by Singiresu S. Rao Pearson education publications, Delhi, 2004.
Reference Books: Theory of Machines, (5th Edition) by R.K.Bansal, Laxmi Publications(p) ltd. New Delhi, 2010

SOFT SKILLS

Course Code	20SS8651	Year	III	Semester	II
Course Category	Institutional Core	Branch	ME	Course Type	Theory
Credits	2	L-T-P	1-0-2	Pre-requisites	Nil
Continuous Internal Evaluation	-	Semester End Evaluation	50	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

COs	Statement	Skill	BT L	Units
CO1	**Develop** logical and **Analytical** skill set through Case Studies	Apply	L3	1,2,3,4
CO2	**Proficient** in giving Presentations	Apply	L3	1,2,3,5
CO3	**Develop** the corporate etiquette	Apply	L3	3,4
CO4	**Develop** Competency in group discussion & Interviews	Apply	L3	2,5
CO5	**Present** themselves with corporate readiness	Apply	L3	1,2,4,5,6

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3-High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								2		2				
CO2									3	3		2		
CO3								2	1	2		1		
CO4									3	3				
CO5										3				

UNIT	Course Content	Mapped CO
I	• Soft Skills- Need & Importance. Intra & Inter Personal Skills • Campus to Corporate- Employability Skills- Need of the hour • SWOT Analysis. • Attitude- Developing Professional & Positive Attitude • Perception – Importance of analytical thinking.	CO1, CO2, CO5
II	• Communication Skills – Need and Methods • Body-Language -I; How to interpret and understand other's body language • Body Language-II; How to improve one's own Body Language • Presentation Skills (Seminar Talk & Power Point Presentation)	CO1 CO2, CO4, CO5
III	• Goal Setting- Need & Importance • Magic of Team Work. • Leadership Qualities. • Six Thinking Hats.	CO1, CO3
IV	• Accountability towards Work. • Paragraph Writing – Descriptive and Analytical with illustrations • Email Writing • Work Etiquette	CO1, CO3, CO5
V	• Group Discussion (Open & Monitored) • Resume Preparation • Interview Skills	CO2, CO4, CO5

	• Mock Interviews	
VI	• Vocabulary- Root Words (A representative Collection of 50) • Vocabulary for Competitive Exams (A list of 500 high frequency Words) • Idioms & Phrases • Verbal Analogies • Correction of Sentences • Sentence Completion – Course of Action • Cloze Test • Reading Comprehension (Skimming, Scanning & tackling different kinds of questions) • Phrasal Collocations (Representative collection of 50 meanings along with sentential illustrations) • SWAR/ VERSANT Test	**CO5**

Learning Resources

Text Books:

1. The ACE of Soft Skills by Gopala swamy Ramesh & Mahadevan Ramesh –Pearson.
2. Working with Emotional Intelligence - David Goleman.
3. Developing Communication Skills by Krishna Mohan and Meera Banerji; MacMillan India Ltd., Delhi.

Reference Books:

1. Soft Skills: Meenakshi Raman.
2. Audio—Visuals / Hand Outs (Compiled/Created by T&P Cell, P.V.P. Siddhartha Institute of Technology),
3. Board & Chalk and Interactive Sessions

Semester End Evaluation

15 marks for Report- Which includes

narks for Resume

Marks for PPT (5M for PPT preparation & Presentation,
5M for Report Preparation on PPT)

35 Marks for External Exam – Which includes

marks for Viva with external examiner,

marks for Vocab test (Which is essential in Recruitment written test)

narks for E-mail Writing (which is important for the student to apply for the job through online, to give consent to job offer and to communicate in the work environment)

CONSTITUTION OF INDIA

Course Code	20MC1601	Year	III	Semester	II
Course Category	Mandatory Course	Branch	ME	Course Type	Theory
Credits	2	L-T-P	3-0-0	Pre-requisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

COs	Statement	Skill	BTL	Units
CO1	Enable the student to understand the importance of	Understand	L2	1
CO2	Understand philosophy of fundamental rights and duties	Understand	L2	2
CO3	Understand the structure of Union government and central and state relation, with respect to financial and administrative, executive, legislature and judiciary	Understand	L2	3
CO4	Understand the structure of State and local government with respect to financial and administrative, executive,	Understand	L2	4
CO5	Understand the autonomous nature of constitutional bodies like Supreme Court and high court, comptroller and auditor general of India and election commission of	Understand	L2	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3-High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1								3						
CO2						3	2	2		1				
CO3								3						
CO4								3						
CO5						2		3						

UNIT	Course Content	Mapped Cos
I	**INTRODUCTION TO INDIAN CONSTITUTION** Constitutional history, constituent assembly, salient features of the constitution, significance of preamble, amending process of the constitution.	CO1
II	**RIGHTS AND DUTIES** Citizenship, fundamental rights and directive principles, fundamental duties	CO2
III	**UNION GOVERNMENT** President and vice president, election, removal and powers, prime minister and council of ministers, parliament, supreme court, union, state relations, emergency provisions.	CO3
IV	**STATE AND LOCAL GOVERNMENTS** Governor, state legislature, assembly and council, chief minister and council of ministers, high court, rural and urban local governments with special reference to 73rd and 74th constitutional amendment acts.	CO4

V	**OTHER CONSTITUTIONAL AND STATUTORY BODIES** Comptroller and auditor general, election commission, finance commission, attorney general and advocate general, union public service commission (UPSC), state public service commissions (SPSCs), tribunals, national human rights commission (NHRC).	**CO5**

Learning Resources
Text Books:
1. J. C. Johari, Indian Government and Politics, Vishal Publications, Delhi,2009. 2. M. V. Pylee, Introduction to the Constitution of India, 5/e, Vikas Publishing House, Mumbai, 2007.
Reference Books:
1. D.D. Basu, Introduction to the Indian Constitution, 21/e, Lexis Nexis, Gurgaon, India, 2011. 2. Subhas C. Kashyap, Our Constitution, 2/e, National Book Trust India, New Delhi,2013
E-Resources& other digital material
1. http://nptel.ac.in/courses.php 2. http://jntuk-coeerd.in/

MECHANICAL VIBRATIONS

CourseCode	20ME4701A	Year	IV	Semester	I
Course Category	Professional Elective- III	Branch	ME	Course Type	Theory
Credits	3	L – T – P	3 – 0 – 0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the basic principles of vibrating systems and acoustics.	Understand	L2	1,2,3,4,5
CO2	Compute the natural frequency and vibration response of single degree freedom systems under free and forced vibrations	Apply	L3	1,2
CO3	Determine the response of Two-degree freedom systems under free and forced vibrations	Apply	L3	3,4
CO4	Determine the equation of motion and find the natural frequencies and corresponding mode shapes of a multi degree of freedom system	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program OutcomesStrength of correlations (3: High, 2: Moderate, 1: Low)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1									3	1
CO2	3	3	1	1									3	1
CO3	3	3	1	1									3	1
CO4	3	3	1	1									3	1

Syllabus		
UNIT	Contents	Mapped COs
I	**UNDAMPED FREE VIBRATIONS OF SDOF SYSTEMS** Introduction, basic concepts of vibration, importance of vibration study, elements of a vibrating system, types of vibration, methods of vibration analysis, harmonic motion, Equation of motion, free vibration of undamped translational system, free vibration of undamped torsional system, Raleigh's energy method. **DAMPED FREE VIBRATIONS OF SDOF SYSTEMS** Introduction, types of damping, free vibration with viscous and coulomb damping, logarithmic decrement.	CO1, CO2
II	**HARMONICALLY EXITED VIBRATIONS** Introduction, equations of motion, response of undamped and damped systems under harmonic excitation, response of a damped system under harmonic motion of the base, response of a damped system under rotating unbalance, vibration, measuring instruments-vibrometer and accelerometer, critical speed.	CO1, CO2

III	**TWO DEGREE OF FREEDOM SYSTEMS:** Introduction, equations of motion for forced vibration, free vibration analysis of an undamped system, torsional system, coordinate coupling and principal coordinates, forced vibration analysis. Dynamic vibration absorber.	**CO1, CO3**
IV	**MULTI-DEGREE OF FREEDOM SYSTEMS**: Introduction, modeling of continuous systems as multi degree of freedom systems, using Newton's second law to derive equations of motion, influence coefficients, Determination of natural frequencies and mode shapes.	**CO1, CO3**
V	**FUNDAMENTALS OF ACOUSTICS:** Human Perception of Sound, Sound Wave Propagation in 1-D, Some Important Acoustic Quantities and Relations, Acoustic Transducers and types of Microphones, acoustic exciters, Sound Level Measurement, Sound Intensity Measurement, Sound Absorption Measurement	**CO1, CO4**

Learning Recourse(s)

Text Book(s)

1. S.S.Rao,MechanicalVibrations,5/e,PearsonEducationInc.,2011.
2. G. K. Grover, Mechanical Vibrations, 8/e, Nem Chand & Bros
3. C. Sujatha, Vibration And Acoustics Measurement and Signal Analysis , Tata McGraw Hill

Reference Book(s)

1. L.Meirovich, Elements of Vibration Analysis,2/e. TataMcGraw Hill,2007.
2. J.S.Raoand,K.Gupta,IntroductoryCourseonTheoryandPracticeofMechanicalVibrations,2/e, NewAge International,1999.

E-Resources & other digital material

1. https://nptel.ac.in/courses/112/103/112103112/
2. . https://nptel.ac.in/courses/112/103/112103111/

GEOMETRIC DIMENSIONING AND TOLERANCING

Course Code	20ME4701B	Year	IV	Semester	I
Course Category	Professional Elective- III	Branch	ME	Course Type	Theory
Credits	3	L – T – P	3 – 0 – 0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO 1	Illustrates basic principles of Geometric and Dimensioning Tolerancing, symbols.	Understand	L2	1,2,3,4,5
CO 2	Set up and use basic rectangular datum reference frames	Apply	L3	3
CO 3	Interpret form, Location, profile, and runout tolerances.	Apply	L3	4,5

Contribution of Course Outcomes towards achievement of Program OutcomesStrength of correlations (3: High, 2: Moderate, 1: Low)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		2				2			2	2	1
CO2	3		2		2				2			2	2	2
CO3	3	3	2		2				2			2	2	1

Syllabus		
UNIT	Contents	Mapped COs
I	**Introduction:** Scope, Definitions, Fundamental Rules, Units of Measure, Types of Dimensioning, Application of Dimensions, Dimensioning Features, Location of Features **Symbology:** Use of Notes to Supplement Symbols, Symbol Construction, Feature Control Frame Symbols, Feature Control Placement, Definition of Tolerance Zone, Tabulated Tolerances	CO1
II	**Principles of Tolerancing:** Direct Tolerancing Methods, Tolerance Expression, Interpretation of Limits, Single Limits, Tolerance Accumulation, Limits of Size, Applicability of Modifiers on Geometric Tolerance Values and Datum Feature References, Screw Methods, Gears and Splines, Boundary Conditions, Angular Surfaces, Conical Tapers, Flat Tapers, Radius, Tangent Plane, Statistical Tolerancing.	CO1
III	**Datum Reference Frames:** Degrees of Freedom, Degrees of Freedom Constrained by Primary Datum Features, Regardless of Material Boundary, Constraining Degrees of Freedom of a Part, Datum Feature Simulator, Theoretical and Physical Application of Datum Feature Simulators, Datum Reference Frame, Datum Features and Controls, Specifying Datum Features in an Order of Precedence, Establishing Datums, Multiple Datum Features, Mathematically Defined Surface, Multiple Datum reference frames, Functional Datum Features, Rotational Constraint about a Datum Axis or Point, Application of MMB, LMB and RMB to Irregular Features of Size, Datum Feature Selection Practical	CO1, CO2

	Applications, Simultaneous Requirements, Restrained Condition, Datum Reference Frame Identification, Customized Datum Reference Frame Construction, Application of a Customized Datum Reference Frame, Datum Targets	
IV	**Form Tolerances:** Form Control, Specifying Form Tolerances, Application of Free-State Symbol Orientation Tolerances: Orientation Control, Orientation Symbols, Specifying Orientation Tolerances, Tangent Plane, Alternative Practice Location Tolerances: Positional Tolerancing, Positional Tolerancing Fundamentals – I and II, Pattern Location, Coaxial Feature Controls, Tolerancing for Symmetrical Relationships	**CO1, CO3**
V	**Profile Tolerances:** Profile, Tolerance Zone Boundaries, Profile Applications, Material Condition and Boundary Condition Modifiers as Composite Profile, Multiple Single-Segment Profile Tolerancing, Combined Controls Runout Tolerances: Runout, Runout Tolerance, types of Runout Tolerances, Applications, specification.	**CO1, CO3**

Learning Resources
Text Books
1. Geometric Dimensioning and Tolerancing by P.S. Gill, (Publ.) S. K. Kataria & Sons, 2009 2. Geometric Dimensioning and Tolerancing: Applications and Techniques for Use in Design: Manufacturing, and Inspection, by James D. Meadows, CRC Press, 1995. 3. Simplified GD & T: Based on ASME-Y 14.5-2009 by Ashok Kumar 2nd Edition, Azuko Publishing 2009
Reference Books
1. Integrated Product Design and Manufacturing Using Geometric Dimensioning and Tolerancing: Robert G. Campbell, CRC Press, 2002

ALTERNATIVE SOURCES OF ENERGY

Course Code	20ME4701C	Year	IV	Semester	I
Course Category	Professional Elective- III	Branch	ME	Course Type	Theory
Credits	3	L – T – P	3 – 0 – 0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes; Upon successful completion of the course, the student will be able to

COS	Statement	Skill	BTL	Units
CO1	Demonstrate Different alternate sources of Energy and energy conversion methods.	Understand, Communication	L2	1,2,3,4,5
CO2	Illustrate Solar energy Principles, various solar collectors, energy storage methods and applications.	Apply, Communication	L3	1
CO3	Summarize various wind energy, biomass energy, Geothermal Energy and Ocean Energy concepts and applications.	Apply, Communication	L3	2,3
CO4	Select suitable fuel cell and energy conversion methods.	Apply, Communication	L3	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H: High, M: Medium, L: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					3	3			2		2	3	2
CO2	3	2				3	3			2		2	3	2
CO3	3					3	3			2		2	3	2
CO4	3					3	3			2		2	3	2

Syllabus

UNIT	Contents	Mapped CO
I	**Role and potential of new and renewable sources**: **Solar Energy**: introduction- Solar Energy option, Solar energy collection-Flat plate collectors, Evacuated Tube Collectors, and concentrating collectors, classification of concentrating collectors-, Compound parabolic Collectors, Parabolic Throughs, Fresnel lens collector, Paraboloid dish collector. **Solar Energy Storage**- Different methods, sensible, latent heat and stratified storage, solar ponds: working principle. Solar applications- solar heating/ cooling techniques, solar distillation and drying.	**CO1 CO2**
II	**Wind Energy**: Sources and potentials, classification of wind mills- horizontal and vertical axis wind mills, effect of wind speed on power generation, considerations for site selection, **Bio Mass Energy**: Properties, principles of production, classification- fixed dome-floating type, comparison, site selection, Plant models in India: floating gas holder- KVIC, fixed dome - Janata type, pragati model, deenbandhu model, constraints for implementation, Factors effecting biomass digestion.	**CO1 CO3**

III	**Geothermal Energy**: Origin and Distribution of Geothermal Energy, Types of Geothermal Resources- Hydrothermal Resources, Geopressured Resources, Hot Dry Rock Resources, Magma Resources, Types of wells, , potential in India. **OCEAN ENERGY** **OTEC:** Principles, utilization, setting of OTEC plants, thermodynamic cycles. **Tidal Energy**: Origin and Potential, conversion techniques: types of basins **Wave Energy:** Origin and Potential, conversion techniques: Heaving Float type, pitching type, Heaving and Pitching type, Oscillating water column type, Surge devices.	**CO1** **CO3**
IV	**Fuel cells:** Principle of fuel cells, Faraday's laws, thermodynamic aspects. Performance limiting factors of fuel cells-reactivity-invariance, electrode losses-chemical polarization-concentration polarization-resistance polarization. **Types of fuel cells:** hydrogen-oxygen fuel cells: Proton exchange membrane fuel cell (PEMFC), Redox fuel cell (RFC), Phosphoric acid fuel cell (PFC); biochemical cells- depolarixatiori or concentration cell, product cell, and redox cell; Regenerative cells.	**CO1** **CO4**
V	**Direct Energy Conversion**: Need for DEC, limitations, principles of DEC. Thermoelectric generators, Seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, Thermionic Generator. **MHD Power Conversion:** MHD generators- principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator- construction and working, Advantages and limitations.	**CO1** **CO4**

Learning Resource
Text books:
1. Non-Conventional Energy Sources, G.D.Rai, Khanna publishers 2. Non-Conventional Energy Sources, B. H. Khan, Tata Mc Graw Hill-2009
Reference books
1. Energy Technology – Non-Conventional, Renewable & Conventional, S. Rao, Khanna publishers. 2. S. P. Sukhame, "Solar Energy- Principles and Applications", Tata Mc Graw Hill-2006 3. G.N Tiwari and M.K Ghosal – "Renewable energy resources" -Narosa Publishing House-2005 4. Future Sources of Electrical Power, M.P. Agrawal, 1st edition, S. Chand& Co., 1999.
e- Resources & other digital material
https://nptel.ac.in/courses/121/106/121106014/
https://nptel.ac.in/courses/112/105/112105050/
https://nptel.ac.in/courses/108/108/108108078/

LOGISTICS & SUPPLY CHAIN MANAGEMENT

Course Code	20ME4701D	Year	IV	Semester	I
Course Category	Professional Elective- III	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to				
CO	**Statement**	**Skill**	**BTL**	**Units**
CO1	Explain the importance of Supply Chain Management	Understand	L2	1,2,3,4,5
CO2	Illustrate Inventory control techniques	Apply	L3	2
CO3	Illustrate various issues in Supply Chain Management	Apply	L3	5
CO4	Interpret supply chain strategies and procurement strategies	Apply	L3	4
CO5	Design Supply Chain Networks suitable for various market conditions	Analyse	L4	3

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Moderate, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1		2							2		3			1
CO2		2							2		3			1
CO3		2							2		3			1
CO4		2							2		3			1
CO5		2							2		3			1

Syllabus		
UNIT	**Content**	**Mapped CO**
I	**Introduction to Supply Chain Management (SCM):** Concept of supply management and SCM, importance of supply chain flows, core competency, value chain, elements of supply chain efficiency, key issues in SCM, decision phases, supply chain integration, process view of a supply chain, competitive strategy and supply chain strategies, uncertainties in supply chain, supply chain drivers.	**CO1**
II	**Inventory Management**: Introduction, selective control techniques, cost involved in inventory system, single stage inventory control, economic lot size models, application to economic production quantity, effect of demand uncertainty, single period models, initial inventory, multiple order opportunities, deterministic models, quantity discounts. periodic and quantity review policies, mathematical modeling under known stock out costs and service levels, joint replenishment for multiple items, inventory system constraints, working capital restrictions, and storage space restrictions.	**CO1 CO2**

III	**Designing Supply Chain Network:** Introduction, network design, factors influencing network design, data collection, data aggregation, transportation rates, warehouse costs, capacities and locations, models and data validation, key features of a network configuration, impact of uncertainty on network design, network design in uncertain environment, value of information: Bullwhip effect, information sharing, information and supply chain trade-offs, distribution strategies, direct shipment distribution strategies, transshipment and selecting appropriate strategies.	**CO1 CO5**
IV	**Supply Chain Integration:** Introduction, push-pull supply chains, identifying appropriate supply chain strategy, Sourcing and procurement, outsourcing benefits, importance of suppliers, evaluating a potential supplier, supply contracts, competitive bidding and negotiation. Purchasing, objectives of purchasing, relations with other departments, centralized and decentralized purchasing, purchasing procedure, types of orders, e-procurement, tender buying, role of business in supply chains.	**CO1 CO4**
V	**Issues in Supply Chain Management:** Introduction, risk management, managing global risk, issues in international supply chain, regional differences in logistics. Local issues in supply chain, issues in natural disaster and other calamities, issues for SMEs, organized retail in India, reverse logistics.	**CO1 CO3**

Learning Resources
Text books:
1. Simchi-Levi, D. Kaminsky, P.Simchi-Levi, E. and Ravi Shankar, Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies, 3/e, Tata McGraw-Hill, 2008. 2. Chopra, S. and Meindl, Supply Chain Management: Strategy, Planning and Operations, 2/e, Pearson Education, 2004.
Reference books
1. Doebler, D.W. and Burt, D.N, Purchasing and Supply Management-Text and Cases, 6/e, McGraw- Hill, 1996. 2. Tersine, R.J, Principles of Inventory and Materials Management, 4/e, Prentice Hall, 1994.
E- Resources & other digital material
1. https://ocw.mit.edu/courses/engineering-systems-division/esd-273j-logistics-and-supply-chain management-fall-2009/lecture-notes/ 2. https://nptel.ac.in/courses/110/108/110108056/

NANO TECHNOLOGY

Course Code	20ME4701E	Year	IV	Semester	I
Course Category	Professional Elective- III	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	UNIT
CO1	Understand the basic concepts and applications of Nanotechnology, nano material and nano structures	Understand	L2	1,2,3,4,5
CO2	Describe different classes of nano materials.	Understand	L2	2
CO3	Illustrate the processes for synthesizing and characterizing nano materials	Apply	L3	3,4
CO4	Choose nano materials for different applications	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H: High, M: Medium, L: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	2	1				1			2	2	1
CO2	3	1	2	2	2				1			2	2	1
CO3	3	2	1	2	3				1	3	1	2	2	1
CO4	3	1	1	2	1	2	2		1			2	2	1

Syllabus

UNIT	Contents	Mapped COs
I	**BASICS OF NANOTECHNOLOGY:** Introduction – Scientific revolutions –Time and length scale in structures – Definition of a nano system–Dimensionality and size dependent phenomena – Surface to volume ratio -Fraction of surface atoms– Surface energy and surface stress- surface defects -Properties at nanoscale (optical, mechanical, electronic, and magnetic).	CO1
II	**DIFFERENT CLASSES OF NANOMATERIALS:** Classification based on Dimensionality-Quantum Dots, Wells and Wires, Carbon- based nanomaterial (buckyballs, nanotubes, graphene), Metal based nanomaterials (nanogold, nano-silver and metal oxides), Nanocomposites - properties, advantages and disadvantages over conventional composites.	CO1, CO2
III	**SYNTHESIS OF NANOMATERIALS:** Bottom-up approaches: Physical Vapor Deposition, Inert Gas Condensation, Laser Ablation, Chemical Vapor Deposition, Molecular Beam Epitaxy, Sol gel method, Top down approaches: Mechanical alloying, Nano-lithography, Physical Methods: Ball Milling – Electrodeposition - Spray Pyrolysis - Flame Pyrolysis.	CO1, CO3
	CHARACTERIZATION OF NANOSTRUCTURES: X-Ray Diffraction (XRD), Small Angle X-ray scattering (SAXS),	

IV	Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), Scanning Tunnelling Microscope (STM), Field Ion Microscope (FEM), Three-dimensional Atom Probe (3DAP), Nanoindentation.	**CO1, CO3**
V	**APPLICATIONS OF NANOMATERIALS:** Nano-electronics, Micro- and Nano-electromechanical systems (MEMS/NEMS), Nano sensors, Nano catalysts, Food and Agricultural Industry, Cosmetic and Consumer Goods, Structure and Engineering, Automotive Industry, Water Treatment and the environment, Nano-medical applications, Textiles, Paints, Energy, Defence and Space Applications, Concerns and challenges of Nanotechnology.	**CO1, CO4**

Learning Resources

Text Books:

1. Pradeep T., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education Pvt. Ltd., 2012.
2. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002.

References:

1. Text Book of Nano Science and Nano Technology – B.S. Murthy, P. Shankar, Baldev Raj, B.B. Rath and James Munday, University Press-IIM.
2. Nabok A., "Organic and Inorganic Nanostructures", Artech House, 2005.
3. Dupas C., Houdy P., Lahmani M., "Nanoscience: Nanotechnologies and Nanophysics", Springer- Verlag Berlin Heidelberg, 2007.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING OF MECHANICAL SYSTEMS

Course Code	20ME4702A	Year	IV	Semester	I
Course Category	Professional Elective- IV	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	NIL
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Mark	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Unit
CO1	Understand the core concepts of Mechanical Systems in the context of Industry 4.0	Understand	L2	1,2,3
CO2	Understand the fundamental concepts of fuzzy sets and its applications.	Understand	L2	4,5
CO3	Apply AI, ML and Deep Learning concepts on Various Mechanical Systems	Apply	L3	2,3
CO4	Provide adequate knowledge of fuzzy logic, in solving social and engineering problems	Apply	L3	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H: High, M: Medium, L: Low)														
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2							1		2	3	2
CO2	3	3	2							1		2	3	2
CO3	3	3	2							1		2	3	2
CO4	3	3	2							1		2	3	2

Syllabus		
UNIT	Course Content	Mapped CO s
I	**Introduction to Mechanical Systems:** Evolution in the context of Industry 4.0, Key issues: Adaptability, Intelligence, Autonomy, Safety, Sustainability, Interoperability, Flexibility of Mechanical Systems. **Introduction of Statistics**: Descriptive statistics: Central tendency measures, Dispersion measures, data distributions, centre limit theorem, sampling, sampling methods; Inferential Statistics: Hypothesis testing, confidence level, degree of freedom, P-value, Chi-square test, ANOVA, Correlation V's Regression, Uses of Correlation and regression.	CO1
II	**Artificial Intelligence:** Brief review of AI history, Problem formulation: Graph structure, Graph implementation, state space representation, search graph and search tree, Search Algorithms: random search, Depth-first, breadth-first search and uniform-cost search. Heuristic: Best first search, A* and AO* algorithm, generalization of search problems. Ontology; Fuzzy; Metaheuristics.	CO1, CO3
III	**Machine Learning:** Overview of supervised and unsupervised learning; Supervised Learning:	CO1, CO3

	Linear Regression, Non-linear Regression Model evaluation methods, Logistic Regression, Neural Networks; Unsupervised Learning: K-means clustering, C-means Clustering. Convolutional Neural Networks (CNN), Pooling, Padding Operations, Interpretability in CNNs, Limitations in CNN. Cases with respect to different mechanical systems.	
IV	**Introduction, Classical Sets and Fuzzy Sets** Background, Uncertainty and Imprecision, Statistics and Random Processes, Uncertainty in Information, Fuzzy Sets and Membership, Chance versus Ambiguity. Classical Sets - Operations on Classical Sets, Properties of Classical (Crisp) Sets, Mapping of Classical Sets to Functions Fuzzy Sets - Fuzzy Set operations, Properties of Fuzzy Sets. Sets as Points in Hypercubes	**CO2, CO4**
V	**Classical Logic and Fuzzy Logic** Classical Predicate Logic – Tautologies, Contradictions, Equivalence, Exclusive OR and Exclusive NOR, Logical Proofs, Deductive Inferences. Fuzzy Logic, Approximate Reasoning, Fuzzy Tautologies, Contradictions, Equivalence and Logical Proofs, Other forms of the Implication Operation, Other forms of the Composition Operation	**CO2, CO4**

Learning Resources

Text Book(s):

1. Rajkumar, Dionisio De Niz ,and Mark Klein, Cyber-Physical Systems, Wesley Professional.
2. Robert Levine et al., “A Comprehensive guide to AI and Expert Systems”, McGraw Hill Inc, 1986.
3. Ross, T. J. (2005), “Fuzzy logic with engineering applications,” John Wiley & Sons.

References:

1. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
2. E. A. Lee and S. A. Seshia, “Introduction to Embedded Systems: A Cyber-Physical Systems Approach”, 2011.
3. C. Cassandras, S. Lafortune, “Introduction to Discrete Event Systems”, Springer 2007.
4. Constance Heitmeyer and Dino Mandrioli, “Formal methods for real-time computing”, Wiley publisher, 1996.
5. Montgomery Douglas, 2017. Design of Experiments, John Wiley and Sons, Inc.
6. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, “Neuro-Fuzzy and Soft Computing” Prentice Hall.

MECHATRONICS

Course Code	20ME4702B	Year	IV	Semester	I
Course Category	Professional Elective- IV	Branch	Mechanical	Course Type	Theory
Credits	3	L – T – P	3 – 0 – 0	Prerequisites	Basic electrical and electronics
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Explain the concepts related to elements of Mechatronic systems.	Understand, Communication	L2	1,2,3,4,5
CO2	Summarize the construction and working of sensors used in building mechatronicsystems.	Apply, Communication	L3	1
CO3	Illustrate various types of actuation systems and their components.	Apply, Communication	L3	2
CO4	Develop mathematical models using building blocks and make use of these models to find the dynamic response.	Apply, Communication	L3	3
CO5	Summarize the construction and working of closed loop controllers, Micro-processor and Micro controllers.	Apply, Communication	L3	4
CO6	Illustrate the features and applications of digital logic, PLC and of Fuzzy logic.	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes Strength of correlations (3: High, 2: Moderate, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3									2		2	3	1
CO2	3									2		2	3	1
CO3	3		3							2		2	3	1
CO4	3	3			2					2		2	3	1
CO5	3				2					2		2	3	1
CO6	3				2					2		2	3	1

Syllabus

UNIT	Course Content	Mapped CO s
I	**INTRODUCTION:** Definition of Mechatronics, evolution of mechatronics, systems, measurement systems, control systems, mechatronic design process, traditional design and mechatronic design, applications of mechatronic systems, advantages and disadvantages of mechatronic systems. **SENSORS:** classification of sensors, basic working principles, Velocity sensors – Proximityand Range sensors, ultrasonic sensor, laser interferometer transducer, Hall Effect sensor, inductive proximity switch. Light sensors – Photodiodes, phototransistors, tactile sensors – PVDF tactile sensor, micro-switch and reed switch, Piezoelectric sensors, vision sensor	**CO1 CO2**

II	**PNEUMATIC AND HYDRAULIC ACTUATION SYSTEMS:** Actuation systems, Pneumatic and Hydraulic systems- constructional details of filter, lubricator, regulator, direction control valves, pressure control valves, flow control valves, actuators-linear and rotary. **ELECTRICAL ACTUATION SYSTEMS:** Electrical systems, Mechanical switches, solid state switches, solenoids, DC motors, AC motors, stepper motors. Characteristics of pneumatic, hydraulic, electrical actuators and their limitations.	**CO1 CO3**
III	**BASIC SYSTEM MODELS:** Mathematical models, mechanical system building blocks, electric system building blocks, fluid system building blocks, thermal system building blocks. **DYNAMIC RESPONSES OF SYSTEMS:** Transfer function, Modelling dynamic systems, first order and second order systems.	**CO1 CO4**
IV	**CLOSED LOOP CONTROLLERS:** Classification of control systems, feedback, closed loop and open loop systems, continuous and discrete processes, control modes, two step mode, proportional mode, derivative control, integral control, PID controller. **MICROPROCESSOR AND MICRO CONTROLLER:** Introduction, Architecture of a microprocessor (8085), Architecture of a Micro controller, Difference betweenmicroprocessor and a micro controller.	**CO1 CO5**
V	**DIGITAL LOGIC:** Digital logic, number systems, logic gates, Boolean algebra, Karnaugh maps, application of logic gates, sequential logic, transducer Signal Conditioning and devicesfor data conversion. **PROGRAMMABLE LOGIC CONTROLLERS**: Introduction, basic structure,input/output processing, programming, mnemonics, timers, internal relays and counters, shift register, master and jump controls. Data handling, Analog input/output, selection of a PLC. **FUZZY LOGIC APPLICATIONS IN MECHATRONICS:** Fuzzy logic systems, Fuzzy control,Uses of Fuzzy expert systems.	**CO1 CO6**

Learning Resources

Text Books:

1. Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering, (3rdedition), by W Bolton, Pearson Education Press, 2005.
2. Mechatronics System Design, 5th Indian reprint, 2009, by Devdas shetty, Richard A. kolk,PWS Publishing Company

Reference Books

1. Mechatronics Source Book, by Newton C Braga, Thomson Publications, Chennai.
2. Mechatronics, by N. Shanmugam, Anuradha Agencies Publishers.
3. Control sensors and actuators, by C.W.Desilva, Prentice Hall.
4. Design with Microprocessors for Mechanical Engineers, by Stiffler, A.K.McGraw- Hill(1992).

E-Resources & other digital Material

1. https://onlinecourses.nptel.ac.in/noc22_me54/course

GAS DYNAMICS AND JET PROPULSION

Course Code	20ME4702C	Year	IV	Semester	I
Course Category	Professional Elective- IV	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	BTD,ATD, HT, FM&HM
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand basic concepts of flow and propulsion theory	Understand	L2	1,2,3,4,5
CO2	Apply the flow and shock theories on various ducts	Apply	L3	2,3
CO3	Analyze the performance of various propulsion techniques	Analyze	L4	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes
Strength of correlations (3: High, 2: Moderate, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1					2					2	3	1
CO2	3	1					2					2	3	1
CO3	3	2					2					2	3	1

Syllabus

UNIT	Contents	Mapped COs
I	**BASIC CONCEPTS OF COMPRESSIBLE FLOW** Introduction: Why study Gas dynamics, Mach number, and flow regimes, Thermodynamics Review of basics, Calorifically perfect gas, and thermally perfect gas. Compressible fluid flow- Energy and momentum equations, stagnation stages, various regions of flow, reference velocities, effect of Mach number on compressibility. Types of waves, Mach cone, Mach angle.	CO1
II	**FLOW THROUGH DUCTS** Flow through variable area ducts-Nozzles and diffusers, Mach number variation, stagnation and critical states, area ratio as a function of Mach number. Flow through constant area ducts-Flow through constant area ducts with friction (Fanno flow), with heat transfer (Rayleigh flow), Variation of flow properties. Use of Gas Tables and Charts.	CO1, CO2
III	**NORMAL AND OBLIQUE SHOCKS** Normal Shock Wave: Principle and derivation of flow properties across the normal shock, Rayleigh Pitot formula, Moving Shock Wave and its Reflection, Use of Tables and Charts. Oblique Shock Wave: Prandtl Meyer Expansion, Shock-expansion analysis of diamond airfoil, Unsteady 1D flow and the shock tube	CO1, CO2
IV	**PROPELLER THEORIES & JET PROPULSION** Propeller Theories: Types of propeller, Propeller thrust: momentum theory, Blade element theories, propeller blade design, propeller selection. Jet Propulsion: Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of	CO1, CO3

	air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics.	
V	**INTRODUCTION TO ADVANCED PROPULSION TECHNIQUES** Introduction to Rocket Propulsion: Types of rocket engines, propellants, combustion instabilities, rocket propulsion theory, performance of rocket engine, multistage rockets, orbital and escape velocities. Advanced Propulsion techniques: Hybrid propellant rocket - Electrical rockets - Electro-thermal, Electro-static and Electro-magnetic propulsion system - arc-jet thruster - Ion thruster - Hall Effect Thruster - Magneto plasma dynamic thruster - Nuclear rockets - solar Propulsion system.	**CO1, CO3**

Learning Resources
Text books
1. Yahya S.M. Fundamentals of Compressible Flow, New Age International (P) Ltd., New Delhi, 2003. 2. Ganesan V, Gas Turbines, Tata McGraw-Hill Publishing Company Ltd., 2003.
Reference books
1. Philip G Hill and Carl R. Peterton, Mechanics and Thermodynamics of Propulsion, Addison-Wesley Publishing Company, 1999. 2. Khajuria P.R and Dubey S.P., Gas turbines and Propulsive Systems, Dhanpat Rai Publications (P) Ltd, New Delhi 2003. 3. Cohen H. Rogers GFC, Saravanamuttoo HIH, Gas Turbines Theory, Addison-Wesley Long man Ltd., 2001.
Resources & other digital material
1.https://onlinecourses.nptel.ac.in/noc22_ae05/preview

NON-DESTRUCTIVE TESTING

Course Code	20ME4702D	Year	IV	Semester	I
Course Category	Professional Elective- IV	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Discuss the basics of various Non-destructive testing methods.	Understand, Communication	L2	1,2,3,4,5
CO2	Illustrate Non-destructive testing methods for identifying defects in various fields.	Apply, Communication	L3	1,2,3,4,5
CO3	Select suitable Non-Destructive testing Methods for given application.	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2		1	2	1			2			1	3	1
CO2	3	2		1	2	1			2			1	3	1
CO3	3	2		1	1	1			2			1	3	1

Syllabus

UNIT	Contents	Mapped CO
I	**Introduction to Non-Destructive Testing (NDT):** Introduction, destructive versus non-destructive testing, Factors influencing the reliability of NDT, Materials, Manufacturing Processes and Non-Destructive Testing Materials. **Visual Inspection**- The eye, Optical aids used for Visual inspection, Applications **Liquid Penetrant Testing –** Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results.	**CO1 CO2**
II	**Magnetic Particle Testing-** Theory of magnetism, inspection materials, Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism. **Eddy Current Testing-**Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.	**CO1 CO2**
III	**Acoustic Emission Testing:** Introduction, principles of acoustic emission testing, sensitivity, applications, advantages and limitations, Structural Integrity Assessment, Leak detection **Ultrasonic Testing**: Properties of sound beam, Ultrasonic transducers, Inspection Methods, Techniques for normal beam inspection and angle beam inspection, Flaw Characterisation Techniques, Flaw detection Equipment, Modes of Display, applications, advantages and limitations.	**CO1 CO2**

IV	**Thermography–** Basic Principles, Detectors and equipment, Techniques, applications**.** **Radiography Testing:** Basic Principle, Electromagnetic Radiation Sources, Radiation and Attenuation in the specimen, effect of Radiation on Film, Radiographic imaging, Inspection Techniques, Applications and limitations, Safety in Industrial Radiography.	**CO1** **CO2**
V	**Selection of NDT Methods:** Types of defects in Materials, welding. Selection of suitable NDT method for inspecting weldments, pressure vassals and pipe lines.	**CO1** **CO2** **CO3**

Learning Resource
Text books
1. Non-Destructive Test and Evaluation of Materials, J. Prasad and C. G. K. Nair, 2/e, Tata McGraw Hill, 2011. 2. Practical Non-Destructive Testing, Baldev Raj, T. Jaya Kumar, M. Thavasimuthu, Narosa Publishing.
Reference books
1. C. Hellier, Handbook of Non-Destructive Evaluation, 1/e, McGraw Hill Professional, 2001. 2. Non-Destructive Examination and Quality Control, 9/e, ASM International, Vol.17, 1989
E- Resources & other digital material
1. https://nptel.ac.in/courses/113/106/113106070/ 2. https://nptel.ac.in/noc/courses/noc19/SEM1/noc19-mm07/

INDUSTRIAL ROBOTICS

Course code	20ME4702E	Year	IV	Semester	I
Course category	Professional Elective- IV	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	-
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the basic anatomy of robots, Kinematics, robot sensors, programming and applications.	Understand, Communication	L2	1,2,3, 4,5
CO2	Apply transformations to solve robot kinematics, dynamics	Apply, Communication	L3	2
CO3	Apply trajectory planning and robot programming skills	Apply, Modern Tool Usage, Communication	L3	3
CO4	Apply knowledge of robot sensors and their applications in industries	Apply, Communication	L3	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3									3			3	1
CO2	3	3	2							3			3	1
CO3	3	3	2		2					3			3	1
CO4	3		2							3			3	1

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction:** Basic concepts - Robot anatomy - classification, robot specifications and Work volume, Types of Robot actuators- Pneumatic, Hydraulic actuators, electric & stepper motors, End Effectors- types of end effectors, grippers and tools, Requirements and challenges of end effectors.	CO1
II	**Transformations** - homogeneous coordinates for translation & rotation, **Kinematics and Dynamics:** Manipulators - kinematics: D-H notation, Forward and inverse kinematics: simple problems, Dynamics- lagrangian formulation, introduction to jacobian computation.	CO1, CO2
III	**Trajectory planning**- trajectory planning with cubic polynomial, blending, higher order trajectories **Robot Programming:** Robot language classification - programming methods - off and on-line programming - Lead through method - Teach pendent method and programming languages, simple programs.	CO1, CO3
IV	**Sensors:** Sensor devices, Types of sensors - contact, position and displacement sensors, Force and torque sensors - Proximity and range sensors - acoustic sensors –slip sensors, Robot vision systems	CO1, CO4

V	**Industrial Applications:** Application of robots - material handling, processing operations, assembly, inspection, safety considerations. Recent developments in robotics -mobile robot, microbots.	**CO1, CO4**

Learning Resource
Text books:
1. Mikell P. Groover. Industrial Robotics Technology Programming and Applications, McGraw Hill Co., Singapore, 1995. 2. Robotics and Control / Mittal R K & Nagrath I J / TMH.2017.
Reference books
1. Robotic Engineering by Richard D.Klafter, Prentice Hall 2. Introduction to Robotics – Saeed B.Niku, Prentice Hall 3. Introduction to Robotics – John J. Craig, Addison Wesley
E-Resources & other digital Material:
1.http://nptel.ac.in/downloads/112101098/

CONDITION MONITORING AND SIGNAL PROCESSING

Course Code	20ME4703A	Year	IV	Semester	I
Course Category	Professional Elective-V	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

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

	Statement	Skill	BTL	Units
CO1	Understand the concepts of maintenance, signal analysis, measuring principles, and various monitoring	Understand	L2	1,2,3,4,5
CO2	Discuss the signal analysis and data acquisition	Understand	L2	2
CO3	Categorize various monitoring techniques and measuring principles of instrumentation	Apply	L3	3,4
CO4	Examine machine tool condition monitoring and various case studies	Apply	L3	5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	1	1						2	3	1
CO2	3	2	2	2	1	1						2	3	1
CO3	3	2	2	2	1	1						2	3	1
CO4	3	2	2	2	1	1						2	3	1

Syllabus

UNIT	Course Content	Mapped CO s
I	**Basics of Maintenance** - Present Status, Fault Prognosis, Future Needs, Principles of Maintenance, Reactive Maintenance, Preventive Maintenance, Predictive Maintenance **Fundamentals of Machinery Vibration**: Introduction, Forced Vibration Response, Base Excitation, Force Transmissibility, and Vibration Isolation, Unbalanced Response, Characteristics of Vibrating Systems, Experimental Modal Analysis	CO1
II	**Signal Analysis**: Classification of Signals, Frequency Domain Signal Analysis, Fundamentals of Fast Fourier Transform **Data Acquisition and signal Recording:** Computer-Aided Data Acquisition, Signal Conditioning, Signal Demodulation, Cepstrum Analysis, Examples	CO1, CO2
III	**Measuring principles in condition monitoring** - Instrumentation: Static and Dynamic Measurements, Basic Measuring Equipment, Vibration, and Noise Measurement Temperature Measurements, Laser-Based Measurements, Chemical composition Measurements. **Vibration Monitoring:** Misalignment Detection, Eccentricity Detection, Cracked Shaft, Bowed and Bent Shaft, Unbalanced Shaft, Looseness, Rub, bearings and gears Diagnostic chart.	CO1, CO3

IV	**Thermography**: introduction, thermal imaging devices, industrial application of thermography, Application of thermography in condition monitoring **Wear Debris Analysis:** Introduction, Mechanism of wear, Detection of wear particles, oil sampling techniques, oil analysis, and limitations. **Electrical Machinery Faults:** Introduction, Construction of an Electric Motor, Faults in Electric Motor, Fault Detection in Electric Motors, MCSA for Fault Detection in Electrical Motors	**CO1, CO3**
V	**Machine Tool condition Monitoring:** Sensors for tool condition monitoring, indirect tool wear measurement, tool condition monitoring system, **Case studies and Failure Analysis**, Bend Pulley Failure Analysis, Root Cause Analysis of Torsion Shaft Failure, Failure Analysis of a Conveyor System Support Structure, Vibration Measurements on a Motor-Multistage Gearbox Drive Set	**CO1, CO4**

Learning Resources

Text Book(s):

1. A. R. Mohanty, Machinery Condition Monitoring: principles and practices, CRC press

References:

1. Collacott, R.A., Mechanical Fault Diagnosis and Condition Monitoring, Chapman & Hall,London,
2. John S. Mitchell, Introduction to Machinery Analysis and Monitoring, Penn Well Books, PennWell Publishing Company, Tulsa, Oklahoma,
3. Nakra, B.C. Yadava, G.S. and Thuested, L., Vibration Measurement and Analysis, National Productivity Council,New Delhi,
4. J.O. Den Hartog, Mechanical Vibrations – McGraw Hill, Newyork,
5. Singiresu S. Rao, Mechanical Vibrations, Addison-Wesley Publishing Company
6. An introduction to predictive maintenance, by R Keith Mobley - Butterworth - Heinemann publishing company

ADDITIVE MANUFACTURING

Course Code	20ME4703B	Year	IV	Semester	I
Course Category	Professional Elective-V	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	UNITS
CO 1	Understand the working principle and process parameters of different AM processes and Design and develop a product for AM process.	Understand Communication	L2	1,2,3,4,5
CO 2	Explore the Vat Photo polymerization AM Process and their applications.	Apply, Communication	L3	2
CO 3	Select the Extrusion-Based AM Processes, Sheet Lamination AM Processes suitable material and process for fabricating a given product.	Apply, Communication	L3	3
CO 4	Identify various Metal Additive Manufacturing process for different products.	Apply, Communication	L3	4,5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1		2							2	3	1
CO2	3	2	1		2							2	3	1
CO3	3	2	1		2							2	3	1
CO4	3	2	1		2							2	3	1

Syllabus

UNIT	Content	Mapped COs
I	**Introduction to Additive Manufacturing (AM):** Need for Additive Manufacturing, Generic AM process, Distinction between AM and CNC, Classification of AM Processes, Steps in AM process, Advantages of AM, Major Applications	**CO1**
II	**Vat Photopolymerization AM Processes:** Stereolithography (SL), Materials, Process Modeling, SL resin curing process, SL scan patterns, Micro-stereolithography, Mask Projection Processes, Two-Photon vat photopolymerization, Process Benefits and Drawbacks, Applications of Vat Photopolymerization, Material Jetting and Binder Jetting AM Processes.	**CO1, CO2**
III	**Extrusion-Based AM Processes:** Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, Bio-Extrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes. **Sheet Lamination AM Processes:** Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.	**CO1, CO3**
IV	**Powder Bed Fusion AM Processes:** Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal	**CO1, CO4**

	and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.	
V	**Directed Energy Deposition AM Processes:** Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes.	**CO1, CO4**

Learning Resources
Text Books
1. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015. 2. Patri K. Venuvinod and Weiyin Ma, "Rapid Prototyping: Laser-based and Other Technologies", Springer, 2004. 3. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015.
Reference Books
1. Neil Hopkinson, Richard Hague, Philip Dickens - Rapid manufacturing_ an industrial revolution for the digital age (2006, Wiley) - libgen.lc.
E- Resources & other digital material
1. https://onlinecourses.nptel.ac.in/noc20_me50/preview 2. https://onlinecourses.nptel.ac.in/noc21_me115/preview

POWER PLANT ENGINEERING

Course Code	20ME4703C	Year	IV	Semester	I
Course Category	Professional Elective-V	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Pre-requisites	Thermodynamics, Heat Transfer
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand various sources of power plants, their working principles and methods of pollution controls.	Understand	L2	1,2,3,4,5
CO2	Apply the basic concepts to evaluate the performance of power plants with different working medium and accessories	Apply	L3	1,2,3
CO3	Analyze the instrumentation concepts and evaluate power plant economics	Analyze	L4	4,5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2			2	3					2	3	1
CO2	3	2	2			2	1					2	3	1
CO3	3	2			2		1				2	2	3	1

Syllabus

UNIT	Contents	Mapped CO
I	**INTRODUCTION TO THE SOURCES OF ENERGY:** Resources and Development of Power in India. **STEAM POWER PLANT:** Plant Layout, Working of different Circuits, Fuel and handling equipment's, types of coals, coal handling, choice of handling equipment, coal storage, Ash handling systems. **COMBUSTION PROCESS:** Properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, and spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, Dust collectors, cooling towers and heat rejection, deration. Corrosion and feed water treatment.	CO1, CO2
II	**DIESEL POWER PLANT:** Introduction – IC Engines, types, construction– Plant layout with auxiliaries – fuel supply system, air starting equipment, lubrication and cooling system – super charging, application and comparison with other plants. **GAS TURBINE POWER PLANT:** Introduction – classification - construction – Layout with auxiliaries – Principles of working of closed and open cycle gas turbines. Combined Cycle Power Plants and comparison, Performance evaluation of the gas turbine plant.	CO1, CO2
	HYDRO ELECTRIC POWER PLANT: Water power – Hydrological cycle / flow measurement – drainage area	

III	characteristics Hydrographs – storage and Pondage – classification of dams and spill ways. Hydro Projects And Plant: Classification – Typical layouts – Site selection of hydro plant - plant auxiliaries – plant operation pumped storage plants. **NUCLEAR POWER PLANT:** Fusion and fission Reactions, Nuclear fuel – breeding and fertile materials – Nuclear reactor – reactor operation, Fuel moderator and coolant. 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.	**CO1, CO2**
IV	**HYBRID POWER PLANTS:** Introduction, Advantages of combined working, Load division between power stations, Storage type hydro-electric plant in combination with steam plant, Run off River plant in combination with steam plant, Pump storage plant in combination with steam or Nuclear power plant, Coordination of hydro electric and gas turbine stations, coordination of hydroelectric and Nuclear power stations, coordination of different types of Power plants. **POWER PLANT INSTRUMENTATION AND CONTROL:** Importance of measurement and instrumentation in power plant, measurement of water purity, Gas analysis, O_2 and CO_2 measurements, measurement of smoke and dust, measurement of moisture in CO_2 circuit, Nuclear measurements	**CO1, CO3**
V	**POWER PLANT ECONOMICS:** Capital cost, investment of fixed charges, operating costs, cost per KWh, general arrangement of power distribution, Load curves, load duration curve. Definitions of connected load, Maximum demand, demand factor, average load, load factor, diversity factor – related exercises. **ENVIRONMENTAL CONSIDERATIONS:** Effluents from power plants and Impact on environment – pollutants and pollution standards – Methods of Pollution control.	**CO1, CO3**

Learning Resources
xt books
1.A Course In Power Plant Engineering by – Arora and Domkundwar, Dhanpatrai & co.2011 2.Power Plant Engineering, by P.K.Nag, TataMcHill-2008.
ference books
1.A Text Book of Power Plant Engineering, by R K Rajput, Lakshmi Publications, 2008. 2.Power Plant Engineering, by P.C.Sharma, S.K.Kataria Publications, 2009. 3.Power plant Engineering, by Ramalingam, Scietech Publishers-2010. 4.An Introduction to Power Plant Technology, by G.D. Rai, Khanna publications-1996.
E-Resources
1.https://onlinecourses.nptel.ac.in/noc21_me86/preview

MATERIALS MANAGEMENT

Course Code	20ME4703D	Year	IV	Semester	I
Course Category	Professional Elective-V	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	IEM
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the concepts of planning, budgeting, purchasing and management of materials	Understand	L2	1,2,3,4,5
CO2	Explain materials planning and budgeting techniques	Understand	L2	2
CO3	Summarize concept of Purchasing, concept of stores management	Apply	L3	3,4
CO4	Apply inventory control techniques	Apply	L3	5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1					3		2			3		2	3
CO2	1					3		2			3		2	3
CO3	1					3		2			3		2	3
CO4	1					3		2			3		2	3

Syllabus

UNIT	Content	Mapped CO
I	**Introduction to Materials Management:** Introduction, Definition, Scope, objectives, functions, Integrated materials management, Organization of Materials Management, Types of Organization al structures, Manpower planning for Materials Management, Manpower planning techniques.	CO1
II	**Materials planning and budgeting:** Introduction, Materials planning-Factors, Techniques, Materials Requirement and Capacity Requirement Planning, Aggregate planning, Master production schedule- Bill of materials, MRP II, JIT Production planning, Budgeting-Materials budget, purchase budget.	CO1, CO2
III	**Purchasing:** Introduction, functions of purchasing department, objectives of purchasing, Methods of purchasing, Purchase Procedure, Steps in purchasing, Make or Buy Decisions, Criteria for make or Buy Decision, Production work order, Purchase order.	CO1, CO3
IV	**Stores Management:** Introduction, Functions, Stores and store keeping, Store location, Layout of stores, stores systems and procedure, Store records, Case studies in Stores management (from Public sector undertakings)	CO1, CO3
V	**Inventory Control:** Introduction, Inventory control records, Material requisition form, Purchase requisition form, perpetual Inventory record; Inventory Policy. **Selective Inventory control:** Mechanics of ABC analysis, purpose of ABC analysis, advantages and Disadvantages, Determining buffer stock, simple problems, VED analysis, SED analysis, FSN analysis.	CO1, CO4project

Learning Resources
Text books
1. S.C. Sharma, Materials Management and Materials Handling, 4th Edition, KhannaPublishers,2008. 2. B. Kumar, Industrial Engineering and Management, 2nd Edition, Khanna Publishers, 2008.
Reference books
1. P. Gopalakrishnan and M. Sundaresan, Materials Management - An integrated approach, 4th Edition, PHI, 2004

RELIABILITY ENGINEERING

Course Code	20ME4703E	Year	IV	Semester	I
Course Category	Professional Elective-V	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	IEM
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Explain various concepts of Reliability.	Understand	L2	1,2,3,4,5
CO2	Illustrate different types of failure distributions.	Apply	L3	2
CO3	Summarize various reliability prediction models	Apply	L3	3
CO4	Illustrate the concepts of reliability management.	Apply	L3	4
CO5	Summarize the concepts of risk assessment	Apply	L3	5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2							2		3			1
CO2	2	2							2		3			1
CO3	2	2							2		3			1
CO4	2	2							2		3			1
CO5	2	2							2		3			1

Syllabus

UNIT	Content	Mapped CO
I	**Reliability Concept**: Reliability function - failure rate - Mean time between failures (MTBF) -Mean time to failure (MTTF). **Reliability Life Testing –**: a priori and a posteriori concept - mortality curve - useful life Availability – maintainability Hazard Rate – system effectiveness.	CO1
II	**Reliability Data Analysis**: Time to failure distributions – statistical and reliability concept of failure data analysis, equipment replacement policy. **Parametric Life time Distributions**: Exponential, normal, Gamma, Weibull, Ranking of data - probability plotting techniques.	CO1, CO2
III	**Reliability Prediction Models**: Series and parallel systems - RBD approach - Standby systems -M/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis -FTA – Limitations. **Input Modeling**: Introduction - steps to build a useful model of input data - data collection, identifying the distribution with data, input models without data, models of arrival processes.	CO1, CO3
IV	**Reliability Management:** Reliability testing - Reliability growth monitoring - Non parametric Methods - Reliability and life cycle costs – Reliability allocation - Replacement model.	CO1, CO4

V	**Concept of risk-** objective and scope of risk assessment- probabilistic Risk- risk perception and acceptability- PRA management- preliminary hazard analysis- HAZOP and HAZAN, FMEA and FMECA analysis, Fault tree Analysis, Reliability-based optimum design, Strength-based reliability.	**CO1, CO5**

Learning Resources
Text Books:
1. Srinath L. S., "Reliability Engineering", East-West Press Pvt. Ltd., ISBN 81-85336-39-3. 2. Bhadury B., Basu S. K., "Terotechnology-Reliability Engineering and maintenance", Asian Books Private Limited, ISBN 81-86299-40-6. 3. Modarres, "Reliability and Risk analysis ", Mara Dekker Inc., 1993.
Reference Books:
1.John Davidson, "The Reliability of Mechanical system ", published by the 2.Institution of Mechanical Engineers, London, 1988. 3.Smith C.O." Introduction to Reliability in Design ", McGraw Hill, London, 1976. 4.Singiresu S. Rao 'Reliability Engineering' 1st Edition Pearson, 2014.
E- resources:
1. http://Life Data Analysis 2. http://nptel.ac.in/courses/10567/reliability 3. www.Reliability Growth Analysis.com 4. www.FMEA and FMECA Analysis.com

OPERATIONS RESEARCH

Course code	20ME2701A	Year	IV	Semester	I
Course category	Open Elective-III	Offering Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the basics of linear programming, transportation, queueing, sequencing of jobs, replacement, inventory and simulation problems	Understand, Communication	L2	1,2,3,4,5
CO2	Apply linear programming, transportation and assignment models to solve real life problems	Apply, Communication	L3	1,2
CO3	Apply Sequencing, queueing, Game and Replacement theories to solve problems	Apply, Communication	L3	3,4
CO4	Apply knowledge of inventory control and simulation to solve practical industrial problems	Apply, Communication	L3	5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3								3	2		3	2
CO2	3	3								3	2		3	2
CO3	3	3								3	2		3	2
CO4	3	3								3	2		3	2

Syllabus		
UNIT	Contents	Mapped CO
I	**Introduction to Operations Research:** History, definition, operations research models, phases of implementing operations research in practice, applications. **Linear Programming**: Introduction, formulation, graphical solution, simplex method, artificial variable techniques – Big M and two-phase methods, duality principle.	CO1 CO2
II	**Transportation**: Formulation, initial feasible solution, optimal solution – MODI method, unbalanced transportation problems, degeneracy in transportation problems. **Assignment**: Formulation, optimal solution, Hungarian method, travelling salesman problem.	CO1 CO2
III	**Queuing theory**: Introduction, Kendall's notation, classification of queuing models, single server and multi-server models, Poisson arrival, exponential service, infinite population **Sequencing**: Introduction, assumptions, processing n-jobs through two machines, n-jobs through three machines, and graphic solution for processing 2 jobs through n machines with different order of sequence.	CO1 CO3
IV	**Game Theory**: Introduction, game with pure strategies, game with mixed strategies, dominance principle, graphical method for 2xn and mx2	CO1 CO3

	games. **Replacement Theory**: Introduction, replacement of items that deteriorate with time - value of money unchanging and changing, simple probabilistic model for replacement of items that fail completely	
V	**Inventory control**: Introduction, inventory costs, Economic Order Quantity (EOQ)Demand rate Uniform and replenishment rate infinite, demand rate non-uniform replenishment rate infinite, Demand rate uniform, models with and without shortages, inventory model with single price break. **Simulation**: Definition, Types of simulation models, phases of simulation, applications of simulation	**CO1** **CO4**

Learning Resource
Text books:
1. Operations Research, by S.D.Sharma, Kedarnath & Ramnath publications (15th edition),2013. 2. Introduction to Operations Research, by Taha, Pearson Education,New Delhi, (8th edition), 2008
Reference books
1. Operations Research, (4th edition) by A.M .Natarajan, P. Balasubramani, ATamilarasi, Pearson Education, New Delhi, 2009. 2. Operations Research, (2nd edition) by R.Pannerselvam, 2009,PHI Publications, Noida 3. Operations Research, (2nd edition) by Wagner, 2007, PHI Publications, Noida 4. Operation Research, (4th edition) by J.K.Sharma, 2009, MacMilan publishers, india Ltd. New Delhi.
E-Resources & other digital Material:
1. http://nptel.ac.in/courses/112106134/ 2. http://nptel.ac.in/courses/112106131/

MANAGEMENT INFORMATION SYSTEMS

Course Code	20ME2701B	Year	IV	Semester	I
Course Category	Open Elective-III	Offering Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the basic concepts of MIS, Decision making, Applications of MIS, Decision support systems, BPR and E- Commerce.	Understand	L2	1,2,3,4,5
CO2	Interpret the MIS decision making and its applications.	Apply	L3	2,3
CO3	Categorize Decision support systems and Business Process Re-Engineering	Apply	L3	4
CO4	summarize the electronic commerce environment and its opportunities.	Apply	L3	5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1			1			1	1	3	2	1	1	3
CO2	2	1			1			1	1	3	2	1	1	3
CO3	2	1			1			1	1	3	2	1	1	3
CO4	2	1			1			1	1	3	2	1	1	3

Syllabus		
UNIT	Contents	Mapped CO
I	**Introduction to MIS**: Definition of MIS, Role and Impact of MIS, MIS: Support to the management, As tool for Management Process, Basic model of organization, Modifications to the basic model, organization as a system, MIS: organization, Strategic management of business.	CO1
II	**Decision Making:** Concepts, Methods, Tools, Procedures, Organizational decision making, MIS and Decision-making concepts, Information: A Quality Product, Classification of information, Value of information, General model of Human as information processor, Types of systems, Handling system complexity, Development of long-range plans of the MIS, Development and implementation of MIS, Factors of Success and failure for MIS.	CO1, CO2
III	**Applications:** Applications in Manufacturing Sector, Personnel, financial, production, materials, marketing management, Applications in service sector, creating a Distinctive service, MIS in service industry, Technology of Information systems, Data processing, Transaction processing, Application processing, TQM of Information systems, Programming languages for system coding.	CO1, CO2
IV	**Decision support systems and BPR:** Concept and philosophy, Deterministic systems, Artificial Intelligence systems, Knowledge based expert system, Enterprise Management systems, ERP basic features EMS	CO1, CO3

	and MIS, Business Process Re- Engineering, Process model of organization, Value stream model of the organization MIS and BPR.	
V	**E-Commerce:** Electronic commerce environment and opportunities: back ground, electronic commerce Environment, Modes of electronic commerce: Approaches to safe electronic commerce, Overview, Secure transport protocols, Secure Transactions, Secure Electronic Payment Protocol, and Secure Electronic Transaction.	**CO1, CO4**

Learning Resource
Text books:
1. W.S. Jawadekar, Management Information Systems: A Global Digital Enterprise Perspective, 5th Edition, McGraw Hill Education, 2013. 2. D. Minoli, Web Commerce Technology Hand Book, 1st edition, McGraw Hill Education, 2000.
Reference books
1. K.C. Laudon and J. Laudon, Management Information Systems: Managing a Digital firm, 11th Edition, Pearson Education, 2012. 2. D. Gordon and M. Oslon, Management Information Systems: Conceptual Foundations, Structure and Development, 2nd Edition, McGraw Hill Education Pvt Ltd, India, 2001. 3. R.G. Murdic, J.E. Ross and J.R. Clagget, Information Systems for Modern Management, 3rd Edition, PHI, 2008. 4. K.Ravi and A.B. Whinston, Frontiers of Electronic Commerce, 1st edition, Pearson India, 2002.
E-Resources & other digital Material:
1. http://nptel.ac.in/courses/112106134/ 2. http://nptel.ac.in/courses/112106131/

MECHATRONICS

Course Code	20ME2702A	Year	IV	Semester	I
Course Category	Open Elective-IV	Branch	ME	Course Type	Theory
Credits	3	L – T – P	3 – 0 – 0	Prerequisites	BEE
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Explain the concepts related to elements of Mechatronic systems.	Understand, Communication	L2	1,2,3,4,5
CO2	Summarize the construction and working of sensors used in building mechatronicsystems.	Apply, Communication	L3	1
CO3	Illustrate various types of actuation systems and their components.	Apply, Communication	L3	2
CO4	Develop mathematical models using building blocks and make use of these models to find the dynamic response.	Apply, Communication	L3	3
CO5	Summarize the construction and working of closed loop controllers, Micro processor and Micro controllers.	Apply, Communication	L3	4
CO6	Illustrate the features and applications of digital logic, PLC and of Fuzzy logic.	Apply, Communication	L3	5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3									2		2	3	1
CO2	3									2		2	3	1
CO3	3		3							2		2	3	1
CO4	3	3			2					2		2	3	1
CO5	3				2					2		2	3	1
CO6	3				2					2		2	3	1

Syllabus		
UNIT	Contents	Mapped CO
I	**INTRODUCTION:** Definition of Mechatronics, evolution of mechatronics, systems, measurement systems, control systems, mechatronic design process, traditional design and mechatronic design, applications of mechatronic systems, advantages and disadvantages of mechatronic systems. **SENSORS:** classification of sensors, basic working principles, Velocity sensors – Proximity and Range sensors, ultrasonic sensor, laser interferometer transducer, Hall Effect sensor, inductive proximity switch. Light sensors – Photodiodes, phototransistors, tactile sensors – PVDF tactile sensor, micro-switch and reed switch, Piezoelectric sensors, vision sensor	CO1 CO2

II	**PNEUMATIC AND HYDRAULIC ACTUATION SYSTEMS:** Actuation systems, Pneumatic and Hydraulic systems- constructional details of filter, lubricator, regulator, direction control valves, pressure control valves, flow control valves, actuators-linear and rotary. **ELECTRICAL ACTUATION SYSTEMS**: Electrical systems, Mechanical switches, solid state switches, solenoids, DC motors, AC motors, stepper motors. Characteristics of pneumatic, hydraulic, electrical actuators and their limitations.	**CO1 CO3**
III	**BASIC SYSTEM MODELS:** Mathematical models, mechanical system building blocks, electric system building blocks, fluid system building blocks, thermal system building blocks. **DYNAMIC RESPONSES OF SYSTEMS:** Transfer function, Modelling dynamic systems, first order and second order systems.	**CO1 CO4**
IV	**CLOSED LOOP CONTROLLERS:** Classification of control systems, feedback, closed loop and open loop systems, continuous and discrete processes, control modes, two step mode, proportional mode, derivative control, integral control, PID controller. **MICROPROCESSOR AND MICRO CONTROLLER:** Introduction, Architecture of a microprocessor (8085), Architecture of a Micro controller, Difference betweenmicroprocessor and a micro controller.	**CO1 CO5**
V	**DIGITAL LOGIC:** Digital logic, number systems, logic gates, Boolean algebra, Karnaugh maps, application of logic gates, sequential logic, transducer Signal Conditioning and devicesfor data conversion. **PROGRAMMABLE LOGIC CONTROLLERS:** Introduction, basic structure, input/output processing, programming, mnemonics, timers, internal relays and counters, shift register, master and jump controls. Data handling, Analog input/output, selection of a PLC. **FUZZY LOGIC APPLICATIONS IN MECHATRONICS**: Fuzzy logic systems, Fuzzy control,Uses of Fuzzy expert systems.	**CO1 CO6**

Learning Resource
Text books:
1. Mechatronics Electronic Control Systems in Mechanical and Electrical Engineering, (3rd edition), by W Bolton, Pearson Education Press, 2005. 2. Mechatronics System Design, 5th Indian reprint, 2009, by Devdas shetty, Richard A. kolk, PWS Publishing Company
Reference books
1. Mechatronics Source Book, by Newton C Braga, Thomson Publications, Chennai. 2. Mechatronics, by N. Shanmugam, Anuradha Agencies Publishers. 3. Control sensors and actuators, by C.W.Desilva, Prentice Hall. 4. Design with Microprocessors for Mechanical Engineers, by Stiffler, A.K.McGraw- Hill(1992).
E-Resources & other digital Material:
1. https://onlinecourses.nptel.ac.in/noc22_me54/course

ROBOTICS

Course code	20ME2702B	Year	IV	Semester	I
Course category	Open Elective-IV	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the basic anatomy of robots, actuators, end effectors, robot sensors, programming and applications.	Understand	L2	1,2,3,4,5
CO2	Understand the working principles of robot actuators, end effectors	Understand	L2	2
CO3	Apply robot programming skills	Apply, Modern Tool Usage	L3	3
CO4	Apply knowledge of robot sensors and their applications in industries	Apply	L3	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3												3	1
CO2	3	3											3	1
CO3	3	3	2		2								3	1
CO4	3		2										3	1

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction:** Automation and robotics – History of robots -Robot anatomy – classification of robots, major components-robot specifications, selection of robots.	CO1
II	**Robot actuators**- Pneumatic, Hydraulic actuators, electric & stepper motors **End Effectors**- types of end effectors, grippers and tools, Requirements and challenges of end effectors.	CO1, CO2
III	**Robot Programming: -** Robot programming languages - programming methods - off and on-line programming - Lead through method - Teach pendent method, simple programs.	CO1, CO3
IV	**Sensors used in robots:** Sensor devices, Types of sensors - contact, position and displacement sensors, Force and torque sensors - Proximity and range sensors - acoustic sensors –slip sensors, Robot vision systems	CO1, CO4
V	**Applications of robots:** Application of robots in industry - material handling, processing operations, assembly, and inspection operations.	CO1, CO4

Learning Resource
Text books:
1. Mikell P. Groover. Industrial Robotics Technology Programming and Applications, McGraw Hill Co., Singapore, 1995. 2. Robotic Engineering by Richard D.Klafter, Prentice Hall
Reference books
1. Introduction to Robotics – Saeed B.Niku, Prentice Hall 2. Introduction to Robotics – John J. Craig, Addison Wesley
E-Resources & other digital Material:
1. http://nptel.ac.in/downloads/112101098/

MANAGERIAL ECONOMICS AND FINANCIAL ANALYSIS

Course Code	20HS7701A	Year	IV	Semester	I
Course Category	*Humanities and Social Science Elective*	Offering Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand basics of managerial economics, demand forecasting, cost analysis, industrial organization, financial accounting and capital and capital budgeting.	Understand	L2	1,2,3,4,5
CO2	Apply the managerial economics, e-commerce, demand forecasting and cost analysis techniques in economics related problems.	Apply	L3	1,2
CO3	Summarize different types of industrial organization	Apply	L3	3
CO4	Analyze the financial accounting and depreciation related problems.	Analyze	L4	4,5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					2		2			3		3	
CO2	3					2		2			3		3	
CO3	3					2		2			3		3	
CO4	3					2		2			3		3	

Syllabus

UNIT	Contents	Mapped CO
I	**INTRODUCTION TO MANAGERIAL ECONOMICS**: Introduction, characteristics, scope & definition of Managerial Economics, its relation with other subjects, Basic economic tools in Managerial Economics. Demand Analysis: Meaning- Demand distinctions- Demand determinants- Law of Demand and its exceptions. **ELASTICITY OF DEMAND & DEMAND FORECASTING**: Definition -Types of Elasticity of demand - Measurement of price elasticity of demand and it's significance: Total outlay method, Point method and Arc method. Demand Forecasting: Meaning - Factors governing demand forecasting - Methods of demand forecasting.	CO1 CO2
II	**THEORY OF PRODUCTION AND COST ANALYSIS-INTRODUCTION TO MARKETS-PRICING POLICIES & E-COMMERCE**: Production Function- Isoquants and Isocosts, Law of variable proportions- Law of returns to scale- Least Cost Combination of Inputs, Cobb-Douglas Production function-Economies of Scale **COST ANALYSIS**: Cost concepts, Determination of Break Even	CO1 CO2

	Point (BEP) with simple problems, Managerial Significance and limitations of BEP. Market structures: Types of competition, Features of Perfect Competition, Monopoly and Monopolistic Competition. Pricing strategies.	
III	**TYPES OF INDUSTRIAL ORGANIZATION & INTRODUCTION TO BUSINESS CYCLES**: Characteristic features of Industrial organization, Features and evaluation of Sole Proprietorship, Partnership, Joint Stock Company, State/Public Enterprises and their types. Changing business environment in post-liberalization scenario.	**CO1 CO3**
IV	**FINANCIAL MANAGEMENT AND INTRODUCTION TO FINANCIAL ACCOUNTING**: Functions of financial management, simple and compound interest, Methods of evaluating alternatives- Present Worth method. Future worth Method, Annual equivalent method. Introduction to Double-entry system	**CO1 CO4**
V	**DEPRECIATION**: Introduction, common methods of depreciation: straight line method, Declining balance method, sum of year's digits method. **CAPITAL AND CAPITAL BUDGETING:** Meaning of capital budgeting, Need for capital budgeting – Capital budgeting decisions (Examples of capital budgeting) - Methods of Capital Budgeting: Payback Method, Accounting Rate of Return (ARR), IRR and Net Present Value Method (simple problems).	**CO1 CO4**

Learning Resources
Text Books:
1. Engineering economics, R. Panneerselvam,2nd Edition, PHI Learning Pvt. Ltd., 2013 . 2. Managerial Economics and Financial Analysis, by J.V.Prabhakar Rao, Maruthi Publications, 2011.
Reference Books:
1. Managerial Economics and Financial Analysis, by A R Aryasri, TMH 2011. 2. Financial Accounting,SN Maheswari,SK Maheswari, Vikas Publishing House Pvt Ltd., NewDelhi, 4th Edition,2006. 3. Managerial Economics by Suma damodaran, Oxford 2011. 4. Mangerial Economice and Financial Analysis by S.A. Siddiqui & A.S. Siddiqui, New Age International Publishers, 2011. 5. Engineering economy- Theusen & Theusen, 8th edition,1993,Prentice Hall.
E-Resources & other digital Material:
1. www.tectime.com 2. www.exinfm.com 3. www.economywatch.com

HUMAN RESOURCE MANAGEMENT

Course Code	20HS7701B	Year	IV	Semester	I
Course Category	*Humanities and Social Science Elective*	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes		Skill	BTL	Unit No
Upon successful completion of the course, the student will be able to				
CO1	Understand the basic concepts, techniques and applications of Human Resource Management.	Understand	L2	1,2,3, 4,5
CO2	Describe job design, job Analysis, job evaluation and different levels of recruitment	Understand	L2	2,3
CO3	Illustrate different Training and development of human resources	Apply	L3	4
CO4	Summarize e-Human Resource Management and Human resource for small scale industries	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H:High(3), M: Medium(2), L:Low(1))

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		2			3					3	1	1	3
CO2	1		2			3					3	1	1	3
CO3	1		2			3					3	1	1	3
CO4	1		2			3					3	1	1	3

Syllabus

UNIT	Content	Mapped CO
I	**Introduction:** Functions, Policies & Roles, Skills for HR Professionals, HRM Models, Evolution of HRM, Recent developments in HRM, Nature of Strategic HRM, Strategic HRM versus Conventional HRM, Strategic Management Process, Benefits of SHRM, Barriers to Strategic HRM, Typical HR Strategies, Selecting Strategies to Enhance Performance. **Human Resource Planning:** Nature of HRP, Importance of HRP, Factors Affecting HRP, The Planning Process, Human Resource Planning and the Government Requisites for Successful HRP, Barriers to HRP	**CO1**
II	**Analysis of Work, Designing Jobs and Job Evaluation:** Nature of Job analysis, Job Analysis and Competitive Advantage, The Process of Job Analysis, Methods of Collecting Job Data, Job Analysis and Strategic HRM, Potential Problems with Job Analysis. **Requisites for Job Analysis**, Competency-based Job Analysis, Job Design, Significance of Jobs Design, Factors Affecting Job Design,	**CO1, CO2**

	Job Design Approaches, Contemporary Issues in Job Design, Job Evaluation, Job Evaluation Process, Methods of Job Evaluation, Alternative to Job Evaluation.	
III	**Recruiting Talent:** Nature of Recruitment, Purposes and Importance, Factors Governing Recruitment, Recruitment Process, Evaluation and Control, Philosophies of Recruiting, Alternatives to Recruitment. **Selecting Right Talent:** Nature of Selection, Selection as a Source of Competitive Advantage, Organization for Selection, Selection Process, Assessment Centers, Barriers to Effective Selection, Evaluation of Selection Process, Making Selection Effective.	**CO1, CO2**
IV	**Training and Development, Career Management and Talent Management:** Orientation, Orientation Programme, Requisites of an Effective Programme, Evaluation of Orientation Programme, Problems of Orientation, Typical Orientation Programme, **Nature of Training and Development**, Inputs in Training and Development, Training and Development as Source of Competitive Advantage, The Training Process, Impediments to Effective Training. Government Initiative, Management Development, Career Development, Talent Management.	**CO1, CO3**
V	**e-Human Resource Management:** Nature of e-HRM, e-HR Activities, e-Recruitment, e-Selection, e-Performance Management, e-Learning, e-Compensation **Human Resource Management in Small Scale Units:** Introduction to Small Business Unit, Significance of MSM Enterprises, Facilities Problems, People Practices in Small Units, Challenges in Introducing HR Practices, Current Practices, Guidelines for Application of HR Practices.	**CO1, CO4**

Learning Resource
Text books:
1. Human Resource Management, Text & Cases by K. Aswathappa
Reference books
1. Human Resource Management, by S. Khandkar, S. Chand Publications 2. Personnel Management - Text & Cases, By C. B. Mamoria& V. S. P. Rao, Himalaya 3. Human Resource Management by Gary Dessler, Pearson Education

ENTREPRENEURSHIP MANAGEMENT

Course Code	20HS7701C	Year	IV	Semester	I
Course Category	*Humanities and Social Science Elective*	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the basic concepts and factors for starting and successful running of different forms of an enterprise.	Understand	L2	1,2,3,4,5
CO2	Describe characteristics, values and attitudes of an entrepreneur.	Understand	L2	2
CO3	Illustrate different forms of Entrepreneurial structures and Intrapreneurship.	Application	L3	3,4
CO4	Summarize critical Factors for starting a new enterprise and ethics to be followed during running of enterprise.	Application	L3	5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		2			3			3		3	2		
CO2	1		2			3			3		3	2		
CO3	1		2			3			3		3	2		
CO4	1		2			3		3	3		3	2		

Syllabus

UNIT	Content	Mapped CO
I	**Introduction to Entrepreneurship**: Meaning, Nature, origin and development of entrepreneurship in India, Need and Importance, Core elements, Principles, Essentials, Types, Functions, Concept of entrepreneurship management, Motives behind being an entrepreneur, Entrepreneurial Process.	CO1
II	**Entrepreneurial Values and Attitudes**: Introduction to entrepreneurial Values and Attitudes, Dominant characteristics of successful entrepreneurs, Internal and external factors for entrepreneurial motivation, Entrepreneurial Skills, Identifying business opportunities. **Role of creativity in Entrepreneurship-** the creative process, the Innovation process, types of innovation, sources of innovation, principles of innovation, Sources of Business Ideas**.**	CO1, CO2

III	**Forms of Entrepreneurial structures**: Sole Proprietorship-meaning, merits and limitations, Partnership-Meaning, Forms, merits and limitations. **Corporations**-Meaning, merits and limitations, Limited Liability partnerships and corporations, Franchising-Meaning, types, merits and limitations.	**CO1, CO3**
IV	**Intrapreneurship**: Meaning, Characteristics, Intrapreneurs Activities, types of Corporate Entrepreneurs, Corporate V/s Intrapreneurial culture, Climate, Fostering Intrapreneurial culture. **Promoting intrapreneurship**- Pinchot's Spontaneous teams and Formal Venture teams, establishing intrapreneurial ventures**.**	**CO1, CO3**
V	**Critical Factors for starting a new enterprise**: Personal, Environmental, Sociological factors, Problems of a new venture-Financial, administrative, marketing, production and other problems **Ethics and Entrepreneurship**: Defining Ethics, Approaches to Managerial ethics, ethics and business decisions, Ethical practices and code of conduct, Ethical considerations in corporate entrepreneurship.	**CO1, CO4**

Learning Resources
Text Books
1. Entrepreneurship development, Moharanas and Dash C.R., RBSA Publishing, Jaipure. 2. Beyond entrepreneurship, Collins and Lazier W, Prentice Hall, New Jersey, 1992. 3. Entrepreneurship, Hisrich Peters Sphephard, Tata McGraw Hill. 4. Fundamentals of entrepreneurship, S.K. Mohanty, Prentice Hall of India.
Reference Books
1. Small scale industries and entrepreneurship, Dr. Vasant Desai, Himalayan Publishing House. 2. Management of small scale industries, Dr. Vasant Desai, Himalayan Publishing House. 3. Management of small scale industries, J.C. Saboo Megha Biyani, Himalayan Publishing House. 4. A Guide to Entrepreneurship, David Oates, Jaico Publishing House, Mumbai, Edn 2009.
E-Resources & other digital Material
1. https://onlinecourses.swayam2.ac.in/cec20_mg19/preview 2. https://onlinecourses.swayam2.ac.in/ntr22_ed08/preview

INDUSTRIAL ENGINEERING & MANAGEMENT

Course Code	20HS7701F	Year	IV	Semester	I
Course Category	*Humanities and Social Science Elective*	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation:	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the basic concepts of management, organizational structures, leadership, operations management and project management.	Understand	L2	1,2,3,4,5
CO2	Explain the leadership qualities and concept of plant layout.	Understand	L2	2
CO3	Apply different quality control techniques.	Apply	L3	3
CO4	Illustrate various operations management Techniques	Apply	L3	4
CO5	Solve operations management and project management problems	Apply	L3	5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1					3		2			3		2	3
CO2	1					3		2			3		2	3
CO3	1					3		2			3		2	3
CO4	1					3		2			3		2	3
CO5	1					3		2			3		2	3

Syllabus

UNIT	Contents	Mapped CO
I	**INTRODUCTION**: Definition of Industrial Engineering, Applications, Role of Industrial Engineer, Quantitative tools of IE, Functions of Management, Taylor's Scientific Management, Fayol's Principles of Management, Douglas Mc-Gregor's Theory X and Theory Y, Hertzberg's Two Factor Theory of Motivation, Maslow's Hierarchy of Human Needs. **ORGANISATIONAL STRUCTURES**: Basic concepts related to Organization – Depart mentation and Decentralization, Flat and Tall organizations, Organizational chart, Line organization, Line and staff organization, functional organization	CO1
II	**LEADERSHIP**: Introduction, Definition, Types of leadership based on authority- their area of applicability and suitability, advantages and limitations, Traits approach to leadership **PLANT LOCATION**: Definition, factors affecting the plant location,	CO1, CO2

	comparison of rural and urban sites. Plant Layout – definition, objectives, types of production, types of plant layout – various data analyzing forms-travel chart.	
III	**INSPECTION AND QUALITY CONTROL**: Types of inspections, Statistical Quality Control techniques, variables and attributes, assignable and non-assignable causes. **Control Charts:** variable control charts- X -bar and R charts, Attribute control charts- P-charts and C-charts. **Acceptance sampling**- Single Sampling, Double sampling, Multiple Sampling, OC curves.	**CO1, CO3**
IV	**WORK STUDY**: Definition, objectives, method study - definition, objectives, steps involved- various types of associated charts-out line process charts, flow process charts, two handed process charts and SIMO charts. **TIME STUDY**: definition, time study, steps involved-equipment, different methods of performance rating- allowances, standard time calculation.	**CO1, CO4**
V	**PROJECT MANAGEMENT**: Network modeling, Probabilistic model-various types of activity times estimation, programme evaluation review techniques (PERT), probability of completing the project, **Deterministic model-** critical path method (CPM), critical path calculation, crashing of simple of networks.	**CO1, CO5**

Learning Resources
Text Books:
1. S.Bhaskar, "Management Science", Anuradha Publications 2. O.P. Khanna, "Industrial Engineering and Management", DhanpatRai 3. T. R. Banga, S. C. Sharma, N. K. Agarwal, "Industrial Engineering and Management Science" Khanna Publishers.
Reference Books:
1. PannerSelvam, Production and Operations Management, PHI, 2004. 2. Ralph M Barnes, Motion and Time Studies, John Wiley and Sons, 2004. 3. Chase, Jacobs, Aquilano, Operations Management, TMH 10th Edition, 2003. 4. L.S.Srinath, PERT / CPM, affiliate East-West Press, New Delhi, 2000. 5. Phillip Kotler, Marketing Management, Pearson, 2004. 6. S. Bhaskar, "Management Science" Anuradha Publications.

PROJECT MANAGEMENT

Course Code	20HS7701G	Year	IV	Semester	I
Course Category	*Humanities and Social Science Elective*	Branch	ME	Course Type	Theory
Credits	3	L-T-P	3-0-0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the concepts of project management.	Understand	L2	1,2,3,4,5
CO2	Explain procedure for analyzing the project risk, market risk and firm risk.	Understand	L2	2
CO3	Apply social-cost benefit analysis on a project.	Apply	L3	3
CO4	Analyze a project by applying various network techniques for planning, scheduling and controlling of different activities of a project.	Analyze	L4	4
CO5	Analyze various aspects to be considered for technical and financial analysis of the Project and the Environmental appraisal	Analyze	L4	5

Contribution of Course outcomes towards achievement of Program outcomes & Strength of correlations (High:3, Medium: 2, Low:1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1							2		3	2	2	1
CO2	2	1							2		3	2	2	1
CO3	2	1							2		3	2	2	1
CO4	2	1							2		3	2	2	1
CO5	2	1							2		3	2	2	1

Syllabus

UNIT	Contents	Mapped CO
I	**MEANING, NATURE AND IMPORTANCE OF PROJECT:** Introduction, Concept of project and project management, Characteristics of project, Project Family tree, Classification of Project, Project selection process, **Project life cycle**, Project report, Project appraisal, Tools and techniques for project management, Project manager's roles and responsibilities	**CO1**
II	**ANALYSIS OF PROJECT RISK, MARKET RISK AND FIRM RISK:** Introduction, Analysis of project risks- Projects with quantified benefits and not quantifiable benefits, **Market risk**- Security market risk, Interest rate risk, Purchasing Power Risk, Firm risk- Business risk, financial risk.	**CO1 CO2**
III	**COST-BENEFIT ANALYSIS:** Introduction, need for social cost benefit analysis, Procedure of social cost benefit analysis, Main feature of social cost benefit analysis, **COST-BENEFIT ANALYSIS APPROACHS:** UNIDO approach, Little-	**CO1 CO3**

	Mirrless approach, SCBA in India, Public investment decision making in India, Limitation of SCBA.	
IV	**NETWORK TECHNIQUES FOR PROJECTMANAGEMENT:** Introduction, Network modelling, Probabilistic model-various types of activity times estimation, Programme evaluation review techniques (PERT), probability of completing the project, **Deterministic model**- critical path method (CPM), critical path calculation, crashing of simple of networks	**CO1** **CO4**
V	**TECHNICAL AND FINANCIAL ANALYSIS OF PROJECT:** Introduction, Technical Analysis-Materials and inputs, Production, Choice of technology, Product Mix, Plant capacity, Location and site, Structures and civil works, Project charts and layouts, financial analysis -Significance of financial analysis, Utility of financial and accounting statements, **ENVIRONMENTAL APPRAISAL OF PROJECTS:** Introduction, Types and Environmental Dimensions of a Project, Stresses on Environment, Environmental Impact Assessment Methodologies	**CO1** **CO5**

Learning Resource
Text books:
1. Prasanna Chandra, Projects Planning, Implementation and Control, Tata McGraw Hill Publishing Company Limited, New Delhi, 1995.
Reference books
1. Project Management Institute (PMI), A Guide to the Project Management of Knowledge Newton Square, PA, 1996 2. J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons, New York, 1995. 3. L.S. Srinath, PERT & CPM Principles & Applications, 3rd edition, East west Press,2001.
e- Resources & other digital material
7. https://nptel.ac.in/courses/105/106/105106149/
8. https://nptel.ac.in/courses/110/104/110104073/

MECHATRONICS LAB

Course Code	20SA8753	Year	IV	Semester	I
Course Category	Skill Advanced course	Branch	ME	Course Type	Lab
Credits	1.5	L – T – P	0 – 0 – 3	Prerequisites:	Nil
Continuous Internal Evaluation	-	Semester End Evaluation	50	Total Marks	50

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Expts
CO1	Build pneumatic and electro pneumatic circuits for various mechanical applications.	Apply	L3	1-8
CO2	Demonstrate the features of simulation software.	Apply	L3	9-12
CO3	Apply the knowledge of MATLAB software to check the truth tables of logic gates.	Apply	L3	13
CO4	Demonstrate the behavior of sensors.	Apply	L3	14
CO5	Develop Ladder (PLC) programs for given application	Apply	L3	15

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		2						3	2		1	3	1
CO2	3		2						3	2		1	3	1
CO3	3		2						3	2		1	3	1
CO4	3		2						3	2		1	3	1
CO5	3		2						3	2		1	3	1

Note: Twelve experiments must be conducted

LIST OF EXPERIMENTS

Syllabus		
Exp. No.	**Content**	**Mapped CO**
PNEUMATICS		
1.	Direct control of single and double acting cylinders	**CO1**
2.	Indirect control of single and double acting cylinders	
3.	Single cycle operation of double acting cylinder	
4.	Multi cycle operation of double acting cylinder	
ELECTRO PNEUMATICS		
5.	Direct control of a double acting cylinder using a solenoid valve	
6.	Indirect control of a double acting cylinder using a solenoid valve and relays	
7.	Operation of double acting cylinder with AND & OR logic circuit using relays	
8.	Single cycle operation of a double acting cylinder using electrical limit switches and relays	
AUTOMATION STUDIO SOFTWARE		
9.	Modeling and simulation of single and double acting cylinder (Direct control)	**CO2**

10.	Modeling and simulation of single and double acting cylinder (Indirect control)	
11.	Modeling and simulation of single cycle operation of a double acting cylinder using limit switch	
12.	Modeling and simulation of multi cycle operation of a double acting cylinder using limit switches	
MATLAB PROGRAMMING		
13.	Simple MATLAB Programmes to verify truth tables of a) NOT b) AND c) NAND d) OR e) NOR f) XOR g) XNOR logic gate	**CO3**
BEHAVIOUR OF SENSORS		
14.	A) Behavior of Inductive sensor NJ B) Behavior of Capacitive sensor CJ C) Behavior of Magnetic sensor MJ D) Behavior of Ultrasonic sensor E) Behavior of Through beam sensors F) Behavior of Reflex photoelectric sensor OBS G) Behavior of Direct detection sensors OJ	**CO4**
PLC PROGRAMMING (LADDER PROGRAMMING)		
15.	A) PLC program to implement various logic gates B) PLC Program to Operate 4 Outputs Simultaneously with Time Delay C) PLC Program to do Mathematical Functions D) PLC Program to Control Traffic Lights.	**CO5**

PROJECT WORK

Course Code	20ME3861	Year	IV	Semester	II
Course Category	Major Project	Branch	ME	Course Type	Lab
Credits	8	L – T – P	0 – 0 – 0	Prerequisites:	Nil
Continuous Internal Evaluation	60	Semester End Evaluation	140	Total Marks	200

MINOR IN AUTOBILE ENGINEERING
AUTOMOBILE ENGINEERING

CourseCode	20ME5402	**Year**	III	**Semester**	I
Course Category	Minor in AE	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1– 0	**Prerequisites**	Nil
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand basic components of an Automobile.	Understand	L2	1,2,3,4,5
CO2	Analyse the working of various systems of engines.	Analyze	L3	1,2
CO3	Analyse the working of various automobile systems.	Analyze	L3	3,4,5
CO4	Analyse various alternative energy resources, emissions standards and application of plastic in automobiles.	Analyze	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1									1	3	1
CO2	3	1	1									1	3	1
CO3	3	1	1									1	3	1
CO4	3	1	1				2					1	3	1

Syllabus

UNIT	Contents	Mapped COs
I	**INTRODUCTION** Components of four-wheeler automobile – chassis and body – power unit –power transmission – rear wheel drive, front wheel drive, 4-wheel drive. Types of automobile engines, engine construction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps – crank case ventilation –engine service, reboring, decarburization, Nitriding of crank shaft. **INTRODUCTION TO NHV:** Definition of Noise, Vibrations & Harshness in reference to Vehicular application.	**CO1, CO2**
II	**FUEL SYSTEM** S.I. Engine: Fuel supply systems, Mechanical and electrical fuel pump – filters–carburetor – types – air filters – petrol injection. C.I. Engines: Requirements of diesel injection systems, types of injection systems, fuel pump, nozzle, spray formation, injection timing, testing of fuel pumps. **COOLING SYSTEM:** Cooling Requirements, Air Cooling, Liquid Cooling, Thermosyphon, Forced Circulation System, evaporating cooling and pressure sealed cooling – antifreeze solutions.	**CO1, CO2**

	IGNITION SYSTEM: Ignition System-, battery, magneto, Electronic ignition	
III	**TRANSMISSION SYSTEM:** Clutches: Principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel. Gear boxes, types, sliding mesh, construct mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. Propeller shaft – Hotch – Kiss drive, Torque tube drive, universal joint, differential rear axles – types – wheels and tyres. **SUSPENSION SYSTEM:** Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, Independent suspension system.	**CO1, CO3**
IV	**STEERING SYSTEM:** Steering geometry – camber, castor, king pin rake, combined angle toe-in, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages. **BRAKING SYSTEM:** Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder, tandem master cylinder, Requirement of brake fluid, Pneumatic and vacuum brakes.	**CO1, CO3**
V	**ELECTRICAL SYSTEM:** Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc. **EMISSION FROM AUTOMOBILES:** Pollution standards National and international – Pollution Control– Techniques – Multipoint fuel injection for SI Engines. Common rail diesel injection. Energy alternatives – Solar, Photo-voltaic, hydrogen, Biomass, alcohols, LPG,CNG, liquid Fuels and gaseous fuels, electrical-their merits and demerits. **KEY AUTOMOTIVE PLASTICS APPLICATIONS:** Safety and Energy Management, Interiors and Occupant Safety. Glazing, Plastic-Metal Hybrid Structures, Headlamps, Body Panels, Under-the-Hood Components.	**CO1, CO3, CO4**

Learning Resources
Text books
1.Automotive Mechanics-Vol.1 & Vol.2, by Kirpal sing, Standard Publishers, New Delhi, 2008. 2.Automobile Engineering, (3rd edition), by William crouse, TMH Distributors, New Delhi. 3.Plastics Application Technology for Safe and Lightweight Automobiles,Sudhakar R Marur, SAE International (30 October 2013), USA
Reference books
1.Automobile Engineering Theory and Servicing, by James D. Halderman and Chase D. Mitchell, Pearson education inc, 2001. 2.Automobile Engineering, by Newton's steeds & Garrett Automotive Mechanics Heitner, Butterworth International, London.
E- Resources & other digital material
1.https://nptel.ac.in/courses/107/106/107106088/

AUTOMOTIVE TRANSMISSION SYSTEMS

CourseCode	20ME5502	Year	III	Semester	I
Course Category	Minor in AE	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes		Skill	BTL	Units
Upon successful completion of the course, the student will be able to				
CO1	Understand the fundamentals and existing technology of various components of Automobiles	Understand	L2	1,2,3,4,5
CO2	Illustrate the significance, operational functions of Clutch and Gear transmission systems	Apply	L3	1,2,3
CO3	Contrast the common types of special transmission and drive axles used in heavy duty commercial vehicles.	Analyse	L4	3,4,5

	Contribution of Course Outcomes towards achievement of Program Outcomes Strength of correlations (3: High, 2: Moderate, 1: Low)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3									2	2	1
CO2	3		3									2	2	1
CO3	3		3									2	2	1

Syllabus		
UNIT	Contents	Mapped COs
I	**CLUTCH:** Necessity of clutch in an automobile, different types of clutches, friction clutches namely Single plate clutch, multi plate clutch, cone clutch, centrifugal clutch, electromagnetic clutch, hydraulic clutches, **Clutch adjustment**/troubles and their causes, requirements, Clutch materials, lining, Vacuum operated clutch, Fluid coupling	CO1, CO2
II	**GEAR BOX:** The need for transmissions, Necessity of gear box, Desirable ratios of 3-speed & 4-speed gear boxes Constructional details of sliding-mesh gear box, constant-mesh gear box, synchromesh gear box, automatic and semi-automatic transmission, overdrive	CO1, CO2
III	**TORQUE CONVERTER AND AUTOMATIC TRANSMISSION:** Principal of torque conversion, single, multi stage and polyphase torque converters, performance characteristics, constructional and operational details of typical hydraulic transmission drives. Automatic transmission: relative merits and demerits when compared to conventional transmission epicyclic and hydromatic transmission continuously variable transmission.	CO1, CO2, CO3
IV	**SPECIAL TRANSMISSION SYSTEMS:**	CO1,

	Hydrostatic drives: principles, construction and working of hydrostatic drives, Janney Hydrostatic drive, advantages and limitations Electrical drives: principles of Ward Leonard system of control Modern electric drive for buses and performance characteristics, advantages and limitations	**CO3**
V	**DRIVE LINE:** Effects of driving thrust and torque reaction. Hotchkiss drive. Torque tube drive, radius rods. Propeller shaft Universal joints. Final drives – different types, double reaction final drive. Two speed rear axles. Rear axle construction – full floating, three quarter floating and semi-floating arrangements. Differential conventional type, no-slip type. Differential locks	**CO1, CO3**

Learning Resources
Text books
1.Fischer and Pollack, “The automotive transmission book”, Springer, 2014 2.Light and Heavy Vehicle Technology, M.J. Nunney, Elsevier, Fourth Edition
Reference books
1.Newton K and Steeds. W. “The Motor Vehicle”, Butter Worth’s & Co., Publishers Ltd, 2001 2.Automatic vehicle transmission, John Wiley Publications 1995 3.Crouse. W.H., Anglin. D.L., "Automotive Transmission and Power Trains construction ", McGraw-Hill 4.Heldt P.M - Torque converters- Chilton Book Co.-1992
E- Resources & other digital material
1.https://nptel.ac.in/courses/107/106/107106088/ 2.https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-de06 3.https://nptel.ac.in/courses/116/102/116102012/

MODERN TECHNOLOGY IN AUTOMOBILE ENGINEERING

CourseCode	20ME5603	Year	III	Semester	II
Course Category	Minor in AE	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes		Skill	BTL	Units
Upon successful completion of the course, the student will be able to				
CO1	Understand the current technologies in the automobile industry	Understand	L2	1,2,3,4,5
CO2	Apply fundamental concepts on digitalizing the engine controls system and subsystem arrangements in automobiles	Apply	L3	2,3
CO3	Apply fundamental knowledge of automobile engineering for design of Electronic sensor and comfort systems	Apply	L3	2,3,4
CO4	Analyse state of art technology in automobile field for design of safety and security systems	Analyse	L4	4,5

	Contribution of Course Outcomes towards achievement of Program Outcomes Strength of correlations (3: High, 2: Moderate, 1: Low)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1			2	2					3	2	1
CO2	2	2	1			2	2					3	2	1
CO3	2	2	1			2	2					3	2	1
CO4	2	2	1			2	2					3	2	1

Syllabus		
UNIT	Contents	Mapped COs
I	**Recent Trends:** Common rail direct injection diesel engine, dual fuel and multi fuel engine, free piston engine, gasoline direct injection engine, homogeneous charge compression ignition engine, lean burn engine, stratified charge ignition engine, variable compression ratio engine, Wankel engine.	CO1
II	**Digital Engine Control System:** Open loop and closed loop control system; engine cooling and warm-up control; acceleration, deceleration and idle speed control; integrated engine control system; exhaust emission control engineering; on-board diagnostics; future automotive electronic systems.	CO1, CO2, CO3
III	**Basic sensor arrangements:** Types of sensors – oxygen sensor, hot wire anemometer sensor, vehicle speed sensor, detonation sensor, accelerometer sensor, crank position sensor. Microprocessor and microcomputer controlled devices in automobiles such as travel information system, keyless entry system, automatic transmission system, electronic steering system.	CO1, CO2, CO3
IV	**Warning and alarm instruments :** Brake actuation warning system,	

	traficators, flash system, oil pressure warning system, engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, neutral gear indicator, horn design, permanent magnet horn, air & music horns. Wind shield wiper. window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, dash board illumination.	**CO1, CO3, CO4**
V	**Safety system:** Antilock braking system, air bag restraint system, voice warning system, seat belt system, road navigation system, anti theft system.	**CO1, CO4**

Learning Resources

Text books

1.Heinz Heisler, Advanced Engine Technology, SAE International Publications, USA, 1998.
2.A.W. Judge, Modern Electrical Equipment of Automobiles, Chapman & Hall, London, 1992.
3.William B. Ribbens -Understanding Automotive Electronics, 5th edition- Butter worth Heinemann, 1998
4.A.P. Young, &L.Griffiths, Automobile Electrical Equipment, English Language Book Society & New Press, 1990.

Reference books

1.W.H.Crouse, Automobile Electrical Equipment, McGraw Hill Book Co Inc., New York, 1980.
2.Robert N Brady, Automotive Computers and Digital Instrumentation, Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.
3.P L. Kohli, Automotive Electrical Equipment, Tata McGraw Hill Publishing Co., Delhi, 2004

E- Resources & other digital material

1.https://nptel.ac.in/courses/107/106/107106088/
2.https://nptel.ac.in/courses/107/103/107103084/
3.https://www.avnet.com/wps/portal/apac/resources/article/automotive-electronics-top-5-tech-trends-tomorrows-smart-cars/

ALTERNATE FUEL AND EMISSION CONTROLS IN AUTOMOTIVES

CourseCode	20ME5604	Year	III	Semester	II
Course Category	Minor in AE	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes		Skill	BTL	Units
Upon successful completion of the course, the student will be able to				
CO1	Understand the fundamental concepts of Alternative fuels and their emission control	Understand	L2	1,2,3,4,5
CO2	Illustrate various pollutants emitting from automotive and their effects and control techniques	Apply	L3	2,3,4
CO3	Analyse the pollutant characteristics and methodologies, testing equipment used to measure pollutants.	Analyse	L4	1,3,4,5

	Contribution of Course Outcomes towards achievement of Program Outcomes Strength of correlations (3: High, 2: Moderate, 1: Low)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	-	2	-	-	-	-	1	3	1
CO2	2	1	-	-	-	-	2	-	-	-	-	1	3	1
CO3	2	1	-	-	-	-	2	-	-	-	-	1	3	1

Syllabus		
UNIT	Contents	Mapped COs
I	**Alternate fuels**: Introduction to alternate energy sources, availability, properties of biofuels, methanol, ethanol, vegetable oils, biodiesel. Gaseous fuels: hydrogen, natural gas, compressed natural gas (CNG), liquefied petroleum gas(LPG) ,Hydrogen ,Producer gas, Oxygenated fuels: benzol, diethyl ether (DEE), dimethyl ether (DME)-properties and their performance.	CO1, CO3
II	**Pollutants and emissions:** Types of pollutants, HC, CO, CO2, NOx, smoke and soot other emissions: aldehydes, sulphur, Emission standards-Bharat stage, Euro norms, Effect of emissions on environment, human health, transient operation effects on pollution.	CO1, CO2
III	**Performance and emission characteristics:** alternate fuels Emission characteristics in SI engines, alcohol – gasoline blends, methanol reformed gas engine. Use of alcohols in CI engines. Properties, production and storage methods of hydrogen, safety precautions, Biogas production and its properties, properties of LPG and CNG. Performance, combustion and emission characteristics of hydrogen, biogas, LPG and CNG in SI and CI engines.	CO1, CO2, CO3
IV	**Emission control techniques:** Engine design changes, Engine operating parameters, EGR systems, glow plugs, thermal converters, Catalytic converters: classification, honey comb, 2-way, 3-way catalytic converters,	CO1, CO2, CO3

	Particulate filter, Selective catalytic reduction (SCR) systems, Fumigation, water injection, secondary air injection, enhanced evaporative emission control system (EVAP), PCV system.	
V	**Methodology and equipment to measure pollutants:** testing equipment-Exhaust gas analyzer, Orsat apparatus, NDIR, FID, Chemiluminescent analyzers, Gas chromatography, smoke meters, measurement of CO2 Test procedures: ECE, FTP Tests. SHED Test - chassis dynamometers, dilution tunnels, Cycle test-I, Cycle test-II.	**CO1, CO3**

Learning Resources
Text books
1.V. Ganesan, Internal combustion engines,4/e, McGraw Hill, 2015. 2.J. Erjavec, A systems approach to automotive technology, 2/e, Cengage Learning, 2013.
Reference books
1.J. B. Heywood, Internal Combustion Engines Fundamentals, McGraw Hill, 2017. 2.M.F. Hordeski, Alternative Fuels: The Future of Hydrogen, The Fairmont Press, Inc., 2008. 3.R.K. Rajput, A textbook of Internal Combustion Engines, 2/E, Laxmi Publications (P) Ltd, 2007. 4.Alternative Fuels: Fuel Cells and Natural Gas, Society of Automotive Engineers, Incorporated, 2000. 5.S.S. Thips, Alternative Fuels: Concepts, Technologies and Developments, Jaico Publishing House, 2010
E- Resources & other digital material
1..https://nptel.ac.in/courses/112/104/112104122/ 2..https://ocw.mit.edu/courses/materials-science-and-engineering/3-080-economic-environmental-issues-in-materials-selection-fall-2005/

AUTONOMOUS VEHICLES

CourseCode	20ME5605	Year	III	Semester	II
Course Category	Minor in AE	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Automobile Engineering
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand technology and advancements applied in and connected, Automated and intelligent Cars	Understand	L2	1,2,3,4,5
CO2	Apply knowledge of sensor and wireless technology to execute systems in connected and autonomous cars	Apply	L3	2,3,5
CO3	Analyze and critically evaluate the safety challenges associated with future vehicles to rate the ethical implications of alternative automotive technologies	Analyze	L4	1,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3		3	1	2	2		2		2	3	2
CO2	3		3		3	1	2			2		2	3	2
CO3	3		3		2	1	2	3		2		2	3	2

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction To Connected, Automated And Intelligent Cars** Introduction to Connected, automated and Intelligent cars- Automotive Electronics Overview, Advanced Driver Assistance Electronic Systems, Connected Car Technology- Connectivity Fundamentals, Navigation and Other Applications, **Connected and Autonomous Vehicle Technology** Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory.	CO1 CO3
II	**Sensor Technology** Sensor Technology for Advanced Driver Assistance Systems- Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, **Impaired Driver Technology** Driver Impairment Sensor Technology, Sensor Technology for Driver Impairment Detection, Transfer of Control Technology	CO1 CO2
III	**Introduction to Self-Driving Vehicle Technology** Fundamentals of state-of-the-art SLAM, multi-sensor data fusion, and other SDV algorithms. Robot Operating System (ROS) and Open	CO1 CO2

	Source Car Control (OSCC). **Wireless System Standards and Standards Organizations** Wireless Networking and Applications to Vehicle Autonomy: Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle Networks	
IV	**Acceptance, Security And Ethics Of Autonomous Driving** Why Ethics Matters for Autonomous Driving, Opportunities and Risks Associated with Autonomous Driving, User / public Acceptance of Autonomous Driving **Regulations, Policies And Standards Of Autonomous Driving** Regulatory bodies for highly automated and autonomous driving, Policies and policy making in autonomous driving, Autonomous driving, standardization bodies and standards	**CO1** **CO3**
V	**Recent Driver Assistance System And Vehicles** Recent Driver Assistance System Technology- Basics of Theory of Operation, Applications – Legacy, Applications – New **Future Applications** Integration of ADAS Technology into Vehicle Electronics, System Examples, Role of Sensor Data Fusion, Recent Driver Assistance System Technology applied in various automobile companies dealing with Non-Passenger Car	**CO1** **CO2** **CO3**

Learning Resources

Text books

1.George Dimitrakopoulos, Aggelos Tsakanikas, Elias Panagiotopoulos, "Autonomous Vehicles Technologies, Regulations, and Societal Impacts", Elsevier Publications, 2021.

2.Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies, 2019, Springer Publications.

3.Hanky Sjafrie, "Introduction to Self-Driving Vehicle Technology", 1st Edition, Published December 11, 2019 by Chapman and Hall/CRC

Reference books

1.G. Mullett, Wireless Telecommunications Systems and Networks, Thomson – Delmar Learning, ISNB#1-4018-8659-0, 2006

2. G. Mullett, Basic Telecommunications: The Physical Layer, Thomson – Delmar Learning, ISBN#1-4018-4339-5, 2003

3.Tom Denton, Automobile Electrical and Electronic Systems, 3rd Edition Elsevier Publications 2004.

AUTOTRONICS

CourseCode	20ME5702	Year	IV	Semester	I
Course Category	Minor in AE	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes		Skill	BTL	Units
Upon successful completion of the course, the student will be able to				
CO1	Understand the basic fundamentals of Automobile Engineering Electronics	Understand	L2	1,2,3,4,5
CO2	Apply the knowledge of automobile engineering for design of electronically operated sensor based fuel injection and ignition systems	Apply	L3	2,3,4
CO3	Analyse basic electronic devices for designing of vehicle intelligence systems on automotive electronics	Analyse	L4	3,4,5

	Contribution of Course Outcomes towards achievement of Program Outcomes Strength of correlations (3: High, 2: Moderate, 1: Low)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2		3			2						2	2	2
CO2	2		3			2						2	2	2
CO3	3		3			3						2	2	2

Syllabus		
UNIT	Contents	Mapped COs
I	**AUTOMOTIVE FUNDAMENTALS:** The engine-components-Drive train -Starting &charging systems operation- Ignition system- Suspension systems-brakes -ABS - Steering system	CO1
II	**AUTOMOTIVE SENSORS:** Temperature sensor-gas sensor-knock sensor-pressure sensor - flow sensor torque sensor-crash sensor-Speed sensor and acceleration sensor-micro sensor-smart sensor-operation, types, characteristics, advantages and their applications. Solenoids, stepper motors, relay.	CO1, CO2
III	**FUEL INJECTION AND IGNITION SYSTEM:** Introduction -fuel system components-electronic fuel system fuel injection-types-throttle body versus port injection-electronic control fuel injection-operation different types-fuel injectors-idle speed control-continuous injection system-high pressure diesel fuel injection -MPFI system -Electronic ignition system-operation-types-Electronic spark timing control.	CO1, CO2, CO3
IV	**FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS** Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.	CO1, CO2, CO3

V	**VEHICLE INTELLIGENCE:** Introduction -basic structure-vision based autonomous road vehicles architecture for dynamic vision system -features-applications- A visual control system using image processing and fuzzy theory-An application of mobile robot vision to a vehicle information system- object detection, collision warning and Avoidance system-low tyre pressure warning system.	**CO1, CO3**

Learning Resources
Text books
1.Willium B. Ribbens, Understanding Automotive Electronics - Sixth edition Elsevier Science 2003. 2.Automotive Sensors Handbook, 8th Edition, 2011, BOSCH 3.Crouse, W.H "Automobile Electrical Equipment", McGraw-Hill Book Co., Inc., New York, 3rd edition, reprint 2010.
Reference books
1.Ronald K.Jurgen, Sensors and Transducers - SAE 2003 2.Jack Erjavec, Robert Scharff, Automotive Technology - Delmar publications Inc 1992 3.Ronald K.Jurgen, Electric and Hybrid-electric vehicles - SAE 2002 4.Ichiro Masaki, Vision-based Vehicle Guidance - Springer Verlag, Newyork 1992 5.Jay Webster, Class Room Manual For Automotive Service And System - Delmer Publications Inc 1995 6.Ron Hodkinson, John Fenton, Light Weight Electric/Hybrid Vehicle Design - Read Educational and Professional Publications Ltd. 2001
E- Resources & other digital material
1. http://nptel.ac.in/courses/108108076/ 2. http://nptel.ac.in/courses/108108176/ 3. https://books.google.co.in/books?id=PaznCAAAQBAJ&printsec=frontcover&dq=isbn:9401168814&hl=en&sa=X&ved=0ahUKEwiIrKC9sN7ZAhXKQY8KHTrwB1gQ6AEIJjAA#v=onepage&q&f=false

ELECTRIC VEHICLES

CourseCode	20ME5703	**Year**		**Semester**	
Course Category	Minor in AE	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1 – 0	**Prerequisites**	Automobile Engineering
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand working of Electric Vehicles and recent trends	Understand	L2	1,2,3,4,5
CO2	Apply the EV, HEV and electric propulsion unit and its control for application of electric vehicles	Apply	L3	1,2,3
CO3	Analyze design and different power converter topology used for electric vehicle application	Analyze	L4	1,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		3		3	1	2	2		2		2	3	2
CO2	3		3		3	1	2			2		2	3	2
CO3	3		3		2	1	2	3		2		2	3	2

Syllabus

UNIT	Contents	Mapped COs
I	**Electric and Hybrid Electric Vehicles** Configuration of Electric Vehicles, Performance of Electric Vehicles, Traction motor characteristics, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving, Energy consumption Concept of Hybrid Electric Drive Trains, Architecture of Hybrid Electric Drive Trains, Series Hybrid Electric Drive Trains, Parallel hybrid electric drive trains.	**CO1 CO2**
II	**Energy storage for EV and HEV** Energy storage requirements, Battery parameters, Types of Batteries, Modelling of Battery, Fuel Cell basic principle and operation, Types of Fuel Cells, PEMFC and its operation, Modelling of PEMFC, Super Capacitors.	**CO1 CO2**
III	**Electric Propulsion** EV consideration, DC motor drives and speed control, Induction motor drives, Permanent Magnet Motor Drives, Switch Reluctance Motor Drive for Electric Vehicles, Configuration and control of Drives	**CO1 CO2**
IV	**Design of Electric and Hybrid Electric Vehicles** Series Hybrid Electric Drive Train Design: Operating patterns, control strategies, Sizing of major components, power rating of traction motor, power rating of engine/generator, design of PPS	**CO1 CO3**

	Parallel Hybrid Electric Drive Train Design: Control strategies of parallel hybrid drive train, design of engine power capacity, design of electric motor drive capacity, transmission design, energy storage design	
V	**Power Electronic Converter for Battery Charging** Charging methods for battery, Termination methods, charging from grid, The Z-converter, Isolated bidirectional DC-DC converter, Design of Z-converter for battery charging, High-frequency transformer based isolated charger topology, Transformer less topology	**CO1** **CO3**

Learning Resources
Text books
1.Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003 2.Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles Principles And Applications With Practical Perspectives, Wiley Publication, 2011.
Reference books
1. C.C. Chan and K.T. Chau, Modern Electric Vehicle Technology, OXFORD University Press, 2001. 2. M. Ehsani, Y. Gao, S. Gay and Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design, CRC Press, 2005 3. Tom Denton, Automobile Electrical and Electronic Systems, 3rd Edition Elsevier Publications 2004.
E- Resources & other digital material
1. https://nptel.ac.in/courses/108106170?msclkid=5d0d97eacf7011ec9203c541a7cda255 2. https://nptel.ac.in/courses/108102121?msclkid=5d0ddd09cf7011ec82d15ce85a00f786

MECHANICAL ENGINEERING MINOR COURSES

MINOR IN DIGITAL MANUFACTURING

BASIC MANUFACTURING PROCESSES

CourseCode	20ME5401	Year	III	Semester	I
Course Category	Minor in DM	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Physics
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand basic principles of various manufacturing process.	Understand Communication	L2	1,2,3,4,5
CO2	Illustrate moulding and casting process	Apply, Communication	L2	2
CO3	Discuss various metal forming processes	Apply, Communication	L3	3,4
CO4	Identify various Metal joining process for different products	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1							2		2	DS	DS
CO2	3		1							2		2	DS	DS
CO3	3		1							2		2	DS	DS
CO4	3		1							2		2	DS	DS

Syllabus

UNIT	Contents	Mapped COs
I	**INTRODUCTION TO FOUNDRY:** **Introduction:** Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy. Introduction to casting process & steps involved. Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance. **Sand Molding**: Basic steps in mold preparation, materials used for mould, types of molds. **Special casting processes**: Shell moulding, Investment casting, die casting, Centrifugal casting, Casting defects and remedies. Advantages and applications of casting.	CO1, CO2
II	**Introduction to metal forming processes** classification of metal forming processes. Hot working & cold working of metals. **Forging:** Classification of forging processes. Forging machines equipment. Expressions for forging pressures& load in open die forging and closed die	CO1, CO3

	forging by slab analysis. Smith forging, drop forging & press forging. Forging Equipment, Defects in forging.	
III	**Rolling**: Classification of rolling processes. Types of rolling mills, Variables of rolling process, expression for rolling load. Roll separating force, Rolling defects. **Drawing & Extrusion:** Drawing of wires, rods &drawing pipes, Variables of drawing process. Difference between drawing & extrusion. Types of Extrusion: Direct, reverse, impact, hydrostatic extrusion. Dies for extrusion, stock penetration. Extrusion ratio of force equipment (with and without friction)	**CO1, CO3**
IV	**Sheet Metal Operations:** Blanking, piercing, punching, drawing, draw ratio, drawing force, variables in Drawing, Trimming, and Shearing. Bending - types of bending dies, bending force calculation, Embossing and coining. Types of dies: Progressive, compound and combination dies.	**CO1, CO 3**
V	**Metal Joining Processes:** Classification of welding processes, types of welds and welded joints, Arc Welding, Submerged Arc Welding, Gas Tungsten Arc Welding, Gas Metal Arc Welding, Electron Beam Welding, Laser Welding, Forge welding, Resistance welding, Friction welding, Explosive welding, Thermit welding and Plasma Arc welding. Soldering and brazing. Adhesive Bonding. Welding defects: causes and remedies	**CO1, CO 4**

Learning Resources

Text books

1.Amitabha Ghosh and Mallick A. K., Manufacturing Science. Affiliated East-West Press Pvt. Ltd. 2010.
2.M. P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Third edition. Wiley India Private Limited, 2009.
3.S. Kalpakjian, Manufacturing Processes for Engineering Materials, Fifth edition. Pearson Education, 2009.

Reference books

1.G. K. Lal and S. K. Choudhury, Fundamentals of Manufacturing Process, 2009. Boca Raton, FL: CRC Press, 2011.
2.J.P. Holman, Experimental Methods for Engineers, McGraw Hills Int. Edition.

E- Resources & other digital material

1.https://nptel.ac.in/courses/112107219

ADDITIVE MANUFACTURING

CourseCode	20ME5501	Year	III	Semester	I
Course Category	Minor in DM	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Basic Manufacturing Processes
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the working principle and process parameters of different AM processes and Design and develop a product for AM process.	Understand Communication	L2	1,2,3,4,5
CO2	Explore the Vat Photo polymerization AM Process and their applications.	Apply, Communication	L2	2
CO3	Select the Extrusion-Based AM Processes, Sheet Lamination AM Processes suitable material and process for fabricating a given product.	Apply, Communication	L2	3
CO4	Identify various Metal Additive Manufacturing process for different products.	Apply, Communication	L2	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1		2							2		
CO2	3		1		2							2		
CO3	3		1		2							2		
CO4	3		1		2							2		

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction to Additive Manufacturing**: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM	CO1
II	**Vat Photopolymerization AM Processes**: Stereolithography (SL), Materials, Process Modeling, SL resin curing process, SL scan patterns, Micro-stereolithography, Mask Projection Processes, Two-Photon vat photo polymerization, Process Benefits and Drawbacks, Applications of Vat Photopolymerization, case studies.	CO1, CO2
III	**Material Jetting AM Processes:** Evolution of Printing as an Additive Manufacturing Process, Materials, Process Benefits and Drawbacks, Applications of Material Jetting Processes. Binder Jetting AM Processes: Materials, Process Benefits and Drawbacks, Research achievements in printing deposition, Technical	CO1, CO3

	challenges in printing, Applications of Binder Jetting Processes.	
IV	**Extrusion-Based AM Processes:** Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, Bio-Extrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes, case studies **Sheet Lamination AM Processes:** Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications, case studies.	**CO1, CO4**
V	**Powder Bed Fusion AM Processes:** Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.	**CO1, CO4**

Learning Resources
Text books
1. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", 2nd Edition, Springer, 2015. 2. Patri K. Venuvinod and Weiyin Ma, "Rapid Prototyping: Laser-based and Other Technologies", Springer, 2004. 3. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015.
Reference books
1.Neil Hopkinson, Richard Hague, Philip Dickens - Rapid manufacturing_ an industrial revolution for the digital age (2006, Wiley) - libgen.lc.
E- Resources & other digital material
1.https://onlinecourses.nptel.ac.in/noc20_me50/preview 2.https://onlinecourses.nptel.ac.in/noc21_me115/preview

DESIGN FOR ADDITIVE MANUFACTURING

CourseCode	20ME5601	Year	III	Semester	II
Course Category	Minor in DM	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Basic Manufacturing Processes
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Illustrate the need of design for additive manufacturing and represent synthetic curves and surfaces using mathematical models	Understand Communication	L2	1
CO2	Apply design for additive manufacturing guidelines in designing of mass customized products	Apply, Communication	L2	2,3
CO3	Discuss design for minimal material, functionality lattice structures using topology optimization	Apply, Communication	L2	4
CO4	Identify methods of powder handling and standards related to Additive Manufacturing	Apply, Communication	L2	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1									2		
CO2	3		1									2		
CO3	3		1									2		
CO4	3		1									2		

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction to Design for Additive Manufacturing (DfAM):** Introduction to geometric modelling, Modelling of Synthetic curves like Hermite, Bezier and B-spline, Parametric Representation of freeform surfaces, Design freedom with AM, Need for Design for Additive Manufacturing (DfAM), CAD tools vs. DfAM tools, Requirements of DfAM methods, General Guidelines for DfAM, The Economics of Additive Manufacturing, Design to Minimize Print Time, Design to Minimize Post-processing.	CO1
II	**Design Guidelines for Part Consolidation:** Design for Function, Material Considerations, Number of Fasteners, Knowledge of Conventional DFM/DFA, Assembly Considerations, Moving Parts, Part redesign, Opportunities for part consolidation, challenges with part consolidation.	CO2
III	**Design for Improved Functionality:** Multi scale design for Additive manufacturing, Mass customization, Biomimetics, Generative design,	CO3

	Design of multi-materials and functionally graded materials	
IV	**Design for Minimal Material Usage:** Topology Optimization, Modelling of Design space, defining design and manufacturing constraints, performing analysis for weight reduction, maximize stiffness, minimize displacement, Post-processing and Interpreting Results, Applications of Topology Optimization, Topology Optimization Tools, Design of cellular and lattice structures, Design of support structures.	**CO 3**
V	**Other AM Considerations:** Designer Machine Operator Cooperation, Health and Safety, Material Exposure, Gas Monitoring, Gas Exhaust, Material Handling, Risk of Explosion, AM Part Standardization and Certification.	**CO1, CO4**

Learning Resources
Text books
1.A Practical Guide to Design for Additive Manufacturing, Diegel, Olaf, Axel Nordin, and Damien Motte, Springer, 2020. 2.The 3D Printing Handbook: Technologies, Design and Applications, Redwood, Ben, Filemon Schoffer, and Brian Garret, 3D Hubs, 2017.
Reference books
1.Design for Advanced Manufacturing: Technologies and Process, Laroux K, Gillespie, McGrawHill, 2017. 2.Additive Manufacturing Technologies, Gibson, Ian, David W. Rosen, Brent Stucker, and Mahyar Khorasani, Springer, 2021.
E- Resources & other digital material
1.https://courses.gen3d.com/courses/enrolled/988400 2.https://markforged.com/resources/blog/design-for-additive-manufacturing-dfam

INDUSTRY 4.0 and IIoT

CourseCode	20ME5602	**Year**	III	**Semester**	II
Course Category	Minor in DM	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1 – 0	**Prerequisites**	Basic Manufacturing Processes
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Illustrate how Industry 4.0 will change the current manufacturing technologies and processes by digitizing the value chain.	Understand Communication	L2	1,2
CO2	Discuss the drivers and enablers of Industry 4.0	Apply, Communication	L2	3
CO3	Apply various IIoT-related protocols	Apply, Communication	L2	4
CO4	Explain simple IIoT Systems using Arduino and Raspberry Pi	Apply, Communication	L2	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1		2							2		
CO2	3		1		2							2		
CO3	3		1		2							2		
CO4	3		1		2							2		

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction to Industry 4.0:** Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Mass Customization, Smart and Connected Business Perspective, Smart Factories	**CO1**
II	**Industry 4.0:** Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis	**CO1, CO2**
III	**Introduction to IIoT:** Architectural Overview, Design principles and needed capabilities, IoT Applications, Sensing, Actuation, Basics of Networking, M2M and IoT Technology Fundamentals- Devices and gateways, Data management, Business processes in IoT, Everything as a Service (XaaS), Role of Cloud in IoT, Security aspects in IoT.	**CO3**
IV	**Elements of IIoT:** Hardware Components- Computing (Arduino, Raspberry Pi), Communication, Sensing, Actuation, I/O interfaces.	**CO3**

	Software Components- Programming API's (using Python/Node.js/Arduino) for Communication Protocols-MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP.	
V	**IIoT Application Development**: Solution framework for IoT applications- Implementation of Device integration, Data acquisition and integration, Device data storage- Unstructured data storage on cloud/local server, Authentication, authorization of devices. Case Studies: IoT case studies and mini projects based on Industrial automation, Transportation, Agriculture, Healthcare, Home Automation.	**CO 4**

Learning Resources
Text books
1.Introduction to Industrial Internet of Things and Industry 4.0, Sudip Misra, Chandana Roy, Anandarup Mukherjee, CRC Press, 2020. 2.A Hands on Approach", Vijay Madisetti, Arshdeep Bahga, İnternet of Things, University Press, 2009. 3.Introduction to Internet of Things: A practical Approach", Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, ETI Labs,2010
Reference books
1.Internet of Things: Architecture and Design, Raj Kamal, McGraw Hill., 2005. 2.Getting Started with the Internet of Things, Cuno Pfister, O Reilly Media, 2007
E- Resources & other digital material
1.https://onlinecourses.nptel.ac.in/noc21_cs17/preview

INTELLIGENT MANUFACTURING SYSTEMS

CourseCode	20ME5701	Year	IV	Semester	I
Course Category	Minor in DM	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Basic Manufacturing Processes
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Discuss reachability graphs for various manufacturing system problems using petri net models	Understand Communication	L2	1
CO2	Illustrate components of knowledge based systems and clustering techniques to identify the variations in information sharing	Understand Communication	L2	2,3
CO3	Apply machine learning techniques for various real life applications in manufacturing systems	Apply, Communication	L2	4
CO4	Evaluate block chain technology in the context of manufacturing systems design	Apply, Communication	L2	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3		1		2							2		
CO2	3		1		2							2		
CO3	3		1		2							2		
CO4	3		1		2							2		

Syllabus

UNIT	Contents	Mapped COs
I	**Petri Nets:** Key concepts and definitions, principles of net theory, Place/Transition Systems and Elementary Net (EN) Systems. Token game, reachability, state graph, behavioral properties like deadlock and boundedness, behavioral equivalence and normal forms. Elementary Net Systems: Causality, conflict, concurrency, and confusion. Examples of Petri net models. Examples in manufacturing Systems	CO1
II	**Components of Knowledge Based Systems:** Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition, Clustering. Examples in manufacturing Systems Cloud Manufacturing and Networking with TCP/IP: Introduction to cloud computing: cloud models, cloud service examples, cloud based services & applications. Introducing TCP/IP, IP Addressing and Related Topics, Data Link and Network Layer TCP/IP Protocols, Internet Control	CO2

	Message Protocol (ICMP), Transport Layer TCP/IP Protocols, Basic TCP/IP Services.	
III	**Machine Learning:** Concept, Artificial Neural Networks, Biological and Artificial Neuron, Deep Nets, Applications in manufacturing; Use of probability and fuzzy logic for machine thinking, Examples in manufacturing Systems.	**CO2**
IV	**Agent and Multi-agent systems:** Agents, agent definitions and classification, multi-agent systems, Models of agency, architectures and languages, Agent communication and interaction protocols. Examples in manufacturing Systems	**CO 3**
V	**Block Chain Technology:** Basic Concepts, Trust- The need for trust, Forms of trust, The problem space for block chain. Cryptography - Information security as a form of trust, Public and Private keys, Digital signatures, Hashing. Examples in manufacturing Systems.	**CO 4**

Learning Resources

Text books

1.Automation, Production Systems and CIM", Groover M.P.,Prentice-Hall, New Delhi, 2009.
2.A Comprehensive guide to AI and Expert Systems", Robert Levine , McGraw Hill Inc, 1986.
3.Automation, Production Systems and Computer Integrated Manufacturing", Mikell P Groover, PHI, 2008, 8th edition.

Reference books

1.Guide to TCP/IP, Ed Tittel, Laura Chappell, Third Edition. Course Technology Incorporated, 2007,
2.Automated Planning- Theory and Practice, Malik Ghallab Malik, Morgan Kaufmann, 2004.
3.Machine Learning, Mitchell T, Mc-Graw Hill, 2012.

HONORS IN MECHANICAL ENGINEERING

POOL-1

ADVANCED THERMODYNAMICS

CourseCode	20ME6401	**Year**		**Semester**	
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1– 0	**Prerequisites**	ETD, ATD
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand availability concept, property relations, non reacting mixture properties, phase equilibrium and chemical reactions of a thermodynamic system.	Understand, Communication	L2	1,2,3,4,5
CO2	Apply property relations to make property calculations of ideal and real gases;	Apply, Communication	L3	2,3
CO3	Analyze combustion products as well as flame velocity and thickness.	Apply, Communication	L3	4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					3	3			2		2	3	2
CO2	3	2				3	3			2		2	3	2
CO3	3					3	3			2		2	3	2

Syllabus

UNIT	Contents	Mapped COs
I	**Review of basic thermodynamics:** First & Second laws, Concept of entropy and entropy generation, Entropy balance for closed & open systems; Concept of exergy & irreversibility, Exergy analyses of open and closed system.	**CO1**
II	**Thermodynamic property relations:** Maxwell relations; Relations involving enthalpy, internal energy and entropy; Mayer relation, Clausius-Clapeyron equation, Joule-Thompson experiment.	**CO1 CO2**
III	**Properties of gas mixtures:** Multi-component and multi-phase systems, Equations of states and properties of ideal and real gas mixtures, Change in entropy in mixing.	**CO1 CO2**
IV	**Thermodynamics of reactive systems:** Combustion and thermochemistry, Reactant and product mixtures, Adiabatic flame temperature, Chemical equilibrium, Equilibrium products of combustion.	**CO1 CO3**
V	**Flames:** Types of flames, Simplified analyses of premixed & diffusion flames, Factors influencing flame velocity and thickness, Quenching, flammability and ignition, Flame stabilization.	**CO1 CO3**

Learning Resources

Text books

1.Adrian Bejan, Advanced Engineering Thermodynamics, John Wiley & Sons, 4th Edition, 2016.

2.Stephen R. Turns, An Introduction to Combustion: Concepts & Applications, McGraw-Hill Education, 3rd Edition, 2012.

Reference books

1.Kenneth K. Kuo, Principles of Combustion, Wiley India Pvt. Ltd, 2nd Edition, 2012.
2.Michael J. Moran & Howard N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley & Sons, 6th Edition, 2010.
3.Mark W. Zemansky & Richard H. Dittman, Heat & Thermodynamics, McGraw Hill, 8th Edition, 2017.

ANALYSIS AND SYNTHESIS OF MECHANISM

CourseCode	20ME6402	**Year**	II	**Semester**	II
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1 – 0	**Prerequisites**	
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the fundamentals of kinematics, linkage synthesis, relative position, velocity and acceleration of links, and coupler curves.	Understand	L2	1,2,3,4,5
CO2	Apply kinematics geometry to formulate and solve constraint equations to design linkages for specified tasks.	Apply	L3	2,3
CO3	Synthesis of multi-DOF systems using coupler curves	Apply	L3	5
CO4	Analyse relative position, velocity and acceleration of various four bar linkages.	Analyse	L4	2,4

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2							1		2	3	2
CO2	3	3	2	2						1		2	3	2
CO3	3	3	2	2						1		2	3	2
CO4	3	3	2							1		2	3	2

Syllabus

UNIT	Contents	Mapped COs
I	**Kinematics of Mechanisms**: Introduction – kinematics and kinetics - Mechanisms and machines- applications of kinematics- identification of need, background research, Detailed design prototyping and testing, production. **Kinematics fundamentals**: Introduction, Degrees of Freedom (DOF), types of motion, links, joints and kinematic chains, Determining Degree of Freedom in Planar Mechanisms and in Spatial Mechanisms. Mechanisms and structures.	**CO1**
II	**Graphical linkage synthesis**: Introduction synthesis, Function, path, and motion generation, Dimensional synthesis, two position synthesis, three position synthesis with specified moving pivots. Quick return mechanisms. **Position Analysis**: Introduction coordinate systems position and displacement – Coordinate transformation. Translation, and rotation, Graphical position Analysis of linkages, The Four bar slider crank position solution, Position of any point on a linkage, Transmission angles, extreme values of the transmission angle.	**CO1, CO2, CO4**
III	**Analytical linkage synthesis**: Introduction, types of kinematic synthesis, Precision points, Two position motion generation by analytical synthesis, Three position motion	**CO1, CO2**

	generation by analytical synthesis, Synthesis for a specified fixed pivot location, Centre point and circle point circles, Four and five position analytical synthesis, Analytical synthesis of a path generator with prescribed timing analytical synthesis of Four bar function generator, Precision point methods.	
IV	**Velocity Analysis**: Introduction-definition of velocity, Graphical velocity analysis, instant centres of velocity, velocity analysis with instant centres, angular velocity ratio, Mechanical Advantage, using instant centres in linkage Design, The Four bar inverted slider crank. **Acceleration Analysis**: Introduction definition of Acceleration Graphical Acceleration analysis, Analytical solutions for acceleration analysis, and the Four bar pin jointed linkage the Four bar slider-crank, Coriolis acceleration. The Four bar inverted slider crank.	**CO1, CO4**
V	**The Euler Savary Equation and Cubic of Stationary Curvature:** The Euler Savary equation and the Inflection circle, The cubic of stationary curvature. **Coupler Curves:** Coupler curves of four bar mechanism, Cognates of four bar mechanism, Designing optimum straight-line four bar linkages, single and double dwell linkages.	**CO1, CO3**

Learning Resources
Text books
1.Design of Machinery by RL. Norton, Tata McGraw Hill, 2009 2.Theory of Machines by S. S. Rattan, Tata McGraw-Hill Education, 2014
Reference books
1.Mechanical Engineering Design by Shigley et al., Tat McGraw Hill, 2011 2.Mechanism Design by Arthur g Erdman Prentice Hall of india,1988 3.Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines. E.W.P.Publishers 4.Theory Of Machines And Mechanisms By P. L. Ballaney, Kanna, 2003.

ADVANCED METAL CASTING

CourseCode	20ME6403	Year	II	Semester	II
Course Category	HONORS	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Illustrate Basics of casting and associated elements in casting.	Understand Communication	L2	1,2,3,4,5
CO2	Express methods of pattern and core making	Apply, Communication	L3	2
CO3	Design feeder, gating system for metal casting processes	Apply, Communication	L3	3,4
CO4	Perform economic and castability analysis using and design for casting.	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3		3								3	2
CO2	3	2	2		2					2			3	2
CO3	3	2	3		3								2	3
CO4	3	2	2		2					2			1	3

Syllabus

UNIT	Contents	Mapped COs
I	**Metal casting-overview:** Applications and production, historical perspective, casting processes. inspection of castings- analysis of casting defects **Design of molds:** Functional requirements of molding materials, type of sands Properties of molding sand, sand testing techniques, Effect of molding on sand properties, Bonding material, Mould surface coating, Sand design and control, Thermal aspect of molding sand, mould wall movement.	CO1
II	**Pattern, mould, and core making:** Machines and Tools for Patternmaking, Allowances and Other Technological Considerations, Metal Patterns Life Expectancy of Patterns, Pattern Storage and Repair, Core Sands and Core making.	CO1, CO2
III	**Feeder design and analysis:** Casting solidification, solidification time and rate, feeder location and shape, feeder and neck design, feed aid design, solidification analysis, vector element method, optimization and validation.	CO1, CO3
IV	**Gating design and analysis:** Mould filling, gating system and types, gating channel layout, optimal filling time, gating element design, mould	CO1, CO3

	filling analysis, numerical simulation, optimization and validation.	
V	**Process planning and costing**: Casting process selection, process steps and parameters, tooling cost estimation, material cost estimation, and conversion cost estimation. **Design for castability:** Product design for castability, process-friendly design, and castability analysis.	**CO1, CO4**

Learning Resources
Text books
1.B.Ravi, "Metal casting: CAD and Analysis", PH Publication, 2014. 2.P.L.Jain, "Principles of Foundry Technology", 2012 3.Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2010.
Reference books
1.A.K.Chakrabarti, Casting Technology and Cast Alloys, Prentice –Hall Of India Ltd, 2005. 2.Beely, Foundry Technology, Newnes-Butterworths, 1979.
E- Resources & other digital material
1.https://onlinecourses.nptel.ac.in/noc22_me57/preview

STATISTICAL QUALITY CONTROL

CourseCode	20ME6404	Year	II	Semester	II
Course Category	HONORS	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	NIL
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand basics of Quality Basics and History, Modeling Process Quality, Statistical Quality Control and Control Charts for Attributes, Acceptance Sampling.	Understand	L2	1,2,3,4,5
CO2	Apply Quality Principles, Modelling Process Quality and Acceptance Sampling.	Apply	L3	1,2,5
CO3	Analyze the Concept of variability and Control chart with line trend, Control Charts for Attributes.	Apply	L4	3,4
CO4	Analyze the Quality function and Modelling Process Quality.	Analyze	L4	1,2

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1		1			2		2			3		1	3
CO2	1		1			2		2			3		1	3
CO3	1		1			2		2			3		1	3
CO4	1		1			2		2			3	3	1	3

Syllabus

UNIT	Contents	Mapped COs
I	**Quality Basics and History:** Meaning of quality, Factors effecting quality, Quality Principles, Quality function, Quality control, Aims and objectives of quality control, Characteristics, Cost of quality, Value of quality, Seven QC tools, Need of management of product quality, Historical perspective of quality control.	CO1 CO2 CO4
II	**Modeling Process Quality:** Variation: Stem-leaf Plot, Frequency distribution Histogram, Box Plot, Discrete Distributions Hyper geometric Distribution, Binomial distribution, Poison Distribution, Continuous Distributions- Normal, Gamma, Exponential and Weibull's distribution.	CO1 CO2 CO4
III	**Statistical Quality Control:** Introduction, Concept of variability , Common vs. Special Causes, Types of Control charts, Measurement of control limits, Control charts for variables -large sample data, Warning limits, Revised control limits, Group control chart, Control chart with line trend.	CO1 CO3
IV	**Control Charts for Attributes**: Control charts for non-confirming Models, control charts for fraction non- conforming. Process and Measurement System Capability Analysis: Using Probability plot, process	CO1 CO3

	capability ratios, specification limits and Tolerances.	
V	**Acceptance Sampling:** Introduction, Advantages and Disadvantages of Sampling methods, Sampling techniques, Sampling Risks and indices, Operating characteristic curves, Average outgoing quality Limit. Sampling plans Single, Double, Multiple and Sequential Sampling Plans Tightened Inspection, Dodge-Rooming system, Sequential plans.	**CO1 CO2**

Learning Resources
Text books
1.E. L. Grant Richard, R.S. Leavenworth, Design Statistical Quality Control, 7th Edition, McGrawHill Pvt Ltd New Delhi, 2011. 2.D. C. Montgomery, Statistical Quality Control,7th Edition, John Wiley Sons, 2012.
Reference books
1.M. Mahajan, Statistical Quality Control, Revised Edition, Dhanapat Rai & Co, 2007. 2.W.W.Hines, D. C.Montgomery, Probability and Statistics in Engineering and Management Science, John Wiley and Sons, New York, 1990. 3.Kapoor, V.K. and Gupta, S.P. (1978): Fundamentals of applied statistics, Sultan Chand & Sons. Gupta, R.C.(1974): Statistical Quality Control.
E- Resources & other digital material
1.https://nptel.ac.in/courses/116/102/116102019/

MATERIALS AND PROCESS SELECTION FOR ENGINEERING DESIGN

CourseCode	20ME6405	Year	II	Semester	II
Course Category	HONORS	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	IEM
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the material selection, process information, Economics and Environmental aspects for Engineering Applications	Understand	L2	1,2,3,4,5
CO2	Describe the Material Selection and Substitution for candidate materials	Describe	L2	1,3,4
CO3	Explain the basics of design-oriented materials selection for engineering applications	Explain	L2	4
CO4	Analyze materials selection case studies for which either single or multiple constraints are active.	Analyze	L4	1,2,4

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2		3	1		1	1	1	1	3	1
CO2	3	2	1	2		2	1		1	1	1	1	3	1
CO3	3	2	3	2		3	3		1		2	1	3	1
CO4	3	2	3	2		3	3		1			1	3	1

Syllabus

UNIT	Contents	Mapped COs
I	**Materials Selection Process:** Introduction, Nature of the Selection Process, Analysis of the Material Performance Requirements and Creating Alternative Solutions, Functional Requirements, Processability Requirements, Cost, Reliability Requirements, Resistance to Service Conditions, Creating Alternative Solutions.	CO1
II	**Strategic thinking:** Matching material to design- The design process- Original design, Redesign, Devices to open corked bottles, **Material and process information for design the strategy:** translation, screening, ranking and documentation, Examples of translation.	CO2
III	**Economics and Environmental impact of materials and Processes:** Introduction, elements of the cost of materials, cost of ore preparation, cost of extraction from the ore, cost of purity and alloying, cost of conversion to semifinished products, cost of conversion to finished products, factors affecting material prices-general inflation and price fluctuations, supply and demand, order size, standardization of grades and sizes, cost extras for special quality geographic location, Comparison of materials on cost basis. **Environmental impact assessment of materials and processes:**	CO3

	Environmental considerations, energy content of materials, Case study: comparing the energy content in drink containers.	
IV	**Case Studies in Material Selection and Substitution:** Introduction, Design and Selection of Materials for Surgical Implants-Main Dimensions and External Forces, Fatigue-Loading Considerations, Wear Considerations, Analysis of Implant Material Requirements-Tissue Tolerance-Corrosion Resistance-Mechanical Behaviour- Elastic Compatibility-Weight-Cost, Classification of Materials and Manufacturing Processes for the Prosthesis Pin, Evaluation of Candidate Materials. **Analysis of The Requirements and Substitution of Materials for Tennis Rackets:** Introduction-Analysis of the Functional Requirements of the Tennis Racket, Design Considerations, classification of Racket Materials-Material Substitution, Ranking of Alternative Substitutes-Conclusion	**CO4**
V	**Planning for Retirement of The Product and Environmental Considerations-** Recycling of Materials, Sources of Materials for Recycling, infrastructure for Recycling Packaging Materials, Sorting, Scrap Processing, Recyclability of Materials.	**CO5**

Learning Resources

Text books

1.Farag, Mahmoud M. Materials and process selection for engineering design. CRC Press, 2020.
2.Ashby, Michael F., Hugh Shercliff, and David Cebon. Materials: engineering, science, processing and design. Butterworth-Heinemann, 2018.

Reference books

1.Ashby, M. F. (2016). Materials Selection in Mechanical Design. United Kingdom: Elsevier Science.
2.Johnson, K., Ashby, M. F. (2013). Materials and Design: The Art and Science of Material Selection in Product Design. Netherlands: Elsevier Science.

E- Resources & other digital material

1.https://nptel.ac.in/courses/112/104/112104122/
2.https://ocw.mit.edu/courses/materials-science-and-engineering/3-080-economic-environmental- issues-in-materials-selection-fall-2005/
3.https://ocw.mit.edu/courses/materials-science-and-engineering/3-080-economic-environmental-issues-in-materials-selection-fall-2005/lecture-notes/lec_ms1.pdf
4.https://ocw.mit.edu/courses/materials-science-and-engineering/3-080-economic-environmental-issues-in-materials-selection-fall-2005/lecture-notes/lec_ms2.pdf
5.https://ocw.mit.edu/courses/materials-science-and-engineering/3-080-economic-environmental-issues-in-materials-selection-fall-2005/lecture-notes/lec_ms3.pdf
6.https://ocw.mit.edu/courses/materials-science-and-engineering/3-080-economic-environmental-issues-in-materials-selection-fall-2005/lecture-notes/

POOL 2
ADVANCED MECHANICS OF FLUIDS

CourseCode	20ME6501	**Year**	III	**Semester**	I
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1– 0	**Prerequisites**	Fluid Mechanics
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the fundamentals of inviscid Incompressible and viscid compressible flow fluid flow systems.	Understand	L2	1,2,3,4,5
CO2	Apply the fundamentals of transition and turbulent flow to various fluid flow systems and Review the concepts of boundary layer	Apply	L3	1,3,4
CO3	Analyze the principles of normal and oblique shock formation through compressible fluid flow and its effects.	Analyze	L4	1,2,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2		3		3		1	2			3	1
CO2	3	3			3		2		1	2			3	1
CO3	3	3			3		2		1	2			3	1

Syllabus

UNIT	Contents	Mapped COs
I	**Inviscid Flow of Incompressible Fluids:** Eulerain Descriptions of fluid motion- Path lines, Stream lines, Streak lines, stream tubes – velocity of a fluid particle, types of flows – Stream and Velocity potential functions. Basic Laws of fluid Flow: Potential flow, Condition for irrotationality, circulation & vorticity Accelerations in Carte systems normal and tangential accelerations, Euler's, Bernouli equations Dimensional Analysis & Similarity	**CO1, CO2, CO3**
II	**Viscous Flow:** Equation of Fluid flow-Continuity & Momentum equation. Derivation of Navier-Stoke's Equations for viscous compressible flow – Exact solutions to certain simple cases: Plain Poisoulle flow – Coutte flow with and without pressure gradient – Hagen Poisoulle flow.	**CO1, CO3**
III	**Boundary Layer Concepts:** External Flow-Prandtl's contribution to real fluid flows –Blasius solution-Prandtl's boundary layer theory – Boundary layer thickness for flow over a flat plate – Approximate solutions – Creeping motion (Stokes) – Oseen's approximation – Von-Karman momentum integral equation for laminar boundary layer	**CO1, CO2**

IV	**Turbulent Flow:** Introduction to Turbulent Flow: Fundamental concept of turbulence – Time Averaged Equations – Boundary Layer Equations – Prandtl Mixing Length Model – Universal Velocity Distribution Law: Van Driest Model –Approximate solutions for drag coefficients – More Refined Turbulence Models – k-epsilon model.	**CO1, CO2, CO3**
V	**Compressible Fluid Flow:** Thermodynamic basics – Sonic Velocity – Mach Number – Generalized and simple 1D compressible flows – Development of Equations – Acoustic Velocity Derivation of Equation for Mach Number – Area – Pressure Velocity Relationship, Nozzles, Diffusers – Isothermal Flow in Long Ducts – Fanno and Raleigh Lines, Property Relations — Normal Compressible Shock, Oblique Shock: Expansion and Compressible Shocks	**CO1, CO3**

Learning Resources
Text books
1.Fox and McDonald – 'Fluid Mechanics' – John Wiley – 2011 – 8th Edition 2.White F. M. – 'Fluid Mechanics' – Mc Graw Hill International Edition – 2010 – 7th Edition 3.C. S. Jog, Fluid Mechanics: Volume 2: Foundations and Applications of Mechanics (Cambridge-IISC), June 2015.
Reference books
1. Munson, Young and Okiishi's Fundamentals of Fluid Mechanics, 8th Edition, Wiley Publications 2. Hermann Schlichting, Klaus Gersten, Boundary Layer Theory, Springer Publications 3. Fluid Mechanics and Machinery/ D. Rama Durgaiah/New Age Publications 4. Fluid Dynamics/ William F. Hughes & John A. Brighton/TMH
E- Resources & other digital material
1.https://nptel.ac.in/courses/112105287 2.https://nptel.ac.in/courses/112105045
Data Books
1.Gas Tables by Ethirajan Rathakrishnan 3rd Edition.

GEAR ENGINEERING

CourseCode	20ME6502	**Year**	III	**Semester**	I
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1– 0	**Prerequisites**	Design of Machine Elements
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Select and design appropriate gear for the given application and against the failures.	Analyze	L4	1,2,3,5
CO2	Design the gear box for given specifications.	Analyze	L4	3
CO3	Optimization of Tooth geometry for gears.	Analyze	L4	4

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2				2			1		2	3	2
CO2	3	3	2				2			1		2	3	2
CO3	3	3	2				2			1		2	3	2

Syllabus

UNIT	Contents	Mapped COs
I	**INTRODUCTION**: Principles of gear tooth action, Generation of Cycloid and Involute gears, Involutometry, gear manufacturing processes and inspection, gear tooth failure modes, stresses, selection of right kind of gears. **GEAR FAILURES**: Analysis of gear tooth failures, Nomenclature of gear tooth wear and failure, tooth breakage, pitting, scoring, wear, overloading, gear-casing problems, lubrication Failures.	**CO1**
II	**BEVEL GEARS:** Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of bevel gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Design of gear shaft. **WORM GEARS:** Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of worm gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load, Heat dissipation considerations. Design of gear shaft	**CO1, CO3**
III	**PLANETARY GEAR TRAIN**: Introduction, Gear Ratio, Conditions of Assembly, Phase Angle of Planet Gears, Efficiency of a Planetary Gear Train, Modifications of Gear Tooth Geometry, Tooth Contact Analysis.	**CO1, CO2, CO4**

	GEARBOX DESIGN - REAR-ENGINED RACING CARS: In-line shaft arrangement, Internal gear arrangement, Face-dog selectors, Bearing arrangement, Crown wheel and pinion layout, Differential location and type, Transverse-shaft arrangement, Selector system, Selector interlock system, Lubrication method, Gearbox casing, Materials guide.	
IV	**ADVANCES IN GEAR MANUFACTURING:** Subtractive or Material Removal Processes, Laser Machining, Abrasive Water Jet Machining, Spark Erosion Machining, Additive or Accretion Processes, Metal Injection Molding, Injection Compression Molding, Micropowder Injection Molding, Additive Layer Manufacturing Processes. **TOOTH GEOMETRY OPTIMIZATION:** Involute Profile Optimization, Gear Pair Size Reduction, Asymmetry Factor Selection, Mesh Efficiency Maximization, Tooth Modeling and Bending Stress Calculation, Root Fillet Optimization, Root Fillet Optimization Method, Fillet Optimization Analysis, Benefits of Fillet Optimization.	**CO3**
V	**GEAR DESIGN DETAILS:** Gear Transmission Density Maximization, Introduction of Volume Function, Volume Functions for Two-Stage Gear Drives, Internal Gear Ratio Optimization, High Gear Ratio Planetary Drives, One-Stage Arrangements, Two-Stage Arrangements. **SELF-LOCKING GEARS:** Self-Locking Conditions, Self-Locking Gear Design, Plastic Gear Design Specifics, Polymer Benefits and Limitations, Direct Gear Design of Polymer Gears, Metal-to-Plastic Conversion.	**CO1**

Learning Resources

Text books

1.Maleev and Hartman, Machine Design, C.B.S. Publishers, 1983.
2.Gear engineering by Henry E. Merrit, 3rd Edition, Ah Wheeler & Co Ltd, Allahabad,1992.
3.Hand Book of Practical Gear design by Darle W. Dudley, CRC Press, 1994.

Reference books

1. Earle Buckingham, Analytical mechanics of gears, Dover publications, New York, 1949.
2. G. M. Maitha, Hand book of gear design, TaTa Mc.Graw Hill publishing company Ltd., New Delhi, 1994.
3. Kapil Gupta, Neelesh Kumar Jain, Rudolph Laubscher, Advanced Gear Manufacturing and Finishing a Classical and Modern Processes, Academic Press is an imprint of Elsevier, UK, 2017.
4. Damir Jelaska, University of Split, Croatia Gears and Gear Drives, A John Wiley & Sons Publication, UK, 2012.
5. Alexander L. Kapelevich, Direct Gear Design, CRC Press, Taylor & Francis Group, New York, 2013.
6. Alec Stokes, Manual Gearbox Design, International Society of Automotive Engineers, Butterworth-Heinemann Ltd, 1992.
7. Faydor L. Litvin, Alfonso Fuentes, Gear Geometry and Applied Theory, Cambridge University Press , Cambridge, New York,2004.

Data Book to be allowed in Examination

1. Design Data (Data Book of Engineers), P. S. G. College of Technology, Revised Edition, Coimbatore, 2004.
2. Design data hand book by K Mahadevan & K Balaveera Reddy, (4th Edition), CBS Publishers, 2013.

ADVANCES IN WELDING TECHNOLOGY

CourseCode	20ME6503	**Year**	III	**Semester**	I
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1– 0	**Prerequisites**	Production Technology
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Illustrates the basic concepts of different types of welding techniques	Understand Communication	L2	1,2,3,4,5
CO2	Understand solid state welding processes and applications and advancements.	Understand Communication	L2	1,2
CO3	Illustrate basic principle of electron beam, laser beam and plasma arc processes and its application.	Apply, Communication	L3	3,4
CO4	Discuss residual stresses in weld joints and methods of minimizing.	Apply, Communication	L3	3,4,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3				2							2	3	1
CO2	3				2							2	3	1
CO3	3				2							2	3	1
CO4	3		2	2	2							2	3	1

Syllabus

UNIT	Contents	Mapped COs
I	**Solid state welding:** classification of solid state welding processes, explosive, diffusion, and Ultrasonic welding – working principle, operation, process characteristics and application. Adhesive bonding, advantages and applications. Principles and operational considerations of pressure welding processes	**CO1, CO2**
II	**Friction welding:** Friction welding process variables, welding of similar and dissimilar materials, Defective analysis of friction welded components, Friction welding of materials with inter layer. **Friction stir welding:** Processes parameters, tool geometry and materials, advantages, limitations and applications. Advancements in Friction stir welding: Under water, Cryogenic, Ultrasonic assistance.	**CO1, CO2**
III	**Electron Beam welding (EBW):** Introduction, Electron Beam welding process parameters, Defective analysis of Electron beam welds and Electron Beam welding dissimilar materials. **Laser Beam welding (LBW):** Laser Beam welding process parameters, atmospheric affect and Laser Beam welding of steels, Processes parameters, Keyhole formation, power densities, forces acting in keyhole,	**CO1, CO3, CO4**

	pressure balance for a generalized keyhole, heat transfer in laser and electron beam welding processes. Applications, Defective analysis of Laser Beam welds and Laser beam welding of dissimilar alloys.	
IV	**Plasma Arc Welding**: Concepts, processes and applications, keyhole and puddle-in mode of operation, low current and high current plasma arc welding and their applications; Magnetically impelled arc butt (MIAB) welding. **Ultrasonic welding,** ultrasonic spot welding, line welding, continuous seam welding , welding of plastic and Induction welding of plastics, process description, application, advantages and limitations.	**CO1, CO3, CO4**
V	**Welding residual stresses** - causes, occurrence, effects and measurements - thermal and mechanical relieving; types of distortion - factors affecting distortion - distortion control methods - prediction - correction, jigs, fixtures and positioners.	**CO1, CO4**

Learning Resources
Text books
1. Modern Welding Technology, Howard B. Cary,Printice Hall, 1998 2. R.S.Mishra, Friction stir welding and processing, ASM International, 2007. 3. Sindo Kou: Welding Metallurgy, Wiley, 2002
Reference books
1. Cnnur L.P., “Welding Handbook Vol I & II”, American Welding Society, 1989. 2. Hauldcraft P.T, “Welding Process Technology”, Cambridge University Press, 1985 3. J. Norrish: Advanced welding Processes, Woodhead publishing, 2006 4. . F. Lancaster: The Physics of welding, Pergamon, 1986 5. R. W. Messler: Principles of Welding, John Wiley and Sons, 1999. 6. W Steen: Laser Material Processing, Springer-Verlag, 1991.
E- Resources & other digital material
1. https://onlinecourses.nptel.ac.in/noc20_me65/course#

MANUFACTURING METHODS IN PRECESSION ENGINEERING

CourseCode	20ME6504	**Year**	III	**Semester**	I
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1 – 0	**Prerequisites**	MP
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Illustrate various precision manufacturing methods and documentation for precision equipment	Understand Communication	L2	1
CO2	Explain Various accuracies required in machines and errors in numerical positioning	Apply, Communication	L3	2
CO3	Apply standards and applications of Lasers in Precision measuring systems.	Apply, Communication	L3	3
CO4	Identify various in-process or In-situ process measurement and Optical features of measurement	Apply, Communication	L3	4
CO5	Select various Nano positioning systems and Servo positioning systems in Precision manufacturing.	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3										1	2	3	1
CO2	3	2								1	1	2	3	1
CO3	3	2			2	1	1			1	1	2	3	1
CO4	3	2	1			1	1			1	1	2	3	1
CO5	3	2	1		2	1	1			1	1	2	3	1

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction to manufacturing and precision engineering:** Introduction to manufacturing process, precision engineering and conventional and unconventional machining process, micromachining, Precision machining and finishing operations. Methods of measurements during machining and during assembly **Assembly and tolerancing:** Documentation for manufacture of precision equipment	**CO1**
II	**Concepts of accuracy:** Introduction - concept of accuracy of machine tools, spindle and displacement accuracies, Accuracy of numerical control systems, Errors due to numerical interpolation, Displacement measurement system and velocity lags	**CO2**
III	**Precision measuring systems**: Units of length, legal basis for length measurement, traceability, Processing system of nanometer, accuracies - LASER light source - LASER interferometer, LASER alignment telescope - LASER micrometer-on-line and in-process,	**CO3**

	measurements of diameter and surface roughness using LASER - Micro holes and topography measurements,	
IV	**In processing or in situ measurement**: Introduction, In processing or in situ measurement of position of processing point-Post process and on-machine measurement of dimensional features and surface, mechanical and optical measuring systems.- Straightness and flatness measurement – Optoelectronic Measurement Systems in Metrology, Optoelectronic devices contact and noncontact types.	**CO4**
V	**Nano positioning systems for Nano accuracy & repeatability:** Guide systems for moving elements - Servo control systems for tool positioning, Computer aided digital and ultra-precision position control.	**CO5**

Learning Resources
Text books
1. M. V. Suryaprakash ,"Precision Engineering" Narosapublications. 2. V C Venkatesh ," Precision Engineering" McGRAW HILLPublications. 3. HiromuNakazawa"Principlesofprecisionengineering"OxfordUniversityPress
Reference books
1.Kalpakjian,"Manufacturingengineering&technology",Addison–Wesley,2ndEdition 2.Debitson A., "Hand book of precisionengineering" 3.J.A.McGeough,"Advancedmethodsofmachining",ChapmanandHall,London,1988 4.Jain V. K., "Introduction to micromachining", NarosaPublishers 5.G.Chryssolouris,"Lasermachining–theoryandpractice",SpringerVerlag,NewYork,1991

DESIGN OF EXPERIMENTS

CourseCode	20ME6505	**Year**	III	**Semester**	I
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1 – 0	**Prerequisites**	Nil
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Illustrates fundamentals, methods used for Design of experiments	Understand Communication	L2	1,2,3,4,5
CO2	Discuss experiments for a critical comparison of outputs	Understand Communication	L2	2
CO3	Propose hypothesis from experimental data	Apply, Communication	L3	3,4
CO4	Implement factorial and randomized sampling from experiments, multi-dimensional optimization	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				3	2							2		
CO2	3	3		3							2			
CO3	3			3	2							2		2
CO4				3	2							2		2

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction:** Strategy of experimentation, basic principles, guidelines for designing experiments. Simple Comparative Experiments: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means: Hypothesis testing, Choice of samples size, Confidence intervals, Randomized and paired comparison design.	**CO1**
II	**Experiments with Single Factor:** An example, The analysis of variance, Analysis of the fixed effect model, Model adequacy checking, Practical interpretation of results, Sample computer output, Determining sample size, Discovering dispersion effect, The regression approach to the analysis of variance, Nonparametric methods in the analysis of variance, Problems.	**CO1, CO2**
III	**Design of Experiments:** Introduction, Basic principles: Randomization, Replication, Blocking, Degrees of freedom, Confounding, Design resolution, Metrology considerations for industrial designed experiments, Selection of quality characteristics for industrial experiments, Parameter Estimation.	**CO1, CO3**

IV	**Response Surface Methods:** Introduction, The methods of steepest ascent, Analysis of a second-order response surface, Experimental designs for fitting response surfaces: Designs for fitting the first-order model, Designs for fitting the second-order model, Blocking in response surface designs, Computer-generated (Optimal) designs, Mixture experiments, Evolutionary operation, Robust design, Problems.	**CO1, CO3**
V	**Design and Analysis:** Introduction, Preliminary examination of subject of research, Screening experiments: Preliminary ranking of the factors, active screening experiment-method of random balance, active screening experiment Plackett-Burman designs, Completely randomized block design, Latin squares, Graeco-Latin Square, Youdens Squares, Basic experiment-mathematical modeling, Statistical Analysis, Experimental optimization of research subject: Problem of optimization, Gradient optimization methods, Non-gradient methods of optimization, Simplex sum rotatable design, Canonical analysis of the response surface, Examples of complex optimizations.	**CO1, CO4**

Learning Resources

Text books

1.Lazic Z. R., Design of Experiments in Chemical Engineering, A Practical Guide, Wiley, 2005.
2.Antony J., Design of Experiments for Engineers and Scientists, Butterworth Heinemann, 2004.

Reference books

1.Montgomery D. C., Design and Analysis of Experiments, Wiley, 5th Edition, 2010.
2.Doebelin E. O., Engineering Experimentation: Planning, Execution, Reporting, McGraw-Hill, 1995.

POOL-3
ADVANCED HEAT AND MASS TRANSFER

CourseCode	20ME6601	**Year**	III	**Semester**	II
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1 – 0	**Prerequisites**	HT,ATD
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the basic concepts of Heat and Mass Transfer	Understand	L2	1,2,3,4,5
CO2	Apply the various numerical approaches in solving convection heat transfer problems	Apply	L3	2,3
CO3	Analyze the systems with various numerical approaches to solve Conduction and Radiation problems	Analyze	L4	1,4

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	1							1	3	1
CO2	3	3	2	1	1							1	3	1
CO3	3	3	2	1	1							1	3	1

Syllabus

UNIT	Contents	Mapped COs
I	**Modes of Heat Transfer, Steady State Conduction:** Analytical Solution-Method of separation of variables, Numerical Solution- FDM **Unsteady Conduction:** Lumped Heat Capacity System, Transient heat conduction in infinite plates, long cylinders and spheres, Heisler charts for Transient heat flow and semi-infinite solids, numerical solution for transient heat flow, explicit approach, Implicit approach.	**CO1**
II	**Forced Convection:** Mechanism of convective heat transfer, Dimensionless expression of heat transfer coefficient. Laminar Boundary Layer: solution of boundary layer equation for flow over flat plate (Blasius solution), wall shear stress and boundary layer thickness, solution of momentum integral equation (Karman Pohihausen method), Boundary layer Analogies, Use of empirical correlations for flow over a flat plate, flow across cylinders and spheres, tube banks – inline and staggered arrangement.	**CO1, CO2**
III	**Free-Convection:** Mechanism of Natural convective heat transfer, Laminar free convection on a vertical surface, approximate solution by the integral method, Use of empirical correlations for vertical plates, horizontal plates, cylinders, spheres and enclosed spaces, Combined free and forced convection.	**CO1, CO2**
IV	**Radiation Heat Exchange**: Radiation heat exchange between black and non-black surfaces separated by non-participating media. **Gas Radiation:** Radiation transfer in enclosures containing absorbing and emitting media - interaction of radiation with conduction and Convection.	**CO1, CO3**

V	**Diffusion Mass Transfer:** Physical Origins and Rate Equations: Fick's law of Diffusion; initial and boundary conditions, mass transfer in non-stationary media, the stationary media approximation, conservation of species for a stationary medium.	**CO1, CO3**

Learning Resources
Text books
1.Introduction to Heat Transfer – S.K. Som, PHI. 2.Principles of Heat and Mass Transfer – Frank P Incropera, David P. Dewitt, Theodore L Bergman and Adrienne S Lavine, Wiley. 3.Heat and Mass transfer - P.K. Nag, TMH.
Reference books
1.Heat Transfer - A Basic Approach - Ozisik M.N., McGraw-Hill. 2.Convective heat and mass transfer - Kays, W.M. and Crawford, M.E., McGraw Hill. 3.Heat and mass transfer - D.S. Kumar, Kataria & sons.
E- Resources & other digital material
1.http://nptel.ac.in/courses/112101097/ 2.http://nptel.ac.in/courses/Webcourse contents/IIScBANG/Heat%20and%20Mass%20Transfer/New_index1.html 3.http://textofvideo.nptel.iitm.ac.in/112101097/lec1.pdf 4.http://www.nptelvideos.in/2012/11/heat-transfer.htm

Data Books

1. Heat and Mass Transfer Data Book by Kothandaraman and Subramanian (or) Domkundwar to be allowed in Examination

CREEP FATIGUE AND FRACTURE

CourseCode	20ME6602	Year	III	Semester	II
Course Category	HONORS	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1– 0	Prerequisites	Material Science and Metallurgy
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the behaviour of material under creep, fatigue and fracture loading.	Understand	L2	1,2,3,4,5
CO2	Analyse the time dependent behaviour of materials and related mechanisms.	Analyse	L4	1,2
CO3	Analyse the fatigue behaviour of materials under different loading conditions and the feature of fatigue by considering size, surface and stress concentration	Analyse	L4	3,4
CO4	Analyse the fracture modes and parameters	Analyse	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2						2		2	3	1
CO2	3	3	2	2						2		2	3	1
CO3	3	3	2	2						2		2	3	1
CO4	3	3	2	2						2		2	3	1

Syllabus

UNIT	Contents	Mapped COs
I	Creep and Stress Rupture, high Temperature Materials Problems, Time dependant Mechanical Behavior, The creep curve, the stress rupture test, structural changes during creep	CO1, CO2
II	Mechanism of creep deformation, deformation mechanism Maps, Activation Energy for steady state creep, super plasticity, High Temperature alloys, Prediction of long time properties, Creep under combined stresses, creep Fatigue Interaction	CO1, CO2
III	**Fatigue of Metals:** Introduction, Stress Cycles, The SN curve, Statistical Nature of Fatigue, Effect of mean stress on fatigue, Cyclic stress strain curve, Low cycle fatigue, strain life equation	CO1, CO3
IV	Structural features of fatigue, Fatigue crack propagation, Effect of stress concentrating on fatigue, size effect, surface effect and fatigue, fatigue under combine stresses, cumulative damage theories, Machine design approach-Infinite Life design, local strain approach	CO1, CO3
V	**Modes of fracture:** Mode I, II and III, Linear Elastic Fracture Mechanics (LEFM), Stress Intensity Factor(SIF), Stress field near the crack tip, Critical SIF and Fracture Toughness, Crack tip opening displacement, Strain Energy Release Rates (SERR), Elasto-Plastic Fracture Mechanics (EPFM), J-Integral Method.	CO1, CO4

Learning Resources
Text books
1.Prashant Kumar, Elements of Fracture Mechanics by Tata McGraw-Hill. 2.George E. Dieter, Mechanical metallurgy, McGraw-Hill Publishing
Reference books
1. J. A. Collins, Failure of Materials in Mechanical Design: Analysis, Prediction, Prevention, 2/3, John Wiley & Sons, 1993

MICRO AND NANO MANUFACTURING

CourseCode	20ME6603	Year	III	Semester	II
Course Category	HONORS	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Pre requisites	MP, MSM, MCMT
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand manufacturing considerations at the micro and nano scale.	Understand Communication	L2	1,2,3,4,5
CO2	Create and characterize nanostructures for a particular industrial application	Apply, Communication	L3	2
CO3	Select appropriate manufacturing methods to create micro sized components	Apply, Communication	L3	3,4
CO4	Design and select industrially-viable processes, equipment and manufacturing tools for specific industrial products.	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3				2				2	2
CO2	2	2	2	3	2				2				2	2
CO3	3	2	2	2	3				2				2	3
CO4	3	3	3	2	3				2				2	3

Syllabus

UNIT	Contents	Mapped COs
I	Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches, challenges in Nanotechnology. Nano materials Synthesis and Processing: Methods for creating Nanostructures; **Processes for producing ultra-fine powders**: - Mechanical grinding; Wet Chemical Synthesis of nanomaterials - sol-gel process, Liquid solid reactions; Gas Phase synthesis of nanomaterials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing (GPC), Chemical Vapour Condensation (CVC)- Cold Plasma Methods, Laser ablation, Vapour - liquid -solid growth, particle precipitation aided CVD, a summary of Gas Condensation Processing (GPC).	**CO1**
II	**Structural Characterization:** X-ray diffraction, Small-angle X-ray Scattering, Optical microscopes and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force microscopy (AFM).	**CO1, CO2**

III	**Microfabrication Techniques:** Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding. MEMS Fabrication Techniques, Bulk Micromachining: Processes used for shaping and sizing of micro products and macro products and Nano finishing techniques, Surface Micromachining, High- Aspect-Ratio Micromachining.	**CO1, CO3**
IV	**Nanofabrication Techniques:** E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly, and Template Manufacturing. MEMS devices and applications: Pressure sensor, an inertial sensor, Optical MEMS and RFMEMS, Micro-actuators for dual-stage servo systems.	**CO1, CO3**
V	Applications of Nano and Micromachining in Industry, **Typical machining methods:** Micro-turning, Micro-drilling and Micro-milling, Product quality in micromachining Micro-grinding and **Ultra-precision Processes**: Introduction, Micro and Nano grinding, Nano grinding tools Applications in optical manufacturing, Semiconductor and electronics related applications.	**CO1, CO4**

Learning Resources
Text books
1.Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture," McGraw- Hill, 2008. 2.V. K. Jain, "Introduction to Micromachining", 2nd Edition, Alpha Science, 2014. 3.Mark James Jackson, "Microfabrication and Nanomanufacturing", CRC Press, 2005.
Reference books
1. Gabor L H, Tibbals H F, Dutta J and Moore J, Introduction to Nan science and Nanotechnology, CRC Press, 2009. 2. Ray F. Egerton, Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer, 2005. 3. B.D. Cullity - Elements of X-Ray Diffraction, 3rd edition, Prentice Hall , 2002.
E- Resources & other digital material
1.https://nptel.ac.in/courses/102108078

OPTIMIZATION TECHNIQUES

CourseCode	20ME6604	**Year**	III	**Semester**	II
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1 – 0	**Pre requisites**	Operations Research
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Explain basics concepts various optimization techniques	Understand, Communication	L2	1,2,3,4,5
CO2	Select suitable Classical, Numerical and Integer programming techniques for optimization of Engineering Problems	Apply, Communication	L3	1,2,3,4,5
CO3	Apply modern methods to optimize engineering problems	Apply, Communication	L3	5
CO4	Analyze multi stage decision making process through dynamic programming	Analyze Communication	L4	4

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	2		2		2		2		2	2	2
CO2	2	3	3	2		2		2		2		2	2	2
CO3	2	3	3	2		2		2		2		2	2	2
CO4	2	2	3	2		2		2		2		2	2	2

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction to optimization**: Introduction, engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function, classification of optimization problems, optimization techniques. **Classical Optimization techniques:** Introduction, single variable optimization, multi variable optimization with no constraints, multi variable optimization with equality constraints-Lagrange multiplier method.	**CO1 CO2**
II	**Non-linear programming, I**: One Dimensional Minimization Methods: Introduction, unimodal function, Elimination methods- unrestricted search, exhaustive search, interval halving method, Fibonacci method, golden section method, interpolation method,	**CO1 CO2**
III	**Non-linear programming II:** Direct Search Method- Nelder- Mead Simplex method, **Indirect search methods**- steepest descent method (Cauchy's method), Newton Method, Marquardt Method	**CO1 CO2**

IV	**Dynamic Programming:** Multistage decision processes, Concepts of sub optimization- calculus method and tabular methods, Linear programming as a case of D.P **Integer Programming**: Introduction, Graphical Representation, Gomory's cutting plane method, Branch-and- bound method.	**CO1, CO2 CO4**
V	**Non-Traditional Optimization Techniques:** Introduction to Genetic Algorithms, Particle swarm optimization, Ant colony optimization, Fuzzy optimization, Neural-network-based methods.	**CO1 CO3**

Learning Resources
Text books
1.S.S.Rao, Engineering optimization theory and practice, , 3rd Edition, New age international,2007. 2.Van Wylen, Fundamentals of Classical Thermodynamics, .John Wylie.
Reference books
1. H.A.Taha, Operations Research, , 9th Edition, Prentice Hall of India, 2010. 2. F.S.Hillier, and G.J.Lieberman, Introduction to Operations Research, , 7th Edition, TMH, 2009.
E- Resources & other digital material
1.https://nptel.ac.in/courses/111/105/111105039/ 2.https://nptel.ac.in/courses/106/108/106108056/ 3.https://nptel.ac.in/courses/111/104/111104071/ 4.https://nptel.ac.in/courses/112/105/112105235/

AEROSPACE PROPULSION

CourseCode	20ME6605	Year	III	Semester	II
Course Category	HONORS	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Pre-requisites	ATD, GDJP, FM
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand basic concepts of Air Breathing and Non Air breathing Engines	Understand	L2	1,2,3,4,5
CO2	Apply thermodynamics of aircraft jet engine, rocket motors and calculate the performance measures, such as thrust and specific fuel consumption in terms of design requirement.	Apply	L3	2,3,4
CO3	Analyze the internal mechanisms of gas turbine engine and rocket engine components and understand the factors that limit the practical performance of thrust chambers, and nozzles	Analyze	L4	1,3,5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3:High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1					2					2	3	1
CO2	3	1					2					2	3	1
CO3	3	2					2					2	3	1

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction:** Classification of power plants - Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption - Thrust and power- Factors affecting thrust and power. **Illustration of working of Gas turbine engine -** Characteristics of turboprop, turbofan and turbojet, Ram jet, Scram jet – Methods of Thrust augmentation.	CO1, CO3
II	**Introduction to rocket propulsion:** Classification and applications of rockets – Reaction principle – Thrust equation – Classification of rockets based on propellants used – solid, liquid and hybrid – Comparison of these engines with special reference to rocket performance – electric propulsion – classification- electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters. **Fundamentals and Definitions** – Thrust, Exhaust Velocity, Energy and efficiencies, multiple propulsion systems, typical performance values, variable thrust and simple problems.	CO1, CO2
III	**Liquid Propellant rocket engine:** Types of propellants, propellant tanks,	CO1,

	propellant feed systems, gas pressure feed systems, tank pressurization, turbopump feed system, rocket engines for maneuvering and orbit adjustments. Introduction to Cryogenic Engines. **Liquid Propellants:** propellant properties, liquid oxidizers, liquid fuels, liquid monopropellants, gaseous propellant, safety and environment concern. Combustion process and instability.	**CO2, CO3**
IV	**Solid Propellant Rocket engine:** Basic relations and propellant burning rate, performance issues, propellant grain and grain configuration, propellant grain stress and strain, altitude control and side maneuver's with solid propellant rocket motors **Solid Propellants:** Classification, propellant characteristics, hazards, propellant ingredients, other propellant categories	**CO1, CO2**
V	**Nozzle Theory and Thermodynamics Relations:** review of thermodynamics relations, ideal rocket propulsion systems, isentropic flow through nozzles, nozzle configuration, real nozzles, nozzle alignment, over expanded, under expanded nozzles and optimum expansion in nozzles **Thrust Chambers:** Injectors, flow characteristics, factors influencing injection behavior, heat transfer analysis, starting and ignition, life of thrust chambers, random variable thrust, sample thrust chamber design analysis, Thrust Vector Control with single nozzle and multiple nozzles. Integration with vehicle.	**CO1, CO3**

Learning Resources
Text books
1.Rocket Propulsion Elements G. P. Sutton Wiley India Pvt Ltd 7th Edition,2010 2.Gas Turbine Theory Cohen, H. Rogers, G.F.C. and Saravanamuttoo H.I.H DORLING KINDERSLEY 5th edition, 2002
Reference books
1. Introduction to Rocket Propulsion James R Church of Care 2018 2. Rocket and Spacecraft Propulsion Martin J l Turner Springer Third Edition 3. Aerothermodynamics of gas turbines and rocket prolusion G.C. Oates AIAA Education Series Third Edition 4. Mechanics and Thermodynamics of Propulsion Hill, P.G. and Peterson, C.R Pearson 2nd edition,2009
E- Resources & other digital material
1.https://onlinecourses.nptel.ac.in/noc22_ae03/preview 2.https://onlinecourses.nptel.ac.in/noc22_me33/preview

POOL4
COMPUTATIONAL FLUID DYNAMICS

CourseCode	20ME6701	**Year**	IV	**Semester**	I
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1– 0	**Prerequisites**	Nil
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understanding for the major theories, approaches and methodologies used in CFD	Understand, Communication	L2	1,2,3,4,5
CO2	Understand physical behaviour of partial difference equations	Understand, Communication	L2	1
CO3	Apply numerical math to convert PDE's into Finite Difference equations	Apply, Communication	L3	2,3
CO4	Apply the skills in Grid generation techniques	Apply, Communication	L3	4
CO5	Analyze different solution schemes of FVM.	Analyze	L4	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3					3	3			2		2	3	2
CO2	3	2				3	3			2		2	3	2
CO3	3					3	3			2		2	3	2
CO4	3					3	3			2		2	3	2
CO5	3					3	3			2		2	3	2

Syllabus

UNIT	Contents	Mapped COs
I	**Introduction to Computational Fluid Dynamics and Principles of Conservation:** Introduction and history of Computational Fluid Dynamics: CFD Applications, difference between Numerical, Analytical and Experimental analysis, Differentiation between Modeling vs Experimentation. Fundamental principles of conservation, Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy	**CO1 CO2**
II	**Classification of Partial Differential Equations and Physical Behavior:** Mathematical classification of Partial Differential Equation, Illustrative examples of elliptic, parabolic and hyperbolic equations Physical applications of elliptic, parabolic and hyperbolic partial differential equations.	**CO1 CO3**
III	**Fundamentals of Discretization:** Discretization principles: Preprocessing, Solution, Postprocessing, Finite	**CO1 CO3**

	Element Method, Finite difference method, Well posed boundary value problem, Possible types of boundary conditions, Conservativeness, Boundedness, Transportiveness.	
IV	**Grid Generation:** Transformation of coordinates. General principles of grid generation – structured grids in two and three dimensions, algebraic grid generation, differential equations based grid generation; Elliptic grid generation. Grid clustering, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation.	**CO1** **CO4**
V	**Finite Volume Method** Introduction to Finite volume method (FVM), Illustrative examples: 1-D steady state heat conduction without and with constant source term, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretized equations using TDMA.Finite volume methods for unsteady problems – explicit schemes, implicit schemes.	**CO1** **CO5**

Learning Resource
Text books:
1. Computational Fluid Dynamics - Basics with Applications - John. D. Anderson, JR. McGraw Hill Education (India) Edition 2012. 2. Computational Fluid Dynamics - T. J. Chung, Cambridge University Press, 2nd Edition, 2014.
1. Introduction to computational fluid mechanics - Niyogi, Chakravarty, Laha, Pearson pub. 1st ed. 2009. 2. Numerical heat transfer and fluid flow - S.V. Patankar, Hemisphere Pub. 1st ed. 3. Computational Fluid flow and Heat transfer - K. Muralidhar and T. Sundararajan, Narosa Pub. 2nd ed. 2003.
1. http://ocw.mit.edu/courses/mechanical-engineering/2-29-numerical fluidmechanics-fall-2011/ 2. http://nptel.ac.in/courses/112105045/(IIT Kharagpur) 3. http://nptel.ac.in/courses/112107080/(IIT Roorkee) 4. http://nptel.ac.in/courses/112104030/(IIT Kanpur) 5. http://www.nptelvideos.in/2012/11/computational-fluid- dynamics.html (IIT Madras) 6. http://www.cfd-online.com/

MECHANICS OF COMPOSITE MATERIALS

CourseCode	20ME6702	Year	IV	Semester	I
Course Category	HONORS	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	MSM
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the features of Composite materials, elastic parameters at micro and macro level and related failures.	Understand, Communication	L2	1,2,3,4,5
CO2	Apply constitutive equations of composite materials and quantify mechanical behavior at micro and macro levels	Apply	L3	2,3,4
CO3	Determine stresses and strains relation in composites materials and understand the failure analysis of the composite	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1									3	1
CO2	3	3	1	1									3	1
CO3	3	3	1	1									3	1

Syllabus

Unit	Contents	Mapped COs
I	**INTRODUCTION TO COMPOSITE MATERIALS** Introduction, Classification: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, nature-made composites, and applications. Fibres- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites.	CO1
II	**ELASTIC BEHAVIOR OF COMPOSITE LAMINA USING MICROMECHANICS** Introduction, Strength of Materials Approach, Semi- Empirical Models, Elasticity Approach, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, , Ultimate Strengths of a Unidirectional Lamina	CO1, CO2
III	**ELASTIC BEHAVIOR OF COMPOSITE LAMINA USING MACROMECHANICS** Introduction, Definitions: Stress, Strain, Elastic Moduli, Strain Energy, stress strain relations for general anisotropic materials, specially orthotropic materials, transversally isotropic materials, orthotropic material under plane stress and isotropic materials, relations between mathematical and engineering constants.	CO1, CO2

IV	**ELASTIC BEHAVIOR OF MULTIDIRECTIONAL LAMINATES** Basic assumptions, laminate code, strain-displacement relations, stress-strain relations of a layer within a laminate, force and moment resultants, Laminate stiffness and laminate compliance, symmetric laminates, balance laminates	**CO1, CO2**
V	**FAILURE, DESIGN OF LAMINA AND LAMINATES** Lamina Strength Failure Theories of an Angle Lamina: Maximum Stress Failure Theory Strength Ratio, Failure Envelopes, Maximum Strain Failure Theory, Tsai–Hill Failure Theory, Tsai–Wu Laminate: Introduction, Special Cases of Laminates, and Failure Criterion for a Laminate, and Design of a Laminated Composite	**CO1, CO3**

Learning Resources

Text books

1.Engineering Mechanics of Composite Materials, (2nd edition), by Isaac and M Daniel, Oxford University Press, 2006.

2.Analysis and performance of fibre Composites, (Second Edition), by B. D. Agarwal and L. J. Broutman, John Wiley & sons, NewYork , New York, 1990

Reference books

1.Mechanics of Composite Materials, (3ed edition), by R. M. Jones, Mc Graw Hill Company, New York, 2006.

2.Analysis of Laminated Composite Structures, by L. R. Calcote, Van Nostrand Rainfold, New York, 1969.

3.Mechanics of Composite Materials, (Second Edition), by Autar K. Kaw, CRC, 2010

DESIGN FOR MANUFACTURING AND ASSEMBLY (DFMA)

CourseCode	20ME6703	**Year**	IV	**Semester**	I
Course Category	HONORS	**Branch**	ME	**Course Type**	Theory
Credits	4	**L – T – P**	3 – 1 – 0	**Prerequisites**	DME
Continuous Internal Evaluation	30	**Semester End Evaluation**	70	**Total Marks**	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the principles of design for manufacturing processes, manual and automated assembly, economical production and material selection.	Understand	L2	1,2,3,4,5
CO2	Apply design rules for ease of forming, machining, casting and assembly.	Apply	L3	2,3,4,5
CO3	Analyse components using design features to facilitate forming, machining and casting.	Analyse	L4	2,3,4

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3			1	1	2				2	3	2
CO2	3	3	3			1	1	2				2	3	2
CO3	3	3	3			1	1	2				2	3	2

Syllabus

UNIT	Contents	Mapped COs
I	Introduction: Design Philosophy - steps in design process - General design rules for manufacturabilty - Basic principles of designing for economical production-creativity in design Materials: Selection of materials for design - Developments in materials technology - Criteria for materials selection - Material selection inter relationship with process selection	**CO1, CO2**
II	Design for Forming: Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.	**CO1, CO2, CO3**
III	Design for Machining: Design features to facilitate machining - drills - milling cutters - keyways – Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability	**CO1, CO2, CO3**
IV	Design for Casting: Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design.	**CO1, CO2, CO3**
V	Design for Assembly: Design guidelines for manual assembly, large assemblies, analysis of an assembly, rules for product design for automation, design for robot assembly, Design for manufacture and	**CO1, CO2**

	Computer aided design.	

Learning Resources
Text books:
1.A K Chitale and R C Gupta, Product Design and Manufacturing, Prentice Hall of India, New Delhi, 2003. 2.Geoffrey Boothroyd, Dewhurst P and Knight W, Product design for manufacture and assembly, CRC press, 2002.
Reference books:
1.James G. Bralla, Design for Manufacturabillity handbook, McGraw hill, 1999. 2.George E. Dieter, Engineering Design - A material processing approach, 5/e, McGraw Hill International, 2003. 3.ASM Handbook, Design for manufacture, 2000. 4.M F Ashby and K Johnson, Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann, 2003. 5.K G Swift and J D Booker, Process selection: from design to manufacture, London: Arnold, 1997.

MANAGEMENT INFORMATION SYSTEMS

Course Code	20ME6704	Year	IV	Semester	I
Course Category	Honors	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Understand the basic concepts of MIS, Decision making, Applications of MIS, Decision support systems, BPR and E- Commerce.	Understand	L2	1,2,3,4,5
CO2	Interpret the MIS decision making and its applications.	Apply	L3	2,3
CO3	Categorize Decision support systems and Business Process Re-Engineering	Apply	L3	4
CO4	summarize the electronic commerce environment and its opportunities.	Apply	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (H: High, M: Medium, L: Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1			1			1	1	3	2	1	1	3
CO2	2	1			1			1	1	3	2	1	1	3
CO3	2	1			1			1	1	3	2	1	1	3
CO4	2	1			1			1	1	3	2	1	1	3

Syllabus		COs
Unit	Contents	
I	**Introduction to MIS**: Definition of MIS, Role and Impact of MIS, MIS: Support to the management, As tool for Management Process, Basic model of organization, Modifications to the basic model, organization as a system, MIS: organization, Strategic management of business.	CO1
II	**Decision Making:** Concepts, Methods, Tools, Procedures, Organizational decision making, MIS and Decision making concepts, Information: A Quality Product, Classification of information, Value of information, General model of Human as information processor, Types of systems, Handling system complexity, Development of long range plans of the MIS, Development and implementation of MIS, Factors of Success and failure for MIS.	CO1, CO2

III	**Applications:** Applications in Manufacturing Sector, Personnel, financial, production, materials, marketing management, Applications in service sector, creating a Distinctive service, MIS in service industry, Technology of Information systems, Data processing, Transaction processing, Application processing, TQM of Information systems, Programming languages for system coding.	**CO1, CO2**
IV	**Decision support systems and BPR:** Concept and philosophy, Deterministic systems, Artificial Intelligence systems, Knowledge based expert system, Enterprise Management systems, ERP basic features EMS and MIS, Business Process Re- Engineering, Process model of organization, Value stream model of the organization MIS and BPR.	**CO1, CO3**
V	**E-Commerce:** Electronic commerce environment and opportunities: back ground, electronic commerce Environment, Modes of electronic commerce: Approaches to safe electronic commerce, Overview, Secure transport protocols, Secure Transactions, Secure Electronic Payment Protocol, and Secure Electronic Transaction.	**CO1, CO4**

Learning Resources

Text Books:

1. W.S. Jawadekar, Management Information Systems: A Global Digital Enterprise Perspective, 5th Edition, McGraw Hill Education, 2013.
2. D. Minoli, Web Commerce Technology Hand Book, 1st edition, McGraw Hill Education, 2000.

Reference Books:

1. K.C. Laudon and J. Laudon, Management Information Systems: Managing a Digital firm, 11th Edition, Pearson Education, 2012.
2. D. Gordon and M. Oslon, Management Information Systems: Conceptual Foundations, Structure and Development, 2nd Edition, McGraw Hill Education Pvt Ltd, India, 2001.
3. R.G. Murdic, J.E. Ross and J.R. Clagget, Information Systems for Modern Management, 3rd Edition, PHI, 2008.
4. K.Ravi and A.B. Whinston, Frontiers of Electronic Commerce, 1st edition, Pearson India, 2002.

ADVANCED METAL FORMING

CourseCode	20ME6705	Year	IV	Semester	I
Course Category	HONORS	Branch	ME	Course Type	Theory
Credits	4	L – T – P	3 – 1 – 0	Prerequisites	Nil
Continuous Internal Evaluation	30	Semester End Evaluation	70	Total Marks	100

Course Outcomes: Upon successful completion of the course, the student will be able to

	Statement	Skill	BTL	Units
CO1	Illustrates fundamental concepts and their applications of different forming techniques.	Understand Communication	L2	1,2,3,4,5
CO2	Solve for strain rates, temperatures and metallurgical states in forming problems using constitutive relations.	Apply, Communication	L3	1,2
CO3	Estimate formability limits for sheets and bulk metals, deformation process parameters for different engineering components.	Apply, Communication	L3	3,4
CO4	Illustrates the Electromagnetic forming processes and its applications.	Apply, Communication	L3	5

Contribution of Course Outcomes towards achievement of Program Outcomes & Strength of correlations (3: High, 2: Medium, 1:Low)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3										3	3
CO2	3	3	3	2	2	2	2						3	3
CO3	3	3	3	2	2	2	2						3	3
CO4	3	3	3										3	3

Syllabus

UNIT	Contents	Mapped COs
I	Introduction: Introduction of metal forming as a manufacturing process and its relation with other processes, Metal Forming from systems point of view, Advantages of metal forming as a manufacturing process, Classifications of metal forming processes, Forming equipment, Presses (mechanical, hydraulic).	CO1
II	Theoretical analysis: Theory of plasticity, Stress-strain relationship, Strain hardening, Material incompressibility, Work of plastic deformation, Work hardening, Yield criteria, Flow rule, and flow rule for Anisotropic material, Initiation, and extent of plastic flow Upper Bound - Slip-Line-Slab Analysis - Problems.	CO1, CO2
III	Bulk Forming Processes: Forging- open-die forging, closed-die forging, coining, nosing, upsetting, heading, extrusion and tooling, rod, wire and tube drawing, Rolling- flat rolling, shape rolling and tooling, spinning, hydroforming, rubber-pad forming, explosive forming, simple problems.	CO 1, CO 3
IV	Sheet Forming Processes: Blanking, piercing, press bending, deep drawing, stretch forming, formability tests, forming limit diagrams, process simulation for deep drawing and numerical approaches, Case	CO1, CO 3

	studies. Problems & Case Studies: Case studies on the manufacturing aspects of products using the lessons learned.	
V	**ELECTROMAGNETIC FORMING AND ITS APPLICATIONS :** Electromagnetic Forming Process – Electro – Magnetic Forming Machines – Process Variables – Coils and Dies – Effect of Resistivity and Geometry – EM tube and sheet forming, stamping, shearing and welding – Applications – Finite Element Analysis of EM forming.	**CO1, CO 4**

Learning Resources
Text books
1.R. Narayanasamy, R Ponalagusamy, "Theory of Engineering Plasticity", Ahuja Book Company, 2000. 2.Henry S. Valberg, "Applied Metal Forming - Including FEM Analysis", Cambridge University Press, 2010. 3.G.K. Lal, P.M. Dixit and N.Venkat Reddy, "Modeling Techniques for Metal Forming Processes", Alpha Science, 2011
Reference books
1.Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003. 2.ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003
E- Resources & other digital material
1. https://nptel.ac.in/courses/112107250