# GANDHI INSTITUTE OF TECHNOLOGY AND MANAGEMENT (GITAM)
## (Deemed to be University)
## VISAKHAPATNAM * HYDERABAD * BENGALURU

**Accredited by NAAC with $A^+$ Grade**

# REGULATIONS AND SYLLABUS

# OF

# M.Tech. Machine Design

**(w.e.f. 2019-20 admitted batch)**

## Vision

The Department of Mechanical Engineering strives to produce innovative, entrepreneurial and successful engineers and technologists of high caliber for the nation, to serve as a valuable resource for industry, academia and society.

## Mission

- To provide the students with opportunities to create, interpret, and apply the knowledge in the field of Mechanical Engineering.
- To train the students in knowledge and skills to make them excel in higher studies.
- To disseminate skills to make the students take up entrepreneurship as a career.
- To make the students imbibe work culture and improve the quality of life.

## Program Educational Objectives (PEO)

The program educational objectives of M.Tech in Machine Design results in their ability to

| | |
|---|---|
| **PEO 1** | possess advanced knowledge and understanding thus enabling them to tackle practical design problems in industrial fields, as well as pursue further academic achievements through research. |
| **PEO 2** | Understand and explore the behaviour of existing and new materials suitable for the design and development of products. |
| **PEO 3** | Develop life skills to become design professionals, administrators and Academicians. |
| **PEO 4** | Apply relevant skills of research and development and other creative/ innovative efforts in their professional career. |

## Programme Specific Outcomes (PSO)

After the completion of the course, the students will be able to acquire:

| | |
|---|---|
| PSO1 | Attain the ability to apply the fundamental knowledge of machine design in synthesis, analysis, design and development of components/machines using modern engineering tools. |
| PSO2 | Make use of modern engineering tools, software and equipment to analyse and complex mechanical engineering problems. |
| PSO3 | Independently carryout research to find out cost-effective solutions to real life problems and to prepare technical reports |

## Program Outcomes (PO)

After the successful completion of this program, the student will be able to

| | |
|---|---|
| PO 1 | Possess knowledge of modern technological concepts and apply specialized expertise practically. |
| PO 2 | Apply mathematical skills in the design and analysis of model generations and analysis. |
| PO 3 | Exercise analytical skills in model verifications and interpretations of FEA results. |
| PO 4 | Apply the engineering knowledge of mechanical engineering practices such as design, manufacturing, thermal sciences, automation and industrial engineering to the solution of complex mechanical systems. |
| PO 5 | Conceptualize and evaluate the mechanical engineering aspects and select feasible solution considering safety, environment, and other realistic constraints. |
| PO 6 | Conduct simulations and experiments, analyze data, and present results. |
| PO 7 | Work on multi-disciplinary group projects to enhance interpersonal and leadership skills. |
| PO 8 | Recognize the need for and ability to engage in life-long learning in the broadest context to work in research laboratories and multidisciplinary environments. |
| PO 9 | Develop the skills of good researchers to work on a problem, starting from the scratch, to research in to literatures, methodologies, techniques, tools and conduct experiments and interpret data. |
| PO 10 | Perceive the traits of professional integrity and ethics, and demonstrate the responsibility to implement the research outcome for sustainable development of the society. |

**M. Tech. in Machine Design**
**REGULATIONS**
**(w.e.f. 2019-20 admitted batch)**

## 1. ADMISSION

Admission into M.Tech in Machine Design program of GITAM (Deemed to be University) is governed by GITAM admission regulations.

## 2. ELIGIBILITY CRITERIA

A pass in B.E./B.Tech./AMIE in Mechanical Engineering or its equivalent.

Admissions into M.Tech will be based on the following:

(i) Score obtained in GAT (PG), if conducted.
(ii) Performance in Qualifying Examination/Interview.
(iii) Candidates with valid GATE score shall be exempted from appearing for GAT(PG).

The actual weightage to be given to the above items will be decided by the authorities at the time of admissions.

## 3. CHOICE BASED CREDIT SYSTEM

Choice Based Credit System (CBCS) was introduced with effect from 2015-16 admitted batch and revised with effect from academic year 2019-20 in order to promote:

- Student centered Learning
- Activity based learning
- Students to learn courses of their choice
- Cafeteria approach

Learning objectives and outcomes are outlined for each course to enable a student to know what he/she will be able to do at the end of the program.

## 4. STRUCTURE OF THE PROGRAM

The Program Consists of

i) Core Courses (compulsory) which give exposure to a student in core subjects related area.

ii) Program Electives.

iii) Open Electives

iv) Mandatory and Audit Courses

Each course is assigned a certain number of credits depending upon the number of contact hours (lectures/tutorials/practical) per week.

In general, credits are assigned to the courses based on the following contact hours per week per semester.

- One credit for each Lecture / Tutorial hour per week.
- One credit for two hours of Practicals per week.

The curriculum of the four semesters M.Tech. program is designed to have a total of 68 credits for the award of M.Tech. degree

## 5. MEDIUM OF INSTRUCTION

The medium of instruction (including examinations and project reports) shall be English.

## 6. REGISTRATION

Every student has to register for the courses in each semester at the time specified in the academic calendar.

## 7. ATTENDANCE REQUIREMENTS

A student whose attendance is less than 75% in all the courses put together in any semester will not be permitted to attend the semester-end examination and he/she will not be allowed to register for subsequent semester of study. He/she has to repeat the semester along with his / her juniors.

However, the Vice-Chancellor on the recommendation of the Principal / Director of the Institute/School may condone the shortage of attendance to the students whose attendance is between 65% and 74% on genuine grounds and on payment of prescribed fee.

## 8. EVALUATION

The assessment of the student's performance in a theory course shall be based on two components: Continuous Evaluation (40 marks) and semester-end examination (60 marks).

A student has to secure a minimum of 40% in any theory course in the two components (ref. 8.1) put together to be declared to have passed the course, subject to the condition that the student must have secured a minimum of 24 marks out of 60 marks (i.e. 40%) in the theory component at the semester-end examination.

Practical/ Project Work/ Viva voce/ Seminar etc. course are completely assessed under Continuous Evaluation for a maximum of 100 marks, and a student has to obtain a minimum of 40% to secure Pass Grade. Details of Assessment Procedure are furnished below in Table 1.

Audit courses are assessed through continuous evaluation for satisfactory or not satisfactory only. No credits will be assigned.

**Table 1: Assessment Procedure**

| S.No. | Component of Assessment | Marks Allotted | Type of Assessment | Scheme of Evaluation |
|---|---|---|---|---|
| 1 | Theory Courses | 40 | Continuous Evaluation | i) Thirty (30) marks for mid Semester examinations. Three mid examinations shall be conducted for 15 marks each; performance in best two shall be taken into consideration.<br>ii) Ten (10) marks for Quizzes, Assignments and Presentations. Sixty (60) marks for Semester-end examinations |
| | | 60 | Semester-end Examination | |
| | Total | 100 | | |

| | | | | |
|---|---|---|---|---|
| 2 | Practical Courses | 100 | Continuous Evaluation | i) Fifty (50) marks for regularity and performance, records and oral presentations in the laboratory. Weightage for each component shall be announced at the beginning of the semester.<br>ii) Ten (10) marks for case studies.<br>iii) Forty (40) marks for two tests of 20 marks each (one at the mid-term and the other towards the end of the semester) conducted by the concerned lab teacher. |
| 3 | Technical Seminar (II Semester) | 100 | Continuous Evaluation | Through five periodic seminars of 20 marks each |
| 4 | Project Work (III Semester ) | 100 | Continuous Evaluation | i) Forty (40) marks for periodic assessment on originality, innovation, sincerity and progress of the work, assessed by the project supervisor.<br>ii) Thirty (30) marks for mid-term evaluation for defending the project, before a panel of examiners.<br>iii) Thirty (30) marks for final report presentation and viva-voce, by a panel of examiners*. |
| 5 | Project Work (IV Semester) | 50 | Continuous Evaluation | i) Twenty (20) marks for periodic assessment on originality innovation, sincerity and progress of the work, assessed by the project supervisor.<br>ii) Fifteen (15) marks for mid-term evaluation for defending the project, before a panel of examiners*.<br>iii) Fifteen (15) marks for interim report presentation and viva-voce. |
| | | 50 | Semester-end Examination | Fifty (50) marks for final project report and viva-voce examination assessed by external examiners. |
| | Total | 100 | | |

| | | | | |
|---|---|---|---|---|
| 6 | Audit Courses | 100 | Continuous Evaluation | Audit courses are assessed for PASS or FAIL only. No credits will be assigned to these courses. If a student secures a minimum of 40 out of 100 marks during continuous evaluation, he / she will be declared PASS, else FAIL. PASS grade is necessary to be eligible to get the degree |

**Panel of Examiners shall be appointed by the concerned Head of the Department*

## 9. PROVISION FOR ANSWER BOOK VERIFICATION AND CHALLENGE EVALUATION

If a student is not satisfied with his/her grade, the student can apply for answer book verification on payment of prescribed fee for each course within one week after announcement of results.

After verification, if a student is not satisfied with revaluation marks/grade, he/she can apply for challenge valuation within one week after announcement of answer book verification result or two weeks after the announcement of results, which will be valued by two examiners i.e., one Internal and one External examiner in the presence of the student on payment of prescribed fee. The challenge valuation fee will be returned, if the student is successful in the appeal by securing a better grade.

## 10. SUPPLEMENTARY AND SPECIAL EXAMINATIONS

The odd semester supplementary examinations will be conducted after conducting regular even semester examinations during April/May.

The even semester supplementary examinations will be conducted after conducting regular odd semester examinations during October/November.

A student who has secured 'F' Grade in Project work shall have to improve his/her work and reappear for viva-voce after satisfactory completion of work approved by panel of examiners.

A student who has completed period of study and has "F" grade in final semester courses is eligible to appear for special examination.

## 11. MASSIVE OPEN ONLINE COURSES (MOOCs)

Greater flexibility to choose variety of courses is provided through Massive Open Online Courses (**MOOCs**) during the period of study. Students without any backlog courses up to first semester are permitted to register for MOOCs in second semester up to a maximum of 6 credits from program elective / open elective/audit courses. However the Departmental Committee (DC) of the respective campuses has to approve the courses under MOOCs. The grade equivalency will be decided by the respective Board of Studies (BoS).

## 12. GRADING SYSTEM

Based on the student performance during a given semester, a final letter grade will be awarded at the end of the semester in each course. The letter grades and the corresponding grade points are as given in Table 2.

**Table 2: Grades and Grade Points**

| Sl.No. | Grade | Grade Points | Absolute Marks |
|---|---|---|---|
| 1 | O (outstanding) | 10 | 90 and above |
| 2 | A+ (Excellent) | 9 | 80 to 89 |
| 3 | A (Very Good) | 8 | 70 to 79 |
| 4 | B+ (Good) | 7 | 60 to 69 |
| 5 | B (Above Average) | 6 | 50 to 59 |
| 6 | C (Average) | 5 | 45 to 49 |
| 7 | P (Pass) | 4 | 40 to 44 |
| 8 | F (Fail) | 0 | Less than 40 |
| 9 | Ab (Absent) | 0 | - |

A student who earns a minimum of 4 grade points (P grade) in a course is declared to have successfully completed the course, and is deemed to have earned the credits assigned to that course, subject to securing a GPA of 5.0 for a Pass in the semester.

## 13. GRADE POINT AVERAGE

A Grade Point Average (GPA) for the semester will be calculated according to the formula:

$$GPA = \frac{\Sigma [C \times G]}{\Sigma C}$$

where, C = number of credits for the course,

G = grade points obtained by the student in the course.

The Cumulative Grade Point Average (CGPA), is calculated using the above formula considering the grades obtained in all the courses, in all the semesters up to that particular semester.

CGPA required for classification of class after the successful completion of the program is shown in Table 3.

**Table 3: CGPA required for Award of Class**

| Class | CGPA Required |
|---|---|
| First Class with Distinction | $\geq$ 8.0* |
| First Class | $\geq$ 6.5 |
| Second Class | $\geq$ 5.5 |
| Pass Class | > 5.0 |

* In addition to the required CGPA of 8.0 or more, the student must have necessarily passed all the courses of every semester in the first attempt.

## 14. ELIGIBILITY FOR AWARD OF THE M. Tech. DEGREE

Duration of the program: A student is ordinarily expected to complete the M. Tech. Program in four semesters of two years. However a student may complete the program in not more than four years including study period.

However the above regulation may be relaxed by the Vice-Chancellor in individual cases for cogent and sufficient reasons.

A student shall be eligible for award of the M.Tech. Degree if he / she fulfills all the following conditions.

a) Registered and successfully completed all the courses and project works.

b) Successfully acquired the minimum required credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated period.

c) Has no dues to the Institute, Hostels, Libraries, NCC / NSS etc, and

d) No disciplinary action is pending against him / her.

## 15. DISCRETIONARY POWER

Notwithstanding anything contained in the above sections, the Vice Chancellor may review all exceptional cases, and give his decision, which will be final and binding.

# M.Tech. in Machine Design

## Department of Mechanical Engineering

### Effective from academic year 2019-20 admitted batch

**Semester I**

| S.No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EME701 | Advanced Mechanics of Solids | PC | 3 | 0 | 0 | 3 |
| 2 | 19EME703 | Mechanics of Machinery | PC | 3 | 0 | 0 | 3 |
| 3 | 19EME705 | Computer Aided Design | PC | 3 | 0 | 0 | 3 |
| 4 | 19EME7XX | Program Elective I | PE | 3 | 0 | 0 | 3 |
| 5 | 19EME7XX | Program Elective II | PE | 3 | 0 | 0 | 3 |
| 6 | 19EME721 | Material Testing and Characterization Lab | PC | 0 | 0 | 3 | 2 |
| 7 | 19EME723 | Computer Aided Design Lab | PC | 0 | 0 | 3 | 2 |
| 8 | 19EMC741 | Research Methodology and IPR | MC | 2 | 0 | 0 | 2 |
| 9 | 19EAC7XX | Audit Course I | AC | 2 | 0 | 0 | 0 |
| | | | | | | | **21** |

**SEMESTER II**

| S.No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EME702 | Mechanical Vibrations | PC | 3 | 0 | 0 | 3 |
| 2 | 19EME704 | Experimental Stress Analysis | PC | 3 | 0 | 0 | 3 |
| 3 | 19EME7XX | Program Elective III | PE | 3 | 0 | 0 | 3 |
| 4 | 19EME7XX | Program Elective IV | PE | 3 | 0 | 0 | 3 |
| 5 | 19EOE7XX | Open Elective | OE | 3 | 0 | 0 | 3 |
| 6 | 19EME722 | Computer Aided Engineering Lab | PC | 0 | 0 | 3 | 2 |
| 7 | 19EME724 | Mechanical Engineering Lab | PC | 0 | 0 | 3 | 2 |
| 8 | 19EME792 | Technical Seminar | PC | 0 | 0 | 4 | 2 |
| 9 | 19EAC7XX | Audit Course II | AC | 2 | 0 | 0 | 0 |
| | | | | | | | **21** |

**SEMESTER III**

| | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EME891 | Project Work I | PW | 0 | 0 | 26 | 13 |
| | | | | | | | **13** |

**SEMESTER IV**

| S.No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EME892 | Project Work II | PW | 0 | 0 | 26 | 13 |
| | | | | | | | **13** |

**Number of Credits**

| Semester | I | II | III | IV | Total |
|---|---|---|---|---|---|
| Credits | 21 | 21 | 13 | 13 | **68** |

**Programme Elective I**

| S.No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EME741 | Computational Methods in Engineering | PE | 3 | 0 | 0 | 3 |
| 2 | 19EME743 | Robotics | PE | 3 | 0 | 0 | 3 |
| 3 | 19EME745 | Nonlinear Solid Mechanics | PE | 3 | 0 | 0 | 3 |
| 4 | 19EME747 | Mechatronics | PE | 3 | 0 | 0 | 3 |

**Programme Elective II**

| S.No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EME749 | Theory of Plasticity | PE | 3 | 0 | 0 | 3 |
| 2 | 19EME751 | Mechanics of Composite Materials | PE | 3 | 0 | 0 | 3 |
| 3 | 19EME753 | 3D Printing | PE | 3 | 0 | 0 | 3 |
| 4 | 19EME755 | Finite Element Analysis | PE | 3 | 0 | 0 | 3 |

**Programme Elective III**

| S.No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EME742 | Optimization Methods in Engineering | PE | 3 | 0 | 0 | 3 |
| 2 | 19EME744 | Fracture Mechanics | PE | 3 | 0 | 0 | 3 |
| 3 | 19EME746 | Tribology | PE | 3 | 0 | 0 | 3 |
| 4 | 19EME748 | Signal Analysis and Condition Monitoring | PE | 3 | 0 | 0 | 3 |

**Programme Elective IV**

| S.No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EME752 | Advanced Finite Element Analysis | PE | 3 | 0 | 0 | 3 |
| 2 | 19EME754 | Product Design | PE | 3 | 0 | 0 | 3 |
| 3 | 19EME756 | Vehicle Dynamics | PE | 3 | 0 | 0 | 3 |
| 4 | 19EME758 | Mechanical Behaviour of Materials | PE | 3 | 0 | 0 | 3 |

**Audit Course I and II**

| S. No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EAC741 | English For Research Paper Writing | AC | 2 | 0 | 0 | 0 |
| 2 | 19EAC742 | Disaster Management | AC | 2 | 0 | 0 | 0 |
| 3 | 19EAC743 | Sanskrit For Technical Knowledge | AC | 2 | 0 | 0 | 0 |
| 4 | 19EAC744 | Value Education | AC | 2 | 0 | 0 | 0 |
| 5 | 19EAC745 | Constitution Of India | AC | 2 | 0 | 0 | 0 |
| 6 | 19EAC746 | Pedagogy Studies | AC | 2 | 0 | 0 | 0 |
| 7 | 19EAC747 | Stress Management By Yoga | AC | 2 | 0 | 0 | 0 |
| 8 | 19EAC748 | Personality Development Through Life Enlightenment Skills | AC | 2 | 0 | 0 | 0 |
| 9 | 19EAC750 | Developing Soft Skills And Personality | AC | 2 | 0 | 0 | 0 |

**Open Electives**

| S. No | Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | 19EOE742 | Business Analytics | OE | 3 | 0 | 0 | 3 |
| 2 | 19EOE744 | Industrial Safety | OE | 3 | 0 | 0 | 3 |
| 3 | 19EOE746 | Operations Research | OE | 3 | 0 | 0 | 3 |
| 4 | 19EOE748 | Cost Management of Engineering Projects | OE | 3 | 0 | 0 | 3 |
| 5 | 19EOE752 | Waste to Energy | OE | 3 | 0 | 0 | 3 |

## 19EME701: ADVANCED MECHANICS OF SOLIDS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course helps in understanding the mechanical behavior of solid structures such as curved beams, thick cylinders, rotating disks and non-circular shafts subject to complex loading with appropriate mathematical relationships. This course teaches the concepts related to the development of elastic relations satisfying fundamental equilibrium and compatibility conditions. This is a higher level course which requires basic knowledge gained from the basic strength of material course and apply it to the study and design of advanced structures.*

**Course Objectives:**

- To familiarize the student with 3-dimensional stress-strain relationships and relationship between various elastic constants.
- To explain techniques for solution of indeterminate structures.
- To demonstrate the response of curved beams and beams subjected to un-symmetric loading.
- To expose the students to mathematical approach for noncircular shafts and thick cylinders.
- To introduce thermal stresses in conjunction with stresses due to structural loads.

**Unit I** **10L**

**Analysis of Stress:** Introduction, Types of forces and stresses in 2D and 3D, Principal Stresses, Stress Invariants, Principal Planes, Mohr's Circles for the Three-dimensional State of Stress, Octahedral Stresses, The State of Pure Shear, Decomposition into Hydrostatic and Pure Shear States, Cauchy's Stress Quadric, Lame's Ellipsoid, Differential Equations of Equilibrium, Equilibrium Equations for Plane Stress State, Boundary Conditions, Equations of Equilibrium in Cylindrical Coordinates, Axisymmetric Case and Plane Stress Case.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the equilibrium conditions for stresses. [**L2**]
- calculate principal stresses and principal planes in 3-dimensions. [**L3**]
- decompose stress into normal and shear components. [**L3**]

**Unit II** **10L**

**Analysis of Strain:** Introduction, Types of strain — Linear and Rectangular Strain Components, The State of Strain at a Point, Shear Strain Components, Cubical Dilatation, Principal Axes of Strain and Principal Strains, Plane State of Strain, Plane Strains in Polar Coordinates, Compatibility Conditions, Strain Deviator and its Invariants.

**Stress–Strain Relations for Linearly Elastic Solids:** Introduction, Generalized Statement of Hooke's Law, Stress–Strain Relations for Isotropic Materials, Modulus of Rigidity, Bulk Modulus, Young's Modulus and Poisson's Ratio, Relations between the Elastic Constants, Displacement Equations of Equilibrium.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the compatibility conditions for strains. [**L2**]

- calculate principal strains in 3-dimensions. [**L3**]
- derive the relationship between various elastic constants. [**L3**]

**Unit III** **10L**

**Energy Methods:** Introduction, Hooke's Law and the Principle of Superposition, Work Done by Forces and Elastic Strain Energy Stored, Reciprocal Relation, Maxwell–Betti–Rayleigh Reciprocal Theorem, First Theorem of Castigliano, Statically Indeterminate Structures, Theorem of Virtual Work, Kirchhoff's Theorem, Second Theorem of Castigliano or Menabrea's Theorem, Generalization of Castigliano's Theorem or Engesser's Theorem.

**Bending of Beams:** Introduction, Straight Beams and Asymmetrical Bending, Euler–Bernoulli Hypothesis, Shear Centre or Centre of Flexure, Shear Stresses in Thin-walled Open Sections: Shear Centre, Bending of Curved Beam (Winkler-Bach Formula).

**Learning Outcomes:**

At the end of this unit, the student will be able to

- apply energy methods for solution of indeterminate structures. [**L3**]
- analyze beams subjected to asymmetrical bending. [**L4**]
- evaluate the behavior of curved beams. [**L5**]

**Unit IV** **8L**

**Torsion:** Introduction, Torsion of General Prismatic Bars–Solid Sections, Torsion of Circular, Elliptical, Triangular Bar, and Rectangular Bars, Membrane Analogy, Torsion of Thin-walled Tubes, Torsion of Thin-walled Multiple-Cell Closed Sections, Torsion of Rolled Sections, Multiple-Connected Sections, Center of Twist and Flexural Center.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- derive shear stresses in non-circular beams subjected to torsion. [**L3**]
- analyze thin walled structures subjected to twisting. [**L4**]
- calculate center of twist and flexural center. [**L5**]

**Unit V** **8L**

**Axisymmetric Problems:** Introduction, Thick-walled Cylinder subjected to Internal and External Pressures-Lame's Problem, Stresses in Composite Tubes-Shrink Fits, Rotating Disks of Uniform Thickness, Disks of Variable Thickness.

**Thermal Stresses:** Introduction, Thermoelastic Stress–Strain Relations, Equations of Equilibrium, Strain-Displacement Relations, Analysis of thermal stresses in Thin Circular Disk, Long Circular Cylinder, Sphere, Normal Stresses in Straight Beams due to Thermal Loading, Stresses in Curved Beams due to Thermal Loading.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- calculate stresses in thick cylinders. [**L3**]
- analyze the stresses in rotating discs. [**L4**]
- evaluate structures subjected to thermal loading . [**L5**]

**Text Book(s):**

1. L.S. Srinath, Advanced Mechanics of Solids, 3/e, Tata-McGraw-Hill Publishing Co. Ltd, 2008.

**References:**

1. A. P. Boresi and R. J.Schmidt, Advanced Mechanics of Materials, 6/e, Wiley India Pvt. Ltd, 2009.
2. J. P. Den Hartog, Advanced Strength of Materials, Revised Edition, Courier Corporation, 2014.

**Course Outcomes:**

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

- recall the fundamental stress-strain relationships derived in strength of materials. [**L1**]
- comprehend the concepts of stresses and strains derived through equilibrium and compatibility conditions. [**L2**]
- calculate the variations in stresses due to various types of loadings in thick cylinders and noncircular shafts. [**L3**]
- analyze various static structures by using energy methods. [**L4**]
- evaluate structures subjected to thermal loading. [**L5**]

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | 1 | 1 | | | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | 1 | | 1 | | | | 1 | | | 1 | 2 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 1 | | | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME703: MECHANICS OF MACHINERY

**L T P C**

**3 0 0 3**

**Course Description:**

*This course exposes the student to low and high degree complex mechanisms. The velocity and acceleration analysis of various complex mechanisms will be dealt using various methods. This course also deals with graphical and analytical methods synthesis of mechanisms.*

**Course Objectives:**

- To introduce the concept of complex mechanisms.
- To familiarize the importance of inflection circle in kinematic analysis.
- To analyze velocities and accelerations of different links in a mechanism.
- To analyze the proportions of different links in a mechanism.
- To introduce the concept of cam dynamics.

**Unit I** **8L**

**Kinematics of complex mechanisms:** Complex mechanisms, Low and high degree of complexity, Goodman's indirect acceleration analysis, Method of normal accelerations, Hall and Ault's auxiliary point method, Carter's method and comparison of methods.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the concept of complex mechanisms. **[L2]**
- differentiate low and high degree complex mechanisms **[L2]**
- calculate velocities and accelerations of complex mechanisms **[L3]**

**Unit II** **10L**

**Advanced kinematics of plane motion:** The inflexion circle - Euler-Savary equation, Analytical and graphical determination of diameter of inflection circle - Bobbileier's construction, Collineation axis - Hartman's construction, Application of inflection circle to kinematic analysis - Polode curvature - General case and special case, Polode curvature in the four-bar mechanism - Coupler motion, Relative motion of the output and input links, Freudenstein's collineation axis theorem - Carter Hall circle, Circling-point curve (general case).

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the concept of polode curvature **[L2]**
- calculate the diameter of inflection circle **[L3]**

**Unit III** **10L**

**Introduction to synthesis (graphical methods):** guiding a point through two, three and four distinct positions - Burmaster's curve, Function generation - Overlay's method, Path generation - Robert's theorem.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- differentiate synthesis and analysis**[L2]**

- analyze the proportions of links using graphical method **[L4]**

**Unit IV** **9L**

**Introduction to synthesis (analytical methods):** Freudenstein's equation - Precision point approximation - Precision derivative approximation - Method of components - Block synthesis. **Forces in mechanisms** - Free body diagrams - Friction in link connections - Forces in linkages.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- analyze the proportions of links using analytical method **[L4]**
- calculate various forces acting on links in a mechanism **[L3]**

**Unit V** **10L**

**Cam dynamics:** Forces in rigid systems, Mathematical models, Response of a uniform - Motion undamped cam mechanism - Analytical method, Follower response by phase - Plane method - Position error, Jump, Crossover shock - Johnson's numerical analysis.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the terminology of cam dynamics **[L2]**
- model the cam mechanism**[L4]**

**Text Book (s):**

1. J. Hirschhorn, Kinematics and Dynamics of Plane Mechanisms, 2/e, McGraw-Hill Education.

**References:**

1. J.E. Shigley, Theory of Machines, 2/e, McGraw-Hill Education.

**Course Outcomes:**

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

- understand the difference between low and high degree complex mechanisms.**[L2]**
- draw the velocity and acceleration diagrams for low and high degree complex mechanisms.**[L3]**
- evaluate forces in linkages. **[L3]**
- evaluate the lengths of links in a mechanism using graphical and analytical methods. **[L3]**
- analyze the follower response.**[L4]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | 1 | 1 | 2 | | | | | | | 2 | | | | 1 | |
| CO3 | 2 | | 2 | | 1 | | | | 1 | | | 1 | 2 | 1 | 2 | | 1 |
| CO4 | 1 | 1 | 2 | 2 | 2 | | | | | | 1 | 2 | | | | 2 | |
| CO5 | | 2 | 1 | 1 | | | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME705: COMPUTER AIDED DESIGN

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*Computers have become inevitable in today era and find their application in various stages of product development. This course intends to introduce students to use of computers in the phases of product design viz. conceptualization, geometric modelling, graphical representation and finite element analysis. The concept of computer aided design (CAD) using computers to control the various stages of design process from the beginning. CAD demonstrates the usage of engineering mathematics related to geometry to understand concepts. This subject gives a scope for applying CAD concepts to product design and development.*

**Course Objectives**

- To provides an overview of how computers are being used in mechanical component design.
- To impart knowledge on computer graphics which are used routinely in diverse areas asScience, engineering, medicine, etc.
- Acquire fundamental understanding of the principles of CAD, including engineering drawing, geometric and surface modeling, and feature-based design.
- Apply computer aided manufacturing principles to perform manual and computer aided numerical control programming.

**Unit I** **10L**

**Fundamentals of CAD**: Introduction, Design process, Application of computer for design, Benefits of CAD, CAD tools, CAD hardware, CAD software, Mechanical applications of CAD.

**Geometric modeling - Types and Mathematical Representations of Curves**: Wireframe models, wireframe entities, curve representation, parametric representation of analytic curves and synthetic curves, simple problems.

**Learning outcomes**

At the end of this Unit, the student will be able to

- describe basic structure of CAD workstation, Memory types, input/output devices and display devices and computer graphics. **[L2]**
- learn the rudiments of computer aided design (CAD) and CAD systems. **[L1]**

**Unit II** **8L**

**Geometric modeling - Types and Mathematical Representations of Surfaces**: Surface models, surface entities, surface representation, parametric representation of analytic surfaces and synthetic surfaces, simple problems.

**Learning outcomes**

At the end of this Unit, the student will be able to

- apply geometric transformations on the created wireframe, surface and solid models. **[L3]**
- use engineering mathematics related to geometry to understand CAD. **[L3]**

**Unit III** **8L**

**Geometric modeling - Types and Mathematical Representations of Solids**: Solid models, solid entities, solid representation, fundamentals of solid modeling, half spaces, Boundary Representation (B-rep), Constructive Solid Geometry (CSG), Sweep Representation, Analytic Solid Modeling (ASM).

**Learning outcomes**
At the end of this Unit, the student will be able to

- understand mathematical aspects of geometrical modeling **[L2]**
- use 3D modeling software to accurately generate and easily modify graphical representations of the product.**[L3]**

**Unit IV** **8L**

**Graphics Concepts - Geometric Transformations**: Transformation of geometric models, mappings of geometric models, inverse transformations and mappings, projections of geometric models. **Graphics Concepts - Visual realism**: Model clean-up, hidden line removal, hidden surface removal, hidden solid removal, Shading, Coloring.

**Learning outcomes**
At the end of this Unit, the student will be able to

- apply geometric transformations on the created wireframe, surface and solid models **[L4]**
- apply algorithms of graphical entity generation. **[L4]**

**Unit V** **8L**

**Mechanical assembly**: Assembly modeling, representation schemes, generation of assembly sequence, assembly analysis. **Mass property calculations**: Geometrical property formulation, mass property formulation, property evaluation, properties of composite objects.

**Learning outcomes**
At the end of this Unit, the student will be able to

- use algorithmic foundation for solving problems by writing computer programs. **[L3].**
- develop program algorithms for calculation of various properties **[L4].**

**Text Book(s):**

1. CAD/CAM Theory and Practice by I. Zeid, 1/e, Tata McGraw-Hill, 1991.

**References:**

1. P. N. Rao, CAD/CAM:Principles and Applications, 3/e, Tata McGraw Hill Publishing Company Ltd., 2010.
2. M. P. Groover and E. W. Zimmer, CAD/CAM Computer Aided Design and Manufacturing, 1/e, Pearson Education, 2003.
3. D. D. Bedworth, M. R. Henderson, P. M. Wolfe, Computer Integrated Design and Manufacturing, McGraw-Hill, 1991.

**Course Outcomes**
After completing the course, the student will be able to

- apply engineering knowledge, techniques, skills and modern tools to analyze problems in design **[L3]**
- integrate the role of graphic communication in the engineering design process **[L4]**.
- develop mathematical models to represent curves, surfaces and solids **[L4]**.

- implement 2D and 3D transformations for positioning/shaping objects, or to change viewing positions **[L4]**.
- formulate the parametric representation of standard conic shapes, 2D and 3D freeform curves and surfaces in the most efficient manner **[L4]**.

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | | | | 1 | | 1 | 1 | 1 | 2 | 1 | | 1 |
| CO2 | 2 | | 2 | 2 | | 1 | | | | | | | | | | 2 | |
| CO3 | | 2 | 1 | | 1 | | | | 1 | | 1 | 1 | 2 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 2 | 1 | | | | | | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | | | | 1 | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME741: COMPUTATIONAL METHODS IN ENGINEERING

**L T P C**
**3 0 0 3**

**Course Description:**

*This course provides an introduction to the computational methods to solve various kinds of equations that students encounter in the field of engineering. The student will develop his/her own programs/subroutines for the computational schemes taught in the course.*

**Course Objectives**

- To study root finding methods and linear algebraic equation solving methods.
- To study the various methods to solve system of linear and nonlinear equations to solve engineering problems.
- To solve integration and differentiation problems numerically.
- To solve initial value and boundary value ordinary differential equations.
- To solve partial differential equations and study transform equations.

**Unit I** **10L**

**Modeling, Computers, and Error Analysis**: Mathematical Modeling and Engineering Problem Solving, Approximations and Round-Off Errors, Truncation Errors and the Taylor Series. **Roots of Equations**: Bracketing Methods – Bisection Method, False Position Method, Incremental searches and Determining Initial Guesses; Open Methods – Fixed Point Iteration, Newton-Raphson Method, Secant Method; Roots of Polynomials – Muller‘s Method, Bairstow‘s method; Application to practical problems – Ideal and Non-ideal gas laws, Vibration Analysis.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- identify the various errors encounter in solving numerical problems. [**L2**]
- estimate the Roots linear and nonlinear equations by various root finding methods.[**L2**]

**Unit II** **8L**

**Linear Algebraic Equations**: Gauss Elimination – Solving Small Numbers of Equations, Naïve Gauss Elimination, Pitfalls, Techniques for improving Solutions, Nonlinear Systems of Equations, Gauss-Jordan; LU Decomposition and Matrix Inversion, Special Matrices and Gauss-Seidel, Application to practical problems – Analysis of a Statically Determinate Truss, Spring Mass Systems.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- identify the system of linear and nonlinear equations in engineering applications.[**L2**]
- estimate the unknowns in system of linear and nonlinear equations by various methods[**L2**]

**Unit III** **10L**

**Numerical Differentiation and Integration**: Newton-Cotes Integration Formulas – Trapezoidal Rule, Simpson‘s Rules, Integration with Unequal Segments, Multiple Integrals; Integration of Equations - Newton-Cotes Algorithms for Equations, Romberg Integration, Gauss Quadrature;
Numerical Differentiation – High Accuracy Differentiation Formulas, Richardson Extrapolation, Derivatives of Unequally spaced Data; Application to practical problems – Integration to Determine the Total Quantity of Heat, Computation of Work.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- recognize the Differentiation and Integration applications in engineering applications.[**L2**]
- compute the Differentiation and Integration problems numerically by various methods[**L2**]

**Unit IV** **10L**

**Ordinary Differential Equations:** Runge-Kutta Methods – Euler's Method, Improvement of Euler's Method, Runge-Kutta Methods, Systems of Equations, Adaptive Runge-Kutta Methods; Stiffness and Multistep Methods, Boundary-12 Value and Eigen value Problems, Application to practical problems – The Swinging Pendulum.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- identify the Ordinary Differential Equations in engineering applications.[**L2**]
- solve the Ordinary Differential Equations numerically by various methods[**L2**]

**Unit V** **8L**

**Partial Differential Equations:** Finite Difference: Elliptic Equations – The Laplace Equation, Solution Techniques, Boundary Conditions, The Control Volume Approach; Finite Difference: Parabolic Equations – The Heat Conduction Equation, Explicit Methods, a Simple Implicit Method, The Crank-Nicolson Method; Application to practical problems - Finite-Element Solution of a Series of Springs.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- identify the Partial Differential Equations in engineering applications.[**L2**]
- solve the Partial Differential Equations problems numerically by various methods[**L2**]

**Text Book(s):**

1. Numerical Methods for Engineers by S. C. Chapra and R. P. Canale, 6/e, Tata McGraw-Hill Company Ltd., 2010.

**References:**


1. S. C. Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, 3/e, McGraw-Hill Company Ltd., 2011.
2. M. L. James, G. M. Smith and J. C. Wolford, Applied Numerical Methods for Digital Computation, 2/e, Harper & Row Publishers, 1977.


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

- demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems. [**L1**]
- apply Computational methods to obtain approximate solutions to engineering problems [**L3**]
- calculate the physical properties of rigid bodies required for the analysis of engineering systems. [**L3**]
- derive computational methods for various mathematical operations and tasks, such as differentiation, integration, the solution of linear and nonlinear equations, and the solution of

differential equations. [**L4**]

- analyze and evaluate the accuracy of common numerical methods. [**L4**]

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | 1 | 1 | | | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | 1 | | 1 | | | | 1 | | | 1 | 2 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 1 | | | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME743: ROBOTICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*The course on robotics is intended to provide a reasonable understanding of robotics, how they function, the mathematics behind position, motion and dynamics of robot. It also involves controlling the robot using motors, controllers etc. It is also expected that students will get a hands on experience through the use of Matlab and simulink to simulate robots or to build simple mobile robots or arms using simple motors and sensors.*

**Course Objectives**

- To study the basics of robots.
- To discuss about the different actuators of Robot.
- To understand the kinematics and inverse kinematics of robots.
- To analyses the trajectory planning for robot.
- To elaborate the control of robots for some specific applications.

**Unit I** **8L**

**Introduction and Robot Kinematics:** Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors.
Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

**Learning Outcomes:**

- understand the basics of robot anatomy**[L1]**
- recognize the significance of need and scope of robots**[L2]**
- calculate the robot kinematics and robot dynamics**[L3]**

**Unit II** **8L**

**Robot Drives and Control:** Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

**Learning Outcomes:**

- understand the controlling the robot motion**[L1]**
- comprehend the concept of drive systems**[L2]**
- understand the concepts of gripper and robot control**[L1]**

**Unit III** **8L**

**Robot sensors:** Transducers and Sensors – Sensors in Robot – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Gribbing – Image processing and analysis – Image segmentation – Pattern recognition – Training of vision system.

**Learning Outcomes:**

- elaborate the function of different sensors in the robot**[L2]**
- calculate the joint forces**[L3]**
- utilize the concept of image processing and analysis**[L4]**

**Unit IV** **8L**

**Robot Cell Design and Application:** Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis, Industrial application of robots.

**Learning Outcomes:**

- understand the concepts of robot work cell design and control**[L1]**
- analyze the robot cycle time**[L4]**
- comprehend the concept of machine interference**[L2]**

**Unit V** **10L**

Robot Programming, Artificial Intelligence and Expert Systems: Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – Problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

**Learning Outcomes:**

- develop the robot programming**[L3]**
- understand the concepts of artificial intelligence**[L1]**
- manipulate robots in different applications**[L4]**

**Text Book(s):**

1. Deb, S.R., Robotics Technology and Flexible Automation, 2/e, Tata McGraw-Hill, 1994.

**References:**

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, Robotics Control, Sensing, Vision and Intelligence, McGraw Hill, July, 1987.
2. Yoram Koren, Robotics for Engineers, McGraw-Hill, 1987.
3. Kozyrey, Yu. ―Industrial Robots, MIR Publishers Moscow, 1985.
4. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, Robotics Engineering – An Integrated Approach, 1/e, Prentice-Hall of India Pvt. Ltd., 2009.
5. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey, Industrial Robotics Technology, Programming and Applications, 1/e, McGraw-Hill, Int. 1986.

**Course Outcomes**

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

- identify various robot configuration and components and their applications in agile manufacturing. **[L1]**
- comprehend to select appropriate drives and sensors for a robot based on specific application **[L2]**
- understand the principles of operation for mobile robots and robot cell layout**[L1]**
- understand the real-time control and programming issues**[L1]**
- make transparent judgments with regards to the design or issues related to engineering problems. **[L5]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 2 | | 2 | 1 | | | | 1 | | 1 | | 2 | 2 | 1 | | 1 |
| CO2 | | | 2 | 1 | | 1 | | | | | | 1 | | | | 2 | |
| CO3 | 1 | 2 | 1 | | 2 | | | | 1 | | | 1 | 2 | 1 | 1 | | 1 |
| CO4 | 2 | 1 | 2 | 1 | 1 | 1 | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | | | | | | | | | 2 | | | 1 |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME745: NONLINEAR SOLID MECHANICS

**L T P C**
**3 0 0 3**

**Course Description:**

*This course helps in understanding the nonlinear behavior of solid materials and the mathematics related to the representation and calculations of nonlinear phenomenon. This course teaches the concepts with emphasis on mathematical formulation for defining material behavior of structures such as rubbers, composites and polymers. This is a higher level course which requires basic knowledge gained from the basic strength of material course and apply it to the study and design of advanced structures.*

**Course Objectives:**

- To introduce continuum mechanics and related mathematics.
- To explain constitutive relations of linear and nonlinear materials
- To familiarize the students to tensor calculations related to stresses and strains.
- To expose the students to mass, momentum and energy balance calculations.
- To demonstrate the concepts required for designing structures exhibiting nonlinear material behavior.

**Unit I** **10L**

**Introduction to Vectors and Tensors:** Algebra of Vectors, Algebra of Tensors, Higher-order Tensors, Eigen values, Eigenvectors of Tensors, Transformation Laws for Basis Vectors and Components, General Bases, Scalar, Vector, Tensor Functions, Gradients and Related Operators, Integral Theorems.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- recall the fundamentals of vector algebra. [**L1**]
- understand higher order tensor calculus. [**L2**]
- calculate Eigen values and Eigen vectors in tensor form. [**L3**]

**Unit II** **10L**

**Kinematics:** Configurations and Motions of Continuum Bodies, Displacement, Velocity, Acceleration Fields, Material, Spatial Derivatives, Deformation Gradient, Strain Tensors, Rotation Tensor, Stretch Tensors, Rates of Deformation Tensors, Lie Time Derivatives. **The Concept of Stress:** Traction Vectors, and Stress Tensors, External Stress Values, Examples of States of Stress, Alternative Stress Tensors.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the concept of continuum. [**L2**]
- perform kinematic operations using continuum concepts. [**L3**]
- calculate stress and strain tensors. [**L3**]

**Unit III** **10L**

**Balance Principles:** Conservation of Mass, Reynolds' Transport Theorem, Momentum Balance Principles, Balance of Mechanical Energy, Balance of Energy in Continuum Thermodynamics, Entropy Inequality Principle, Master Balance Principle.

**Some Aspects of Objectivity:** Change of Observer, and Objective Tensor Fields, Superimposed Rigid-body Motions, Objective Rates, Invariance of Elastic Material Response.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the balance of mass, mechanical energy and thermal energy. [**L2**]
- understand the principles of superimposition and invariance. [**L2**]
- apply Transport theorem and Master Balance Principle. [**L4**]

**Unit IV** **10L**

**Hyperelastic Materials:** General Remarks on Constitutive Equations, Isotropic Hyperelastic Materials, Incompressible Hyperelastic Materials, Compressible Hyperelastic Materials, Some Forms of Strain-energy Functions, Elasticity Tensors, Transversely Isotropic Materials, Composite Materials with Two Families of Fibers, Constitutive Models with Internal Variables, Viscoelastic Materials at Large Strains, Hyperelastic Materials with Isotropic Damage.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand hyperelasticity and its mathematical representation. [**L2**]
- perform calculations related to composite materials and viscoelasticity. [**L3**]
- apply constitutive models to represent large strains and damage behavior. [**L4**]

**Unit V** **10L**

**Thermodynamics of Materials:** Physical Preliminaries, Thermoelasticity of Macroscopic Networks, Thermodynamic Potentials, Calorimetry, Isothermal, Isentropic Elasticity Tensors, Entropic Elastic Materials, Thermodynamic Extension of Ogden's Material Model, Simple Tension of Entropic Elastic Materials, Thermodynamics with Internal Variables. **Variational Principles:** Virtual Displacements, Variations, Principle of Virtual Work, Principle of Stationary Potential Energy, Linearization of the Principle of Virtual Work, Two-field Variational Principles, Three-field Variational Principles.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the effect of thermodynamic principles during material response. [**L2**]
- apply the principle of virtual work and potential energy. [**L4**]
- apply two field and three field variational principles. [**L4**]

**Text Book(s):**


1. G. A. Holzapfel, Nonlinear Solid Mechanics: A Continuum Approach for Engineering, Wiley-Blackwell, 2000.


**Reference:**


1. A. Ibrahim Begovic, Nonlinear Solid Mechanics: Theoretical formulations and finite element solutions, 1/e, Springer publications, 2010.
2. J. Besson , G. Cailletaud , J-L. Chaboche , S. Forest , M. Bletry, Non-Linear Mechanics of Materials (Solid Mechanics and Its Applications), Springer, 2010.

**Course Outcomes:**

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

- understand constitutive models related to elastic and hyperelastic material behaviour. [**L2**]
- perform tensorial calculations for stress and strain. [**L3**]
- calculate kinematic parameters in continuum [**L3**]
- use equilibrium equations for mass and momentum balance. [**L4**]
- apply selected materials models on an engineering problem. [**L4**]

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 2 | | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | | 1 | | 1 | | | | | | 2 | | | | 2 | |
| CO3 | 2 | | 1 | | 1 | | | | 1 | | | 1 | 2 | 1 | 2 | | 1 |
| CO4 | 1 | 1 | 2 | 2 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 2 | 1 | 1 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME747: MECHATRONICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course helps in understanding the representation of electro-mechanical systems and their design processes. The knowledge is useful for data acquisition in real time systems and selection of sensors for detection and monitoring of critical mechanical and electrical systems. This is a higher level course which is mandatory for design of systems which require both electrical and mechanical components.*

**Course Objectives:**

- To introduce key electro-mechanical elements.
- To explain the modeling of electrical and mechanical systems and their interactions.
- To familiarize the students with various types of sensors.
- To expose the students to data acquisitions hardware and software.
- To demonstrate the design of electro-mechanical systems required in key industrial and safety applications.

**Unit I** **10L**

**Mechatronics system design:** Introduction to Mechatronics: What is mechatronics, integrated design issues in mechatronics, Mechatronics key elements, the mechatronics design process, Advanced approaches in mechatronics.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the basics of mechantronics. [**L2**]
- understanddesign issues and design process in mechatronics. [**L2**]
- understand advanced approaches in mechatronics. [**L2**]

**Unit II** **10L**

**Modeling and simulation of physical systems:** Simulation and block diagrams, Analogies and impedance diagrams, Electrical systems, Mechanical translational systems, Mechanical rotational systems, Electro mechanical coupling, Fluid systems.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand electrical, mechanical, coupled and fluid systems. [**L2**]
- perform simulations using block diagrams. [**L3**]
- draw impedance diagrams. [**L3**]

**Unit III** **8L**

**Sensors and transducers:** An introduction to sensors and transducers, Sensors for motion and position measurement, Force, torque and tactile sensors, Flow sensors, Temperature-sensing devices.

**Actuating devices:** Direct current motor, permanent magnet stepper motor, fluid power actuation.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understandthe mechanism of various sensors. [**L2**]
- perform calculations and operations with various motors. [**L3**]

- select the type of sensor required for a specific application. [**L4**]

**Unit IV** **10L**

**Signals, systems and controls:** Introduction to signals, systems and controls, System representation, Linearization of nonlinear systems, Time delays.

**Real time interfacing:** Introduction, Elements of a data acquisition and control system, Overview of the I/O process, Installation of the I/O card and software.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- represent linear and nonlinear systems in graphical form. [**L3**]
- install and operate data acquisition software and hardware. [**L3**]
- use data acquisition to read real time data [**L4**]

**Unit V** **8L**

**Advanced applications in mechatronics:** Sensors for condition monitoring, Mechatronic control in automated manufacturing, Artificial intelligence in mechatronics, Microsensors in mechatronics.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- comprehend the use of sensors for condition monitoring. [**L2**]
- figure out about the applications of mechatronics in automation. [**L2**]
- understand the role of artificial intelligence in mechantronics. [**L2**]

**Text Book(s):**

1. Devdas Shetty and Richard A. Kolk, Mechatronics System Design, 2/e, Cengage, 2012.

**Reference:**

1. W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, 4/e, Pearson Education, 2010.
2. N.P.Mahalik, Mechatronics: Principles, Concepts and Applications, McGraw Hill Education, 2017.

**Course Outcomes:**

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

- identify the type of sensor required for a particular application [**L2**]
- draw block diagrams and simulate physical systems. [**L3**]
- perform data acquisition by installing the required software and hardware . [**L3**]
- apply mechatronics in advanced applications such as automation and condition monitoring. [**L4**]
- design a mechatronic system using electrical mechanical interaction. [**L5**]

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 2 | 1 | | 1 |
| CO2 | | 2 | 1 | 2 | | | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | | | 1 | 1 | | | 1 | | | 2 | 2 | 1 | 2 | | 2 |
| CO4 | 2 | 1 | 2 | 1 | 2 | | | | | | 1 | 1 | 1 | | | 1 | |
| CO5 | | 1 | 1 | 1 | | | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME749: THEORY OF PLASTICITY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This is a postgraduate course aimed towards providing strong conceptual foundations for developing continuum theories of plastic deformation with a broad overview of plasticity. Several important formulations of plastic flow are reviewed which are of much practical use in current industrial applications. The special cases when elasticity like elastoplastic bending and torsion were discussed. The concepts of Plastic analysis of beams and frames with minimum weight design by considering influence of axial forces. Steady and un-steady problems in plane strain were analyzed in several cases like cold rolling, hot rolling and notched bars etc.*

**Course Objectives**

- Analyze the stress strain behavior in plasticity
- Compute elastoplastic bending and torsion of cylindrical bars thin-walled tubes.
- Expose the Plastic analysis of beams and frames under variable repeated loading
- Steady and in-Steady problems in plane strain by considering notch in bars and beams.

**Unit I** **8L**

**Stresses and Strains**: Stress-strain behavior, Analysis of stress and strain rate, Mohr's representation of stress, strain hardening postulates, role of plastic flow, stress-strain relations, total strain theory.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- identify the stress strain behavior in plasticity.[**L1**]
- estimate the stress strain relations in plastic flow.[**L2**]

**Unit II** **10L**

**Elastoplastic bending and torsion**: Plane strain compression and bending, cylindrical bars under torsion and tension, thin-walled tubes under combined loading, pure bending of prismatic beams, bending of beams under transverse loads, torsion of prismatic bars, torsion of bars of variable diameter, combined bending and twisting of bars.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- identify the Elastoplasic behavior in bending and torsion.[**L1**]
- analyze the Elastoplasic behavior of bars and beams under combined loads.[**L4**]

**Unit III** **10L**

**Plastic analysis of beams and frames**: limit analysis of beams, limit analysis of plane frames, displacements in plane frames, variable repeated loading, minimum weight design, influences of axial forces, limit analysis of space frames.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- explain the Plastic analysis of beams and frames.[**L1**]
- analyze the Plastic analysis of bars and beams under variable repeated loading.[**L4**]
- evaluate influence of axial forces with minimum weight design **[L6]**

**Unit IV** **12L**

**Steady problems in plane strain**: Symmetrical extrusion through square dies, unsymmetrical and multi-hole extrusion, limit analysis of plane strain extrusion, cold rolling of strips, and analysis of hot rolling.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- explain the Steady problems in plane strain.[**L1**]
- analyze the Extrusion process through various dies.[**L4**]
- analyze cold and hot rolling **[L4]**

**Unit V** **12 L**

**Un-steady problems in plane strain**: Indentation of flat punch, yielding of notched bars in tension, bending of single notched bars, bending of double notched bars, bending of beams and curved bars.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- explain the Un-Steady problems in plane strain. [**L1**]
- analyze the yielding of notched bars in bending. [**L4**]
- analyze bending of beams and curved bars. **[L4]**

**Text Book(s):**

1. J. Chakrabarty, Theory of Plasticity, 3/e, Butterworth-Hienemann, 2006.

**Reference:**

1. JacobeLubliner, Plasticity theory, 1/e, Pearson Education, Inc., 2006.

**Course Outcomes:**

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

- obtain a basic understanding of the behavior of plastic flow . [**L1**]
- calculate the Elastoplastic bending and torsion of bars and beams. [**L3**]
- perform plastic analysis of beams and frames **[L4]**
- apply the principles Plastic analysis in beams and frames. [**L3**]
- analyze Steady and Un-steady problems in Extrusion and notched bars. [**L4**]

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | | | | 1 | | 2 | | 1 | 1 | 2 | | 1 |
| CO2 | | 2 | 1 | 2 | | 1 | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | | | 1 | | | | 1 | | | 2 | 2 | 1 | 1 | | 2 |
| CO4 | | 2 | 2 | 1 | 2 | 1 | | | | | 1 | 1 | | | | 1 | |
| CO5 | 1 | | 1 | | 1 | | | | | | 1 | | 1 | | 1 | | 1 |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME751: MECHANICS OF COMPOSITE MATERIALS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*Composites materials are a relatively new class of materials replacing conventional materials owing tolow weight, corrosion resistance, high fatigue strength, and faster assembly. This course in composite materials deals the need of composites, fabrication processes, and prediction of composite properties and stress analysis of composite materials. The prerequisite for this course is mechanics of solids in under graduation level and material science and engineering.*

**Course objectives**

- To introduce advantages of composite materials over conventional metals
- To explain the differences between anisotropic, orthotropic and isotropic materials
- To explore the various methods for fabrication of FRP composites.
- To familiarize the stress strain relations in a orthotropic lamina.
- To present classical lamination theory for predicting stresses in a laminate.

**Unit I** **8L**

**Introduction to composite materials**: Classification and characteristics of composite materials, Mechanical behavior of composites, Basic terminology of laminated fiber reinforced composite materials, Advantages, Applications, Different types of fibers and matrix materials, Manufacture of laminated fiber reinforced composite materials - Hand layup, bag molding, Resin transfer molding, filament winding and pultrusion.

**Learning outcomes:**

At the end of this unit, the student will be able to

- understand the advantages of composites [**L1**]
- classify the composite materials [**L2**]
- present various matrix materials, fibers for reinforcement [**L2**]
- outline the processes for fabrication of FRP composites [**L3**]

**Unit II** **10L**

**Micromechanical behavior of a lamina:** Introduction, Stress-strain relations for anisotropic materials - generalized hooks law, Stiffens, compliances and engineering constants for orthotropic materials, Restrictions on engineering constants, Stress-strain relations for plane stress in orthotropic materials, Stress-strain relations for a lamina of arbitrary orientation, Invariant properties of an orthotropic lamina, strengths of an orthotropic lamina, Biaxial criteria for an orthotropic lamina.

**Learning outcomes:**

At the end of this unit, the student will be able to

- express the generalized hook's law [**L2**]
- present on axis and off axis stiffness matrices [**L3**]
- calculate the stresses and strains in a lamina of arbitrary orientation [**L4**]
- define the invariant properties of a lamina [**L3**]

**Unit III** **10L**

**Micromechanical behavior of lamina**: Introduction, Mechanics of materials approach to stiffness, Elasticity approach to stiffness, comparison of approaches to stiffness, Mechanics of materials approach and elasticity approach to strength.

**Learning outcomes:**

At the end of this unit, the student will be able to

- predict the properties of lamina using rule of mixtures[**L2**]
- present the prediction of properties using mechanics of materials approach and elasticity approach [**L3**]
- differentiate and understand the drawback of various approaches in predicting the properties of composites [**L3**]

**Unit IV** **10L**

**Macro mechanical behavior of laminate**: Introduction, Classical lamination theory (CLT), ABD matrices, Special cases of laminate stiffness, Theoretical versus measured laminate stiffness, Strength of laminates, Inter laminar stresses.

**Learning outcomes:**

At the end of this unit, the student will be able to

- express the CLT for a laminate [**L3**]
- understand the coupling matrices in CLT [**L2**]
- calculate the stresses and strains in a laminate [**L5**]
- analyze the effect of inter-laminar stresses in a laminate.[**L4**]

**Unit V** **9L**

**Bending of laminated plates**: Introduction, governing equations for bending of laminated beams and plates, deflection of simply supported laminated plates under distributed transverse load.

**Learning outcomes:**

At the end of this unit, the student will be able to

- develop the governing equations for a laminated beams subjected to bending moments [**L4**]
- develop the governing equations for a laminated plates subjected to transverse loads**[L4]**
- calculate the stresses and strains in a laminated plates in bending [**L5**]

**Text Book(s):**

1. R. M. Jones, Mechanics of composite materials, 2/e, Taylor and Francis, 1999.

**References:**

1. B. D. Agarwal, L. J. Broutman and K. Chandrasekhara, Analysis and performances of Fiber composites, 3/e, John Wiley & Sons, Inc., 2006.
2. J. C. Halpin, Primer on composite materials, revised edition, Technomic Publishing Company, Inc., 1984.

**Course outcomes:**

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

- acquaint various fabrication methods of composites.**[L2]**

- calculate the stresses in a lamina with arbitrary fiber orientations.**[L3]**
- predict the properties of composites using micromechanical approaches. **[L2]**
- analyze the stresses in a lamina using CLT.**[L4]**
- develop governing equations for laminated plates and beams.**[L4]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | | | | 1 | | 2 | | 1 | 1 | 2 | | 1 |
| CO2 | | 2 | | 1 | | 1 | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | 1 | | 1 | | | | 1 | 1 | | 2 | 2 | 1 | 1 | | 2 |
| CO4 | 2 | 1 | 2 | 2 | 2 | | | | | | 1 | 1 | | | | 2 | |
| CO5 | | 2 | 1 | 1 | | 1 | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME753: 3D PRINTING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*3D printing is defined by the ASTM F42 committee as the fabrication of objects through the deposition of a material using a print head, nozzle, or other printer technology. In particular, it is associated with machines that are lower in relative price and overall functional capability. 3D Printing is used to build physical models, prototypes, patterns, tooling components and production parts with materials like plastics, metal, ceramic, glass, and composite materials. 3D Printing systems use thin, horizontal cross sections from computer-aided design (CAD) models, 3D-scanning systems, medical scanners, and video games to produce parts in about every shape imaginable. Design and manufacturing organizations use 3D Printed parts for products in the consumer, industrial, medical implants, and military markets, to name just a few which are benefited by the 3D Printing technology.*

**Course Objectives**

- Understand the fundamentals of various Additive Manufacturing Technologies for application to various industrial needs.
- Able to convert part file into STL format.
- Able to understand the method of manufacturing of liquid based, powder based and solid based techniques.
- Understand the manufacturing procedure of a prototype using FDM technique.

**Unit I** **10L**

**Introduction:** Introduction of 3D Printing, Evolution of 3D Printing, General procedure of 3D Printing, Prototyping fundamentals, Historical development, Advantages of AMT, Commonly used terms, process chain, 3D modeling, Data Conversion, and transmission, Checking and preparing, Building, Post processing, RP data formats, Classification of AMT process, Applications to various fields.

**Learning outcomes**

At the end of this unit, the student will be able to

- understand history, concepts and terminology of additive manufacturing[**L1**]
- differentiate between additive and subtractive manufacturing techniques[**L4**].

**Unit II** **10L**

**Liquid based systems:** Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies.

**Solid ground curing (SGC):** Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.

**Learning outcomes**

At the end of this Unit, the student will be able to

- able to prepare CAD model, understand the various software tools, processes and techniques that enable manufacturing and personal fabrication[**L3**]
- articulate the various tradeoffs that must be made in selecting additive manufacturing processes, devices and materials to suit particular product requirements [**L4**]

**Unit III** **10L**

**Solid based systems:** Laminated object manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and disadvantages, Case studies.

**Fused Deposition Modeling (FDM):** Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration.

**Learning outcomes**

At the end of this Unit, the student will be able to

- identify the need for liquid and solid based additive manufacturing systems [**L3**]
- demonstrate the application of different AM techniques [**L2**].

**Unit IV** **10L**

**Powder Based Systems:** Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

**Three dimensional printing (3DP):** Models and specification, process, working principle, applications, advantages and disadvantages, case studies.

**Learning outcomes**

At the end of this Unit, the student will be able to

- design and develop newer tooling models[**L3**].
- analyzethe best powder based AM method for present day market requirements [**L4**].

**Unit V** **8L**

**Medical And Bio-Additive Manufacturing:** Customized implants and prosthesis: Design and production. Bio-Additive Manufacturing- Computer Aided Tissue Engineering (CATE)– Case studies.

**Learning outcomes**

At the end of this Unit, the student will be able to

- evaluate the Additive Manufacturing systems, scope for new product development for medical and bio implants [**L5**]
- Analyze the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools[**L4**].

**Text Book(s):**


1. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, 3/e, World Scientific Publishers, 2010.
2. Gebhardt A., Rapid prototyping, Hanser Gardener Publications, 2003.


**References:**


1. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2/e, 2014.
2. Liou L.W., Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007.
3. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
4. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000.

**Course Outcomes**

After completing the course, the student will be able to

- understand the fundamentals of Additive Manufacturing Technologies for engineering applications[**L3**].
- understand the methodology to manufacture the products using SLA and SGC technologies and study their applications, advantages and case studies[**L1**].
- understand the methodology to manufacture the products using LOM and FDM technologies and study their applications, advantages and case studies[**L2**]
- understand the methodology to manufacture the products using SLS and 3D Printing technologies and study their applications, advantages and case studies[**L3**].
- Understand Bio-Additive Manufacturing and Computer Aided Tissue Engineering **[L3]**

| | Programme Objectives (Pos) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 2 | 1 | | 1 | 1 | 1 | | | 2 | 1 | 2 | | 1 | 1 | 2 | | 1 |
| CO2 | | 2 | 2 | 1 | | 1 | | | | | | 1 | | | | 2 | |
| CO3 | 2 | | 1 | | 2 | | | | 1 | 1 | | 2 | 2 | 1 | 1 | | 2 |
| CO4 | 1 | 1 | 2 | 2 | 1 | | | | | | 1 | 1 | | | | 2 | |
| C05 | 1 | | 1 | | 1 | 1 | | | | | 1 | | 1 | | 1 | | 1 |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME755: FINITE ELEMENT ANALYSIS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course exposes the students to deal with various modeling techniques and uses different numerical methods for solving a system of governing equations over the domain of a continuous physical system, which is discredited into simple geometric shapes called finite element. This course also capitalizes on knowledge of mechanics and solves problems that can only be tackled numerically on the computer.*

**Course Objectives**

- Introduce the basic principles of finite element analysis.
- Teach the theory and characteristics of finite elements that represent engineering structures.
- Discuss the finite element solutions to static and dynamic structural problems.
- Demonstrate the methodology to model and to solve complex problems in engineering
- Familiarize the students with the knowledge and skills needed to effectively use commercial finite element software.
- Impart Advanced FEA knowledge and techniques for solving complex problems in engineering.

**Unit I** **10L**

**Overview of finite element method (FEM):** Basic concept, historical background, engineering applications of FEM, general description of the FEM, comparison of FEM and other methods.
**Discretization of the domain:** Basic element shapes, discretization process, node numbering scheme, automatic mesh generation.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the significance of FEM **[L1]**
- comprehend the concept of discretization and mesh generation**[L3]**

**Unit II** **10L**

**Interpolation models:** Interpolation polynomial in terms of nodal degree of freedom, selection of the order of the interpolation polynomial, interpolation polynomial for vector quantities, linear interpolation polynomials in terms of global coordinates and local coordinates. **Higher order and Isoparametric elements:** Higher order elements in terms of natural coordinates, higher order elements in terms of classical interpolation polynomials, one-dimensional elements using classical interpolation polynomials, two-dimensional (rectangular) elements using classical interpolation polynomials.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- comprehend the concept of polynomial techniques **[L2]**
- utilize the concept of global and local coordinates **[L3]**
- comprehend the concept of Higher order elements **[L2]**

**Unit III** **10L**

**Derivation of Element Matrices and Vectors:** solution of equilibrium and Eigen value problems

using variational (Rayleigh-Ritz) approach and weighted residual (Galerkin and Least squares) approach.

**Assembly of Element Matrices and Vectors and Derivation of System Equations:** Coordinate Transformation, Assemblage of Element Equations, Incorporation of Boundary Conditions. Numerical Solution of Finite Element Equations of Equilibrium and Eigenvalue Problems

**Learning Outcomes:**

At the end of this unit, the student will be able to

- comprehend the concept of Dynamics in FEM **[L2]**
- develop the Consistent and lumped mass matrices**[L3]**
- evaluate the Eigen values and Eigen vectors. **[L5]**

**Unit IV** **10L**

**Application to Solid Mechanics Problems - Static Analysis: Basic Equations and Solution Procedure:** Basic equations of solid mechanics, formulations of solid and structural mechanics, formulation of finite element equations. **Analysis of Trusses, Beams and Frames:** Space truss element, beam element, space frame element, planar frame element. **Analysis of Plates:** Triangular membrane element, numerical results with membrane element, bending behavior of plates, finite element analysis of plate bending, triangular plate bending element, numerical results with bending elements, analysis of three dimensional structures using plate elements.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- comprehend the concept of Trusses, Beams and Frames **[L2]**
- aquatint with concept of numerical integration **[L2]**
- analyze the beams and frames and to evaluate shear force and bending moment of the given continuum**[L4]**

**Unit V** **10L**

**Application to Solid Mechanics Problems - Dynamic Analysis:** Dynamic equations of motion, consistent and lumped mass matrices, free vibration analysis, dynamic response using finite element method. **Application to Heat Transfer Problems:** Basic equations of heat transfer, governing equation for three-dimensional bodies, statement of the problem, derivation of finite element equations, straight uniform fin analysis, tapered fin analysis, analysis of uniform fins using quadratic elements, unsteady state problems, heat transfer problems with radiation.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- comprehend the concept of Dynamics and Heat transfer in FEM **[L2]**
- analyze the uniform fins and unsteady state problems **[L4]**
- interpretheat transfer problems with radiation. **[L2]**

**Text Book(s):**

1. SS Rao, The finite element method in Engineering, 4/e, Elsevier, Butterworth-Heinemann, Burlington, MA, 2005.

**References:**

1. J. N. Reddy, An introduction to the finite element method, 3/e, McGraw-Hill Education, 2005.

2. R.D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, Concepts and Applications of Finite Element Analysis, 4/e, John-Wiley & Sons, Inc., 2002.
3. L.J. Segerlind, Applied Finite Element Analysis, 2/e, John-Wiley & Sons, Inc., 1984.

**Course Outcomes**

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

- gain knowledge to have a clear understanding of how to solve basic real-world problems **[L1]**
- comprehend the solution path to engineering problems. **[L2]**
- apply the theoretical FEA concepts in solving simple to complex multi-physics FEA problems using advanced softwares.**[L3]**
- infer and analyze the results obtained from finite element analysis software.**[L4]**
- make transparent judgments` with regards to the design or issues related to engineering problems.**[L5]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 2 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 2 | | 1 | 2 | 1 | | 1 |
| CO2 | | 2 | 1 | 2 | | | | | | 1 | | 1 | | | | 2 | |
| CO3 | 2 | | | | 1 | 1 | | | 1 | | | 1 | 2 | 1 | 2 | | 2 |
| CO4 | 2 | 1 | 2 | 1 | 1 | 1 | | | | | 1 | 2 | | | | 1 | |
| CO5 | | 2 | 1 | 1 | | | | | | 1 | | | | 1 | | | 1 |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME721: MATERIAL TESTING AND CHARACTERIZATION LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

1. On UTM static and dynamic properties evaluation Toughness, ductility, Resilience and stiffness
    a. Tensile
    b. Compression
2. Fatigue test
3. 3 - point bending test
4. 2-point bending test
5. Wear test on Pin on disc
6. Evaluation of Damping properties:
    a. Polymers
    b. Metals/Alloys
7. Friction and Wear test on four ball tester
8. Study of microstructure of steel, CI and non-ferrous alloys.
9. Effect of heat treatment on grain structure/ size.
10. Study of microstructure of weld joints in the heat affected zone.
11. Study of microstructure of annealed, normalized and tempered materials.

## 19EME723: COMPUTER AIDED DESIGN LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

1. Introduction to Modeling packages – Pro-Engineer, Ideas, CATIA, Uni Graphics, Solid Works.
2. 2D-drawings using sketcher options
3. 3D-modelling using form features
4. Assembly Drawing
    a) Flange coupling
    b) Knuckle joint
    c) Oldham coupling
5. Drafting
6. Introduction to pre-processing software
7. 2D-Meshing and 3D-Meshing

## 19EMC741: RESEARCH METHODOLOGY AND IPR

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 2 |

**Course Description:**

*This course introduces the student, to the fundamentals of research, research process, technical writing and intellectual property rights. Students will be able to use this knowledge to gain interest in their subject area and pursue their career in research.*

**Course Objectives**

- To familiarize the meaning, objectives and sources of research
- To acquaint the student with the importance and methods of literature review/research ethics
- To impart the knowledge of technical writing for preparing reports, presentations, research proposals, conference/journal publications
- To introduce the terminology and process of obtaining intellectual property rights
- To expose the intricacies in the process of obtaining patent rights

**Unit I** **5L**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the meaning of a research problem
- list the different sources of research problem
- enumerate the different criteria of good research and list the different errors in selecting research problem
- contrast the different approaches of research
- compare the different methods for data collection and analysis

**Unit II** **5L**

Effective literature studies approaches, analysis Plagiarism, Research ethics

**Learning Outcomes**

After the completion of this unit, the student will be able to

- list and elaborate the different steps of the research process
- explain the importance of carrying out an effective literature review
- identify the research gaps from literature review
- describe the ethical principles to be following during research process and authorship
- define the terminology and list the methods to avoid being accused of plagiarism
- list the different types of research misconduct

**Unit III** **5L**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

**Learning Outcomes**

After the completion of this unit, the student will be able to

- list the attributes, reasons and guidelines for effective technical writing
- contrast between conference paper, technical presentation and journal paper
- choose a particular research contribution for patenting or journal publication
- define the terminology related to citation, citation index, h-index etc

**Unit IV** **5L**

**Nature of Intellectual Property**: Patents, Designs, Trademarks and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. **International Scenario**: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the codes and standards in building intellectual property rights
- list the subject, importance and requirements for of patentability
- explain the process of patenting and commercialization in academia
- enumerate the procedure for application preparation, filing and grant of Patents
- define the terminology related to citation, citation index, h-index etc

**Unit V** **8L**

**Patent Rights**: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. **New Developments in IPR**: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- explain the scope of patent rights
- describe the process for licensing and transfer of technology
- identify the sources of patent information and databases
- elaborate the administration of patent system
- describe the new developments in IPR in computer software, biological systems etc

**Text Book(s):**


1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for Science and engineering students”, Tata Mcgraw Hill India, 2013.
2. Ranjit Kumar, “Research Methodology: A Step by Step Guide for beginners”, 2/e, Prentice Hall of India, 2013.

**References:**


1. Halbert, “Resisting Intellectual Property”, Taylor and Francis Limited, 2007.
2. Mayall, “Industrial Design”, McGraw Hill, 1992.
3. Niebel, “Product Design”, McGraw Hill, 1974.
4. Asimov, “Introduction to Design”, Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, 2016
6. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand Publishers, 2008


**Course Outcomes**

After successful completion of the course, the student will be able to

- define the meaning, sources, approaches for research problems
- explain the guidelines for carrying out effective literature review and identify research gaps
- describe effective guidelines for preparing technical reports, research publications, presentations and research proposals
- describe the codes, standards and process of obtaining intellectual property rights
- enumerate the new developments of IPR in engineering systems

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 2 | 1 | | 2 | 1 | | | | 1 | | 2 | | 1 | 2 | 2 | | 1 |
| CO2 | | 2 | 2 | 1 | | 1 | | | | 1 | | 1 | | | | 1 | |
| CO3 | 2 | | 1 | | 1 | | | | 1 | | | 2 | 2 | 1 | 1 | 1 | 1 |
| CO4 | 1 | 2 | 2 | 2 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 1 | | 1 | | | | 1 | | | | 1 | | | 1 |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME702: MECHANICAL VIBRATIONS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*The primary objective of this course is to enable to build and solve mathematical models of vibrating systems. The response of single, two and multi degree of freedom systems and continues system under free and forced vibrations will also be covered. Also discusses the various aspects of vibration control, including the problems of elimination, isolation, and absorption.*

**Course objectives**

- To understand the basics of Vibration theory and types of vibration.
- Able to mathematically model real-world mechanical vibration problems.
- Able to write the differential equation of motion of vibratory systems.
- To make free and forced (harmonic, periodic, non-periodic) vibration analysis of single and multi-degree of freedom linear systems.
- To derive the equation of motion of a continuous system from the using Newton s second law.
- To find the natural frequencies and mode shapes of the system using harmonic solution.
- To design active vibration-control systems, undamped and damped vibration absorbers

**Unit I** **10L**

**Fundamentals of Vibration:** Brief history of vibration, Importance of the study of vibration, basic concepts of vibration, classification of vibrations, vibration analysis procedure, spring elements, mass or inertia elements, damping elements, harmonic analysis.

**Free Vibration of Single Degree of Freedom Systems:** Introduction, Free vibration of an undamped translational system, free vibration of an undamped torsional system, stability conditions, Raleigh's energy method, free vibration with viscous damping, free vibration with coulomb damping, free vibration with hysteretic damping.

**Learning outcomes:**

After completion of this unit, students will be able to

- describe briefly the history of vibration and indicate the importance of study of vibration **[L3]**
- compute the values of spring constants, masses, and damping constants **[L3]**
- compute the natural frequency, damped frequency, logarithmic decrement, time constant. **[L3]**
- find the responses of systems with Coulomb and hysteretic damping. **[L3]**

**Unit II** **9L**

**Harmonically Excited Vibrations:** Introduction, Equation of motion, response of an undamped system under harmonic force, Response of a damped system under harmonic force, Response of a damped system under harmonic motion of the base, Response of a damped system under rotating unbalance, forced vibration with coulomb damping, forced vibration with hysteresis damping.

**Learning outcomes:**

After completion of this unit, students will be able to

- find the responses of undamped and viscously damped single-degree-of-freedom systems subjected to different types of harmonic force, including base excitation and rotating unbalance. **[L3]**
- distinguish between transient, steady-state, and total solutions. **[L2]**
- understand the variations of magnification factor and phase angles with the frequency of excitation and the phenomena of resonance and beats. **[L1]**

- find the response of systems involving Coulomb, hysteresis, and other types of damping. **[L3]**

**Unit III** **10L**

**Vibration Under General Forcing Conditions:** Introduction, Response under a general periodic force, Response under a periodic force of irregular form, Response under a non periodic force, convolution integral.

**Two Degree of Freedom Systems:** Introduction, Equation of motion for forced vibration, free vibration analysis of an undamped system, Torsional system, Coordinate coupling and principal coordinates, forced vibration analysis.

**Learning outcomes:**

After completion of this unit, students will be able to

- find the responses of single-degree-of-freedom systems subjected to general periodic forces using Fourier series. **[L3]**
- formulate the equations of motion of two-degree-of-freedom systems. **[L2]**
- compute the eigenvalues or natural frequencies of vibration and the modal vectors. **[L3]**
- understand the concepts of coordinate coupling and principal coordinates. **[L1]**
- determine the forced-vibration solutions under harmonic forces. **[L3]**

**Unit IV** **10L**

**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, Free and Forced vibration of undamped systems, forced vibration of viscously damped systems.

**Determination of Natural Frequencies and Mode Shapes:** Introduction, Dunkerley's formula, Rayleigh's method, Holzers' method, Matrix iteration method, Jacobi's method.

**Learning outcomes:**

After completion of this unit, students will be able to

- formulate the equations of motion of multi degree-of-freedom systems using Newton's second law, influence coefficients, or Lagrange s equations.**[L3]**
- determine the free- and forced-vibration response of undamped systems using modal analysis.**[L3]**
- understand Rayleigh s principle, and the properties of Rayleigh s quotient, and compute the fundamental natural frequency of a system using Rayleigh s method.**[L1]**
- find the approximate natural frequencies of vibration and the modal vectors by using Holzer s method, Matrix iteration method, Jacobi's method.**[L3]**

**Unit V** **9L**

**Continuous Systems:** Transverse vibration of a spring or a cable, longitudinal vibration of bar or rod, Torsional vibration of a bar or rod, Lateral vibration of beams, Critical speeds of rotors.

Vibration Control: Introduction, Control of vibration, Control of natural frequencies, Vibration isolation, Vibration absorbers.

**Learning outcomes:**

After completion of this unit, students will be able to

- find the natural frequencies and mode shapes of the system using harmonic solution.**[L3]**
- apply one- and two-plane balancing techniques for eliminating vibration (unbalance).**[L3]**
- design vibration and shock isolations for systems with fixed base as well as vibrating base.**[L5]**
- design active vibration-control systems, undamped and damped vibration absorbers.**[L5]**

**Text Book(s):**

1. S.S.Rao, Mechanical Vibrations, 5/e, Pearson publications.

**References:**

1. G.K. Grover, Mechanical Vibrations, 8/e, S. Chand & Co.
2. W.T. Thomson, Mechanical Vibrations, 2/e, Prentice Hill India.
3. S. Graham Kelly, Fundamentals of mechanical vibrations, 2/e McGraw-Hill.

**Course Outcomes**

After successful completion of the course, the student will be able to

- analyze the single, two, multi degree of freedom systems. **[L5]**
- evaluate natural frequencies and mode shapes. **[L3]**
- Analyze continuous systems **[L4]**
- design active vibration-control systems. **[L5]**
- design shock isolations for systems with fixed base **[L5]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | | | | 1 | | 2 | 1 | 1 | 1 | 1 | | 2 |
| CO2 | 2 | 2 | 1 | 1 | | 1 | | | | 1 | | 1 | | 1 | | 2 | |
| CO3 | 1 | | 2 | | 1 | | | | 1 | | 1 | 2 | 2 | 1 | 1 | | 1 |
| CO4 | 1 | | 1 | | 1 | 1 | | | | | 1 | | 1 | | 1 | | 1 |
| CO5 | | 1 | | 1 | | 1 | | | 1 | | 1 | 1 | | 1 | | | 1 |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME704: EXPERIMENTAL STRESS ANALYSIS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course provides an introduction to the physical principle used by various experimental techniques and also provides a guideline to select an experimental technique for a given application. The role of analytical, numerical and experimental methods in solving a problem in solid mechanics is addressed. Stress and strain at a point is discussed in most courses on solid mechanics but little attention is paid on the variation of these quantities over the field of the model. Engineering Mathematics, Strength of Materials, Theory of Elasticity, Metrology & Measurements are prerequisite for this course.*

**Course Objective**:

- To Describe variety of strain gauges, mounting techniques and strain gauge circuits and calculate strain using strain gauge rosettes.
- To explain the nature of light and process of polarization.
- To explain different methods of 2 D photo-elasticity along with properties of different materials for strain measurement.
- To describe the different methods of 3D photo elasticity for strain measurement stress fringe, and Moirés method.

**Unit I** **8L**

**Light and Optics as Related to Photo Elasticity**: Behavior of light, polarized light, plane polarizers, wave plates, conditioning of light by a series combination of a linear polarizer and a wave plate, arrangement of the optical elements in polariscope, construction details of diffused light and lens type polariscopes, lens formulas.

**Theory of Photo elasticity**: The stress optic law in two dimensions at normal incidence, effects of stress model in plane polariscope, effects of a stressed model in a circular polariscope – Dark field and light field, photoelastic photography, fringe multiplication by photographic methods, fringe sharpening with partial mirrors, fringe multiplication with partial mirrors.

**Learning outcomes:**

At the end of this unit, the student will be able to

- Utilize the concepts of light at different conditions. [**L3**]
- analyze photoelastic effects [**L4]**
- make use of stress optic law[**L3]**

**Unit II** **9L**

**Photo elastic Model Materials for Two Dimensional Applications**: Criteria for selection of model materials, properties of commonly employed photo elastic materials, calibration methods.

**Analysis Techniques**: Isochromatic fringe patterns, Isoclinic fringe patterns, compensation techniques, separation techniques, scaling model to prototype stresses.

**Learning outcomes:**

At the end of this unit, the student will be able to

- calibrate for photo elastic materials [**L2]**
- analyze different fringe patterns[**L4]**

- understand selection of material [**L2]**

**Unit III** **10L**

**Three Dimensional Photoelasticity**: Locking in model deformations, materials for three dimensional photoelasticity, slicing the model and interpretation of the resulting fringe patterns, effective stresses, the shear difference method in three dimensions.

**Application of Photoelastic Methods**: Stresses about a circular hole near the edge of uniformly loaded half plane, photoelastic analysis of a reactor closure head, dynamic stress distribution on the boundary of a circular hole in a half plane.

**Learning outcomes:**

At the end of this unit, the student will be able to

- determine the fringe patterns[**L3]**
- analyze the circular hole in a half plane[**L4]**
- identify the Stresses at different boundary conditions for circular hole[**L2]**

**Unit IV** **8L**

**Introduction to Strain Measurements**: Definition of strain and its relation to experimental determinations, basic characteristics of a strain gage, types of strain gage, Moire method of strain analysis, grid method of strain analysis.

**Electrical resistance strain gages:** Factors producing strain sensitivity in metallic alloys, Gage construction, Temperature compensation, factors influencing gage selection, Gage sensitivity and gage factors, corrections for transverse strain effects, Semi conductor strain gages.

**Learning outcomes:**

At the end of this unit, the student will be able to

- make a use the Principles of measurement & Electrical resistance strain gage and related materials for gage construction[**L3]**
- analyze Different strain measuring instruments[**L4]**
- apply the Principle of photo elasticity and related techniques for stress measurements [**L3]**

**Unit V** **8L**

**Rosette Analysis**: Three element rectangular rosette, Delta rosette, four element rectangular rosette, four element tee-delta rosette, Stress gage.

**Strain Gage Circuits**: The potentiometer and its applications to strain measurement, range and sensitivity of the potentiometer circuit, temperature compensation and signal addition in the potentiometer circuit, potentiometer output, load effects on the potentiometer circuit, the Wheatstone bridge, Wheatstone bridge sensitivity, null balance bridges, commercial strain indicators, criteria for circuit selection.

**Recording Instruments**: The galvanometer and oscillograph, transient response of galvanometers, response of galvanometer to a sinusoidal signal, the Wheatstone bridge and the galvanometer, frequency response of the Wheatstone bridge and galvanometer system, Wheatstone bridge and galvanometer circuits, the cathode ray oscilloscope, potentiometer recorder.

**Learning outcomes:**

At the end of this unit, the student will be able to

- understand the Principles of measurement & recording instruments[**L2]**
- analyze 3element &4 element rosette, strain gages[**L4]**
- apply the principle of photoelasticity and related techniques for stress measurements[**L3]**

**Text Book(s):**

1. Dally,J.W., and Riley, W.F., Experimental Stress Analysis, 4/e, McGraw-Hill Inc. , 2005.

**References:**

1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., Experimental Stress Analysis,Tata McGraw-Hill, 1984.
2. Hetyenyi M., Hand book of Experimental Stress Analysis, John Wiley and Sons Inc., 1972.

**Course Outcomes**

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

- understand the overall concepts of stress/strain analysis by experimental means. **[L1]**
- familiar with the theory and practice of common experimental stress analysis Methods including moire methods, photo elasticity**[L2]**
- acquire the knowledge on Brittle and birefrigent coatings and working of strain gauges. **[L2]**
- analyze Different strain measuring instruments[**L4]**
- apply the principle of photoelasticity and related techniques for stress measurements[**L3]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | | | | 1 | | 2 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | 2 | 2 | | 1 | | | | 1 | | 2 | | | 1 | 1 | |
| CO3 | 1 | | 1 | | 1 | | | | 1 | | 2 | 1 | 2 | 2 | 1 | | 1 |
| CO4 | 1 | | 1 | | 1 | 1 | | | | | 1 | | 1 | | 1 | | 1 |
| CO5 | | 1 | | 1 | | 1 | | | 1 | | 1 | 1 | | 1 | | | 1 |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME742: OPTIMIZATION METHODS IN ENGINEERING

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course is exposes the evaluation of best possible solution for various engineering planning and design problems. The aim of the course is to train the students to develop a mathematical model and to solve the model by applying an appropriate mathematical programming technique. This course covers all advanced optimization techniques like geometric, dynamic, integer, stochastic and unconventional optimization techniques.*

**Course Objectives**

- To illustrate the importance of advanced optimization techniques in theory and practice.
- To formulate and solve engineering design problems in the industry for optimal results
- To test the analytical skills in solving realistic engineering problems by applying appropriate optimization technique.
- To demonstrate various advanced and unconventional optimization techniques being developed in recent times.
- To develop and promote research interest in problems of Engineering and Technology

**Unit I** **8L**

**Geometric programming (G.P):** Unconstrained minimization problem, Solution of an unconstrained geometric programming, differential calculus method and arithmetic method, Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P), Complementary Geometric Programming, constrained minimization.

**Learning Outcomes:**

At the end of this Unit, the student will be able to

- formulate the geometric programming problem [**L3**]
- evaluate the optimal solution to geometric programming problem[**L4**]

**Unit II** **8L**

**Dynamic programming (D.P):** Multistage decision processes, Concepts of sub optimization, computational procedure in dynamic programming calculus method and tabular methods. Linear programming as a case of D.P and Continuous D.P.

**Learning Outcomes:**

At the end of this Unit, the student will be able to

- formulate the given linear/non-linear programming problem as a dynamic programming problem[**L3**]
- evaluate the optimal solution to dynamic programming problems using multi-stage decision process [**L4]**

**Unit III** **9L**

**Integer programming (I.P):** Integer linear programming, Graphical representation, Gomory's cutting plane method, Bala's algorithm for zero-one programming problem, Integer nonlinear programming, Branch-and-bound method, sequential linear discrete programming, generalized penalty function method

**Learning Outcomes:**
At the end of this Unit, the student will be able to

- formulate the integer and/or binary programming problem [**L3**]
- evaluate the optimal solution to integer and/or binary programming problem [**L4**]

**Unit IV** **8L**

**Stochastic Programming (S.P):** Basic concepts of Probability Theory, Stochastic linear programming, stochastic non-linear programming.

**Learning Outcomes:**
At the end of this Unit, the student will be able to

- define random variables and formulate thestochastic programming problem [**L1&L3**]
- analyze the optimal solution to given problem under uncertainty [**L4**]

**Unit V** **9L**

**Unconventional optimization techniques:** Multi-objective optimization - Lexicographic method, Goal programming method, Genetic algorithms, Simulated Annealing, Neural Networks based Optimization.

**Learning Outcomes:**
At the end of this Unit, the student will be able to

- formulate themulti-variable optimization problem [**L3**]
- evaluate the optimal solution to multi-variable optimization problem [**L4]**

**Text Book(s):**

1. Rao S.S., Engineering Optimization - Theory and Practice, 3/e, New Age International (P) Ltd. Publishers, 1996.

**References:**

1. Ravindran, Phillips and Solberg, Operations Research- Principles and Practice, 2/e, John Wiley, 2007.
2. Hiller and Lieberman, Introduction to Operations Research, 7/e, McGraw Hill, 2002.
3. James P. Ignizio, Goal Programming and Extensions, 2/e, Lexigton Books, 1976.
4. David E. Goldberg, Genetic Algorithms - In Search, Optimization and Machine Learning, 1/e, Addison-Wesley Longman (Singapore) Pvt. Ltd., 1989.

**Course Outcomes:**
After the successful completion of this course, the students will be able to

- formulate and solve geometric programming problems (**L4&L3**)
- solve any complex optimization problem as a dynamic programming problem and analyze its solution (**L3&L4**)
- recognize the significance of integer and/or binary solutions and apply suitable algorithm for better decision making (**L1&L3**)
- formulate and solve stochastic optimization problems for decision making under uncertainty (**L4&L3**)
- formulate and solve multi-objective optimization problems; to propose various modern unconventional optimization techniques. (**L4&L3**)

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | 1 | 1 | 1 | | | | 1 | | 2 | | 1 | 1 | 2 | | 1 |
| CO2 | | 1 | 1 | 1 | | 1 | | | | 1 | | 1 | | | | 2 | |
| CO3 | 1 | | | | 1 | | | | 1 | | | 2 | 1 | 2 | 1 | | 1 |
| CO4 | 2 | 1 | 2 | 2 | 2 | 1 | | | | | 1 | 1 | | | | 2 | |
| CO5 | | 2 | 1 | 1 | | 1 | | | | 1 | | | | 1 | | | 1 |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME744: FRACTURE MECHANICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*The course covers the basic aspects of failures that triggered the birth of fracture mechanics, Modes of loading, Classification as linear elastic fracture mechanics, elastic plastic fracture mechanics, Crack growth and fracture mechanisms, Energy release rate, Resistance, Griffith theory of fracture, extension of Griffith theory by Irwin and Orowan and R-Curve. Necessary and sufficient conditions for fracture, Stress and Displacement fields in the very near and near-tip fields, Westergaard, Williams and generalized Westergaard solutions, various methods for evaluating Stress Intensity Factors, Modeling plastic zone at the crack-tip, Irwin and Dugdale models, Fracture toughness testing, Paris law, J-integral and Mixed-mode fracture, Crack arrest methodologies.*

**Course Objectives**

- Introduce the physical and mathematical principles of fracture mechanics and their applications in wide range of engineering design.
- Analyze linear and nonlinear fracture mechanics principles and their applications to structural design.
- Expose the concepts of experimental methods to determine the fracture toughness and develop the students understanding on the design principle of materials and structures using fracture mechanics approaches.
- Expose the concepts of fatigue crack propagation by different methods.

**Unit I** **8L**

**Fundamental Concepts**: Introduction, Historical perspective, Linear Elastic Fracture Mechanics, An Atomic View of Fracture, Stress Concentration Effect of Flaws, The Griffith Energy Balance, The Energy Release Rate, Instability and the R Curve, Stress Analysis of Cracks, Relationship between K and G, Crack-Tip Plasticity, K-Controlled Fracture, Plane Strain Fracture, Mixed-Mode Fracture, Interaction of Multiple Cracks.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- recognize the significance of Linear Elastic Fracture Mechanics in design.[**L1**]
- estimate fracture by different theories.[**L3**]

**Unit II** **9L**

**Elastic-Plastic Fracture Mechanics**: Crack-Tip-Opening Displacement, The J Contour Integral, Relationships Between J and CTOD, Crack-Growth Resistance Curves, Controlled Fracture, Crack-Tip Constraint Under Large-Scale Yielding. **Dynamic and Time-Dependent Fracture**: Dynamic Fracture and Crack Arrest, Creep Crack Growth, Viscoelastic Fracture Mechanics.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- identify Crack-Tip-Opening Displacement.[**L1**]
- estimate Crack-Tip by different theories.[**L3**]

**Unit III** **9L**

**Fracture Mechanisms in Metals**: Ductile Fracture, Cleavage, the Ductile-Brittle Transition, Intergranular Fracture. **Fracture Mechanisms in Nonmetals**: Engineering Plastics, Ceramics and Ceramic Composites,

Microcrack Toughening, Concrete and Rock.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- identify Fracture Mechanisms in Metals and non-Metals.[**L1**]
- investigate Ductile-Brittle Transition in metals and non-Metals.[**L3**]

**Unit IV** **8L**

**Fracture Toughness Testing of Metals**: General Considerations, $K_{Ic}$ Testing, K-R Curve Testing, J Testing of Metals, CTOD Testing, Dynamic and Crack-Arrest Toughness, Fracture Testing of Weldments, Testing and Analysis of Steels in the Ductile-Brittle Transition Region, Qualitative Toughness Tests. **Fracture Testing of Nonmetals**: Fracture Toughness Measurements in Engineering Plastics, Precracking and Other Practical Matters, Interlaminar Toughness of Composites, Ceramics.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- recognize the General Considerations for Fracture Toughness measurement. [**L1**]
- compute fracture Toughness by experimental testing methods in metals and non-Metals.[**L3**]

**Unit V** **9L**

**Application to Structures**: Linear Elastic Fracture Mechanics, The CTOD Design Curve, Elastic-Plastic J-Integral Analysis, Failure Assessment Diagrams, Probabilistic Fracture Mechanics.

**Fatigue Crack Propagation**: Similitude in Fatigue, Empirical Fatigue Crack Growth Equations, Crack Closure, The Fatigue Threshold, Variable Amplitude Loading and Retardation, Growth of Short Cracks, Micro-mechanisms of Fatigue, Fatigue Crack Growth Experiments, Damage Tolerance Methodology.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- apply Fracture theories to the Structures. [**L3**]
- compute Crack Propagation by different theories.[**L3**]

**Text Book(s):**


1. T.L. Anderson, Fracture Mechanics: Fundamentals and Applications, 3/e, CRC Press, Florida, 2005.


**References:**


1. D. Broek, Elementary Engineering Fracture Mechanics, 3/e, Martinus Nijhoff, 1982.
2. D. Broek, The Practical Use of Fracture Mechanics, Kluwer Academic Publishers, 1989.
3. R. W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, 5/e, John-Wiley & Sons, 2012.
4. J.M. Barsom and S.T. Rolfe, Fracture and Fatigue Control in Structures: Applications of fracture mechanics, 3/e, ASTM International, 1999.
5. A. F. Liu, Mechanics and Mechanisms of Fracture: An Introduction, 2/e, ASTM International, 2005.


**Course Outcomes**
After the successful completion of this course, the students will be able to

- predict material failure for any combination of applied stresses.**[L2]**
- estimate failure conditions of a structure. **[L3]**

- investigate Ductile-Brittle Transition in metals and non-Metals.[**L3**]

- determine the stress intensity factor for simple components of simple geometry**[L3]**
- predict the likelihood of failure of a structure containing a defect. **[L2]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | | | | 1 | | 2 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | 1 | 2 | | 2 | | | | 1 | | 1 | | | | 2 | |
| CO3 | 1 | | | | 1 | | | | 1 | | | 2 | 2 | 2 | 1 | | 1 |
| CO4 | 2 | 1 | 2 | 1 | 1 | 1 | | | | 1 | 1 | 1 | | | | 1 | |
| CO5 | 1 | | 1 | | 1 | | | | | | 1 | 1 | 1 | | | 1 | 1 |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME746: TRIBOLOGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course exposes the students to friction, lubrication and wear of different materials. This course allows identifying different mechanisms of wear, designing bearings and different types of lubrication and their properties.*

**Course Objectives**

- Familiarize different mineral oils and their properties.
- Introduce elasto hydrodynamic lubrication.
- Explain different wear mechanisms.
- Analyze loads, stresses and deformations in bearings.
- Explain the effects of friction on wear.

**Unit I** **8L**

Historical background - Viscosity - Viscometry - Effect of temperature on viscosity - Effect of pressure in viscosity - Other physical properties of mineral oils - The generalized Reynolds equation - Flow and shear stress - The energy equation - The equation of state - Mechanism of pressure development.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- explain properties of oils. [**L1**]
- identify the mechanism of pressure development. [**L3**]

**Unit II** **10L**

Circumferential flow - Oil flow through a bearing having a circumferential oil groove - Heat generation and lubricant temperature - Heat balance and effective temperature - Bearing design: Practical considerations - Design of journal bearings - Parallel surface bearing - Step bearing - Some situations under squeeze film lubrication - The mechanism of hydrodynamic instability - Stiffness and damping coefficients - Stability.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- design suitable journal bearing for various applications. [**L4**]
- analyze the stability of hydrodynamic journal bearing. [**L4**]

**Unit III** **9L**

**Elasto hydrodynamic lubrication**: Theoretical consideration - Grubin type solution - Accurate solution - Point contact - Dimensionless parameters - Film thickness equations - Different regimes in EHL contact - Deep-groove radial bearings - Angular contact bearings - Thrust ball bearings - Geometry - Kinematics - Stress and deformations - Load capacity.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- identify regimes of elastohydrodynamic lubrication. [**L2**]
- analyze stress and deformations in bearings.[**L4**]

**Unit IV** **8L**

Surface topography - Surface characterization - Apparent and real area of contact - Derivation of average Reynolds equation for partially lubricated surface - Effect of surface roughness on journal bearings

**Learning Outcomes:**

At the end of this unit, the student will be able to

- identify apparent and real area of contact. [**L2**]
- analyze the **e**ffect of surface roughness on journal bearings.[**L4**]

**Unit V** **9L**

Laws of friction - Friction theories - Surface contaminants - Frictional heating - Effect of sliding speed on friction - Classification of wear - Mechanisms of wear - Quantitative laws of wear - Wear resistance materials.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- comprehend the concept of friction.[**L2**]
- identify wear resistance materials. [**L1**]
- analyze wear mechanisms.[**L4**]

**Text Book(s):**

1. B.C. Majumdar, Introduction to Tribology of Bearings, 2/e, S Chand &Company Ltd., 2012.

**References:**

1. Alistair Cameron, Basic Lubrication Theory, 3/e, John Wiley & Sons, 1981
2. Gwidon W. Stachowiak and Andrew W. Batchelor, Engineering Tribology, 4/e, Elsevier, 2013.
3. Bernard J. Hamrock, Steven R. Schmid and Bo O. Jacobson, Fundamentals of Fluid Film Lubrication, 2/e, CRC Press, 2014.
4. Earnest Rabinowicz, Friction and Wear of Materials, 2/e, John Wieley& Sons, 1995.

**Course Outcomes:**

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

- identify the most suitable oils for application to gears, bearings, etc. [**L3**]
- calculate stress and deformations in bearings. [**L3**]
- estimate laod rating capacity of bearings **[L3**]
- analyze various failure theories **[L4]**
- analyze different wear mechanisms. [**L4**]

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | | 2 | | | | | | | | 2 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 2 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME748: SIGNAL ANALYSIS AND CONDITION MONITORING

**L T P C**
**3 0 0 3**

**Course Description:**

*The course covers the fundamentals of signal analysis, starting from the basic concepts, and gives an introduction to Fast Fourier Transform (FFT) as a diagnostic technique. Also study the process of monitoring a parameter of condition in machinery (vibration, temperature etc.), in order to identify a significant change which is indicative of a developing fault.*

**Course Objectives**

- Explain the basics of signal types signal analysis equipments.
- Explainthe Practical analysis of stationary signals
- Explain the Practical analysis of continuous non-stationary signals.
- Explain the Practical analysis of transients.
- Explain Condition monitoring in real systems

**Unit I** **10L**

**Introduction:** Basic concepts, Fourier analysis, Bandwidth, Signal types, Convolution.
**Signal analysis:** Filter response time, Detectors, Recorders, Analog analyzer types.
**Learning Outcomes:**
At the end of this unit, the student will be able to

- study the fundamentals of signal.[**L1**]
- analyze the signal using various equipment**[L4]**

**Unit II** **8L**

**Practical analysis of stationary signals**: Stepped filter analysis, Swept filter analysis, High speed analysis, Real-time analysis.
**Learning Outcomes:**
At the end of this unit, the student will be able to

- study the fundamentals of stationary signals.[**L1**]
- analyze the stationary signals using various filters **[L4]**

**Unit III** **9L**

**Practical analysis of continuous non-stationary signals**: Choice of window type, Choice of window length, Choice of incremental step, Practical details, Scaling of the results.
**Learning Outcomes:**
At the end of this unit, the student will be able to

- study the fundamentals of continuous non-stationary signals.[**L1**]
- analyze the continuous non-stationary signals using various Choices **[L4]**

**Unit IV** **8L**

**Practical analysis of transients**: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth), Analysis by repeated playback (variable bandwidth).
**Learning Outcomes:**
At the end of this unit, the student will be able to

- study the fundamentals of periodic signal.[**L1**]

- analyze the periodic signal using various bandwidth **[L4]**

**Unit V** **9L**

**Condition monitoring in real systems**: Diagnostic tools, Condition monitoring of two stage compressor, Cement mill foundation, I.D. fan, Sugar centrifugal cooling tower fan, Air separator, Preheater fan, Field balancing of rotors, ISO standards on vibrations.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- identify the Diagnostic tools.[**L1**]
- monitor the condition of various real time equipment**[L3]**

**Text Book(s):**

1. R. Collacott, Mechanical Fault Diagnosis and condition monitoring, 1977 edition, Springer, 2011.

**References:**

1. R.B.Randall, Frequency Analysis, 3/e, BruelKjaer, 1987.
2. V. Ramamurti, Mechanical Vibrations Practice with Basic Theory, 3/e, Narosa Publishing House, 2002.

**Course Outcomes:**

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

- obtain a basic understanding of the signal and types of signals. [**L1**]
- analyze various types of signals to identify faults in real type mechanical systems [**L4]**
- Understand practical analysis of transients. [**L1**]
- analyze the signals using various filters [**L3**]
- perform condition monitoring of various systems [**L4**]

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | | 2 | | | | | | | | 2 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 2 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 2 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME752: ADVANCED FINITE ELEMENT ANALYSIS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course exposes the students to deal with various modeling techniques and uses different numerical methods for solving a system of governing equations over the domain of a continuous physical system, which is discredited into simple geometric shapes called finite element. This course also capitalize on knowledge of linear and non-linear analysis.*

**Course Objectives:**

- Introduce basic principles of finite element analysis procedure
- Discuss the theory and characteristics of finite elements that represent engineering structures
- Demonstrate finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses performed by others
- Familiarize the students in modeling complex geometry problems and solution techniques.
- Impart advanced FEA knowledge and techniques for solving complex problems in engineering.

**Unit I** **9L**

**Introduction**: Mathematical models, numerical simulations, finite element method, nonlinear analysis. **The Finite Element Method-A Review**: Introduction, one dimensional problems, two dimensional problems, library of two dimensional finite elements, numerical integration, computer implementation

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the significance of FEM **[L1]**
- comprehend the concept of numerical integeration **[L3]**

**Unit II** **9L**

**Heat Transfer and other Field Problems in One Dimension**: Model differential equations, weak formulation, finite element model, solution procedure, computer implementation.

**Nonlinear Bending of Straight Beams:** Introduction, Euler-Bernoulli beams, Timoshenko beams.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the significance of weak and strong formulation **[L1]**
- comprehend the concept of Non-Linear problems **[L3]**

**Unit III** **10L**

**Heat Transfer and other Field Problems in Two Dimensions**: Model equations, weak form, finite element model, solution procedures, computer implementation. **Nonlinear Bending of Elastic Plates**: Introduction, classical plate theory, variational formulation of PPT, finite element models of PPT, computer implementation aspects and numerical results of PPT elements, first order shear deformation plate theory, finite element models of FSDP, computer implementation aspects and numerical results of FSDP elements, theory of doubly curved shells, finite element analysis of shells.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- comprehend the concept of Heat transfer in FEM **[L2]**
- analyze the plates and double curved shells**[L4]**
- interpret numerical results of FSDP. **[L2]**

**Unit IV** **10L**

**Flows of Viscous Incompressible Fluids**: Introduction, governing equations, governing equations in terms of primitive variables, velocity-pressure finite element model, penalty finite element model, computational aspects, computer implementation, numerical examples, least square finite element models. **Nonlinear Analysis of Time-Dependent Problems**: Introduction, time approximations, stability and accuracy, transient analysis of non-linear problems, computer implementation, numerical examples

**Learning Outcomes:**

At the end of this unit, the student will be able to

- comprehend the concept of viscous Incompressible Fluids **[L2]**
- acquaint with concept of transient analysis**[L2]**

**Unit V** **10L**

**Finite Element Formulations of Solids and Structures**: Introduction, strain and stress measures, strain and stress measures between configuration, constitutive equations, total Langrangian and update Langrangian formulations of continua, finite element models of two dimensional models of continua, shell finite element.

**Material Nonlinearities and Coupled Problems**: Introduction, nonlinear elastic problems, small deformation theory of plasticity, non-newtonial fluids, coupled fluid flow and heat transfer.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understand the significance of stress and strain **[L1]**
- comprehend the concept of nonlinear elastic problems **[L2]**
- analyze the non-newtonialand coupled fluid flow problems **[L4 & L5]**

**Text Book(s):**

1. J. N. Reddy, An Introduction to Nonlinear Finite Element Analysis, 2/e, Oxford University press, 2004.

**References:**

1. T. Belytschko,W. K. Liu, and B. Moran,Nonlinear Finite Elements for Continua and Structures, 1/e, JohnWiley and Sons, 2000.
2. J. C. Simo and T. J. R. Hughes, Computational Inelasticity, 1/e, Springer, 1998.
3. T. J. R. Hughes, The Finite Element Method: Linear Static and Dynamic Finite Element Analysis, Dover Publications, 2000.

**Course Outcomes**

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

- gain knowledge to have a clear understanding of how to solve basic real-world problems **[L1]**

- comprehend the solution path to engineering problems. **[L2]**
- make suitable boundary conditions to a global structural equation, and reduce it to a solvable form.**[L5]**
- identify how the finite element method expands beyond the structural domain, for problems involving dynamics, heat transfer, and fluid flow**[L2]**
- apply the theoretical FEA concepts in solving simple to complex non-linear FEA problems using advanced software. **[L3]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 2 | | 1 | 2 | 1 | | 1 |
| CO2 | | 2 | | 2 | | | | | | | | 2 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 2 | 1 | 1 | | 2 |
| CO4 | 1 | 1 | 1 | 1 | 2 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 2 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME754: PRODUCT DESIGN

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*Innovation, improvements, and expansion of new technologies have led Product Design and Manufacturing as a compelling field for the students. Managing the product development process, right from idea generation, conceptualization, designing for strength, aesthetic, manufacturing and to fabrication of final product has to be systematic and effective to meet the customer needs, while incorporating the time-to-market constraint as well. This course presents an overview of the product design and development process, along with the manufacturing systems aspects. The concepts of failure theories for assisting the design for strength, design for manufacturing, assembly, and environment for development, costing and manufacturing would help the students and practitioners learn to conceptualize, design, test and manufacture competitively-priced quality products.*

**Course objectives**

- To introduce design process for a complete product.
- To familiarize static and fatigue failure theories.
- To explore various techniques for concept generation, concept selection and testing.
- To present design methodologies for various manufacturing processes.
- To explain human engineering considerations involved in designing a product.

**Unit I** **10L**

**Design philosophy**: Design process, Problem formation, Introduction to product design, various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability.

**Learning Outcomes:**

After completion of the unit, the student should be able to

- understand the process of design **[L1]**
- express the various product design models **[L3]**
- outline the concept of creativity and creativity techniques **[L3]**
- design and analyze the product for safety and reliability **[L5]**

**Unit II** **10L**

**Failure theories**: Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory. Fatigue failure theories, Fatigue mechanisms, Fatigue failure models, Fatigue failure criteria, Methods to reduce fatigue, Design for fatigue, Modified Goodman Diagram, Gerber method, Soderberg line, Surface failure models, Lubrication, friction and wear.

**Learning Outcomes:**

After completion of the module, the student should be able to

- understand the difference between various static failure prediction theories. **[L1]**
- design the components subjected fatigue loads **[L5]**
- outline the various surface failure models **[L3]**
- express the importance of lubrication to avoid different wear failures. **[L5]**

**Unit III** **8L**

**Product Design**: Product strategies, Product value, Product planning, Product specifications, Concept generation, Concept selection, Concept testing.

**Learning Outcomes:**

After completion of the unit, the student should be able to

- understand the various strategies for designing a product **[L1]**
- express the value of a product and its specifications **[L3]**
- generate the concept for a particular need **[L4]**
- test the concept for the need. **[L5]**

**Unit IV** **8L**

**Design for manufacturing**: Forging design, Casting design, Design process for non-metallic parts-Plastics, Rubber, Ceramic, Wood and Glass.

**Learning Outcomes:**

After completion of the unit, the student should be able to

- express various factors to be considered for forging and casting designs**[L2]**
- outline the design process for non-metallic parts **[L3]**
- understand the behavior of various materials during fabrication **[L3]**

**Unit V** **9L**

**Economic factors influencing design**: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design.

**Learning Outcomes:**

After completion of the unit, the student should be able to

- analyze the economics involved in a product fabrication **[L4]**
- select the material for a product designed to a particular need **[L3]**
- outline the manufacturing process **[L3]**
- express the various modern approaches in product design. **[L1]**

**Text Book(s):**

1. A.K. Chitale, R.C. Gupta,Product Design and Manufacturing, 4/e, Prentice Hall, 2007.

**References:**

1. Joseph Shigley, Mischke, Mechanical Engineering Design, 6/e, Tata McGraw Hill, 2004.
2. R.L. Norton, Machine Design - An Integrated Approach, 5/e, Prentice Hall, 2012.
3. Karl T. Ulrich, Steven D. Eppinger, Product design and development, 3/e, Tata McGraw Hill, 2003.

**Course outcomes:**

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

- acquaint the static and fatigue failure theories**.[L2]**
- conceptualize and customize the product for the need. **[L2]**
- design the product for manufacturing. **[L5]**
- understand the behavior of various materials during fabrication **[L3]**

- carryout break even analysis for a product. **[L3]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | | 2 | | | | | | | | 2 | | | | 2 | |
| CO3 | 1 | | 1 | | 2 | 1 | | | 1 | | | 1 | 2 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 2 | | | | 1 | |
| CO5 | | 2 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME756: VEHICLE DYNAMICS

**L T P C**
**3 0 0 3**

**Course Description:**

*When engineers design vehicles, they are likely to encounter competing demands relating to dynamics and stability. This course will teach you how engineers analyze vehicle dynamics in performance, handling and ride modes. Mastery of these techniques will enable you to better predict dynamic behaviour of a vehicle, and thus reconcile competing demands inherent in the design of vehicles.*

**Course Objectives**

- Describe, investigate and analyze complex engineering systems and associated issues (using systems thinking and modelling techniques)
- Develop creative and innovative solutions to engineering problems
- Comprehend and apply advanced theory-based understanding of engineering fundamentals and specialist bodies of knowledge in the selected discipline area to predict the effect of engineering activities
- Apply underpinning natural, physical and engineering sciences, mathematics, statistics, computer and information sciences.
- Understand the scope, principles, norms, accountabilities and bounds of contemporary engineering practice in the specific discipline

**Unit I** **8L**

**Introduction to Vehicle Dynamics**: Various kinds of vehicles, Motions, Mathematical modeling methods, Multi body system approach, Lagrangian formulations, Methods of investigations, Stability concepts.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- develop physical and mathematical models to predict the dynamic response of vehicles. **[L1]**
- apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response. **[L3]**

**Unit II** **10L**

**Mechanics of pneumatic tyres**: Tyre construction, SAE recommended practice, Tyre forces and moments, rolling resistance of tyres, Tractive effort and longitudinal slip, Cornering properties of tyres, Performance of tyre traction on dry and wet surfaces, Ride properties of tyres.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- extend the mathematical analysis of the passenger car to heavy vehicles.**[L3]**
- be familiar with the terminology of road vehicle dynamics, stability and handling.[**L1]**

**Unit III** **9L**

**Performance characteristics of road vehicle**: Equation of motion and maximum tractive effort, Aerodynamic forces and moments, Vehicle power plant and transmission characteristics, Prediction of vehicle performance, Operating fuel economy, Braking performance.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- develop and implement computer models of vehicle dynamics behaviour and critically analyse results from numerical simulations.**[L2]**
- be able to analyse the dynamics of road vehicles.**[L2]**

**Unit IV** **9L**

**Handling and stability characteristics of road vehicles**: Steering geometry, Steady state handling characteristics, Steady state response to steering input, Testing of handling characteristics, Transient response characteristics, Directional stability, Effects of tyre factors, Mass distribution and engine location on stability of handling.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- develop and implement computer models of vehicle dynamics behaviour and critically analyse results from numerical simulations.**[L1]**
- modify a model of a vehicle to enable it to meet design performance criteria **[L3]**

**Unit V** **9L**

**Vehicle ride characteristics**: Human response to vibration, Vehicle ride models, Introduction to random vibration – Road surface profile as a random function, Frequency response function, Evaluation of vehicle vertical vibration in relation to ride comfort criteria, Active and semi active systems, Optimum design for ride comfort and road holding.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- characterize changes in vehicle performance and vehicle/roadway interaction. **[L2]**
- understand the techniques used to engineer safety in to vehicles.**[L1]**
- understand the evaluation of vehicle safety using crash data. **[L1]**

**Text Book(s):**

1. Wong, J.Y., Theory of Ground Vehicles, 4/e, John Wiley and Sons, 2008.

**References:**

1. Gillespie, T.D.,Fundamentals of Vehicle Dynamics, SAE Publication, 1992.
2. Dixon, J.C., Tyres, Suspension and Handling, SAE Publication, 2/e, Warrendal, USA and Arnold Publication, 1996.

**Course Outcomes:**

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

- develop physical and mathematical models to predict the dynamic response of vehicles. **[L1]**
- be familiar with the terminology of road vehicle dynamics, stability and handling.[**L1]**
- develop and implement computer models of vehicle dynamics behaviour and critically analyze results from numerical simulations.**[L2]**
- characterize changes in vehicle performance and vehicle/roadway interaction. **[L2]**
- understand the evaluation of vehicle safety using crash data. **[L1]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | 2 | 1 | 1 | 1 | | | 1 | | 2 | | 1 | 1 | 1 | | 1 |
| CO2 | | 2 | | 2 | | | | | | | | 2 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 2 | 1 | 2 | | 2 |
| CO4 | 2 | 1 | 2 | 1 | 2 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 2 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME758: MECHANICAL BEHAVIOUR OF MATERIALS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This is an advanced course to the subject taught at UG level that provides better understanding on material response upon subjected to different loading conditions. It has all the concept to understand fatigue, creep and fracture. As a Mechanical Engineer it is suggested to opt for this course for a brief understanding computational method in Mechanical system from a Material Property Point of view.*

**Course Objectives**

- Explains the structural effect of material that affects mechanical properties.
- Comprehension of the defects inside the structure and their effects on the mechanical properties
- Understanding of failure mechanisms in ductile and brittle material
- Basics of elastic and Plastic deformation of material under uniaxial loading conditions
- A brief idea about cyclic loading and cause of fatigue failure

**Unit I** **9L**

**Introduction to deformation behaviour**: Concept of stresses and strains, engineering stresses and strains. **Elasticity Theory**: The State of Stress and strain, stress and strain tensor, tensor transformation, principal stress and strain, elastic stress-strain relation, anisotropy, elastic behavior of metals, ceramics and polymers.

**Learning Outcomes:**

At the end of this unit, the student will be able to

- understands the concept of stress and strain in Brittle and Ductile materials [**L1**]
- recognizes the stress tensors [**L1**]
- basics of Material behavior in Metals, Ceramics and Polymers [**L1**]

**Unit II** **8L**

**Yielding and Plastic Deformation**: Hydrostatic and Deviatoric stress, Octahedral stress, yield criteria and yield surface, texture and distortion of yield surface, Limitation of engineering strain at large deformation, true stress and true strain, effective stress, effective strain, flow rules, strain hardening, Ramberg- Osgood equation, stress - strain relation in plasticity, plastic deformation of metals and polymers

**Learning Outcomes:**

At the end of this unit, the student will be able to

- recognizes the concepts of plastic deformation in materials [**L3**]
- understandings of stress-strain curve for brittle and ductile material [**L1**]
- basics of strain hardening and study of plasticity [**L3**]

**Unit III** **8L**

Different types of loading and temperature encountered in applications, Tensile Test- stress – strain response for metal, ceramic and polymer, elastic region, yield point, plastic deformation, necking and fracture. Effect of strain rate on flow properties, Effect of Temperature on flow properties. Engineering stress-strain curve, True stress-true strain curve. Hardness/Indentation test- Types of indenter, hardness test,Knoop, Vickers, Brinell, Rockwell, Load~displacement curve obtained during

instrumented indentation and their analysis.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- recognizes the process of Tensile testing (Metals and Alloys), effect of tensile parameters[**L-1**]
- basic understanding of Failure and Fracture in materials [**L2**]
- concept of Indentation technique to evaluate hardness [**L2**]

**Unit IV** **8L**

**Microscopic view of plastic deformation**: crystals and defects, classification of defects, thermodynamics of defects, geometry ofdislocations, slip and glide, dislocation generation - Frank Read and grain boundary sources, stress and strain field around dislocations, force on dislocation - self-stress, dislocation interactions, partial dislocations, twinning, dislocation movement and strain rate, deformationbehavior of single crystal, critical resolved shear stress (CRSS),deformation of poly-crystals - Hall-Petch and other hardening mechanisms, grain size effect - source limited plasticity, Hall- Petch breakdown.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- recognizes the effect of crystal defects on mechanical behavior of materials [**L1**]
- basic understandings of interaction of dislocation with planes [**L1**]
- analysis of Hall-Petch equation with respect to grain size [**L4**]

**Unit V** **8L**

**Fracture**: fracture in ceramics, polymers and metals, different types of fractures in metals, fracture mechanics – Linear fracture mechanics –$K_{IC}$, Deformation under cyclic load - Fatigue: S-N curves, Low and high cycle fatigue, Life cycle prediction, Fatigue in metals, ceramics and polymers. **Deformation at High temperature**: Time dependent deformation - creep, different stages of creep, creep and stress rupture, creep mechanisms and creep mechanism maps.

**Learning Outcomes:**
At the end of this unit, the student will be able to

- basic understandings of fatigue (Methods, Sample Preparation and Analysis) [**L2**]
- determination of Fracture toughness and evaluation methods [**L2**]
- basic understandings of creep and time dependent loading [**L3**]

**Text Book(s):**


1. George E. Dieter, Mechanical Metallurgy, Mc Graw Hill, 2/e, 2005.
2. J. E. Dorn, Mechanical behavior of materials at elevated temperatures, McGraw Hill, 2000.


**References:**


1. Hellan K, Introduction to Fracture Mechanics, Mc Graw Hill, 2002.


**Course Outcome:**
Upon successful completion of the course, the students will be able to

- acquiring the basic level knowledge of Materials Science and Engineering Utilizing state of the art techniques in the area of Materials Science and Engineering**. [L1]**

- finding the ways to improve the existing knowledge. **[L1]**
- selecting and utilizing the knowledge of mathematics, science and engineering in order to apply them for the benefits of Materials Science and Engineering. **.[L2]**
- defining and solving the engineering problems related with material characteristics and properties. **.[L1]**
- determination of Fracture toughness and evaluation methods [**L2**]

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 2 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 2 | 1 | 1 | | 2 |
| CO2 | | 2 | | 2 | | | | | | | | 2 | | | | 2 | |
| CO3 | 1 | | 1 | | 2 | 1 | | | 1 | | | 1 | 2 | 1 | 2 | | 1 |
| CO4 | 2 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 2 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME722: COMPUTER AIDED ENGINEERING LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

1. Introduction to Finite Element Analysis software – ANSYS / NISA / Nastran
2. Static Structural Analysis of 1D problems – bars, trusses, beams and frames
3. Static Structural Analysis of 2D problems – plane stress, plane strain, axisymmetric
4. Static Structural Analysis of 3D problems – various brackets
5. Dynamic Structural Analysis of 1D problems – beams and frames
6. Steady State Thermal Analysis of 1D and 2D models
7. Transient Thermal Analysis of 1D and 2D models
8. Couple Field (Thermal/Structural) Analysis

## 19EME724: MECHANICAL ENGINEERING LAB

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

1. To determine the radius of gyration of given bar by using bifilar suspension.
2. Find the CG of a connecting rod using free vibration techniques.
3. To determine natural frequency of free torsional vibrations of single rotor system.
   (a) Horizontal rotor (b) Vertical rotor
4. Harmonic excitation of cantilever beam using electro-dynamic shaker and determination of resonant frequencies.
5. Finding the damping presence in the structure using logarithmic decrement method.
6. Finding the damping presence in the structure using half power band width method.
7. Finding the natural frequencies and mode shapes of cantilever beam.
8. Finding the natural frequencies and mode shapes of plate at different boundary conditions
9. Study of vibration measuring instruments.
10. Applications of photoelasticity: Demonstration of photoelastic techniques.
11. Plane Polariscope

## 19EAC741: ENGLISH FOR RESEARCH PAPER WRITING

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 0 |

**Course Description:**

*This course introduces the student, to the different aspects of research paper writing including planning, preparation, layout, literature review write-up etc. Specifically the perspective and style of writing in different sections of a research paper is highlighted. Students will exposed to English language skills relevant to research paper writing.*

**Course Objectives:**

- To write clearly, concisely and carefully by keeping the structure of the paper in mind.
- To use standard phrases in English and further improve his command over it.
- To write with no redundancy, no ambiguity and increase the readability of the paper.
- To plan and organize his paper by following a logical buildup towards a proper conclusion.
- To decide what to include in various parts of the paper.
- To write a suitable title and an abstract in order to attract the attention of the reader.
- To identify the correct style and correct tense.
- To retain the scientific value of the paper by using minimum number of words.

**Unit I** **5L**

Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

**Learning Outcomes**:

After the completion of this unit, the student will be able to

- To know the expectations of various journals and referees
- To know the typical structure of a paper
- Learn to put words in a sentence in the correct order
- To write short and clear sentences from the very beginning of the paper
- To increase the readability of the paper by making it easy to read and 100% clear
- Learn to be concise without losing any important content
- To avoid some typical grammar mistakes made in research papers

**Unit II** **5L**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction.

**Learning Outcomes**:

After the completion of this unit, the student will be able to

- Learn to make useful contribution worth recommending for publication
- Learn good use of language to make readers notice the key findings
- Learn to anticipate or predict possible objections to the claims made in the paper
- To understand what is plagiarism, and how to paraphrase other people's work
- Learn to attract the right kind of readers with a suitable title

- Learn to sell the abstract to potential readers by attracting their curiosity

**Unit III** **6L**

**Review of the Literature**, Methods, Results, Discussion, Conclusions, The Final Check. key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

**Learning Outcomes**:

After the completion of this unit, the student will be able to

- have a deep knowledge about everything that has been previously written on the topic and decide what is important to know in Introduction.
- Learn to provide the right amount of literature regarding the sequence of events leading up to the current situation in the Literature review

**Unit IV** **6L**

**Writing Skills:** skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

**Learning Outcomes**:

After the completion of this unit, the student will be able to

- Learn to describe the materials used in experiments and/or the methods used to carry out the research
- The key skill is in reporting the results simply and clearly
- Learn to structure the Discussion and satisfy the typical requirements of the referees
- Learn to provide a clear and high-impact take-home message in the conclusion

**Unit V** **6L**

**Good Paper Writing:** Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission.

**Learning Outcomes**:

After the completion of this unit, the student will be able to

- Learn various lists of frequently used phrases that have a general acceptance in all disciplines and use in specific sections of the paper
- Learn various kinds of things one should look for when doing the final check

**Text Book (**s**):**


1. Goldbort R, Writing for Science, Yale University Press, 2006
2. Day R, How to Write and Publish a Scientific Paper, Cambridge University Press, 2006
3. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM, Highman, 1998.


**References:**


1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.


**Course Outcomes:**

By the end of the course the students will be able to:

- Improve his command over English by using standard phrases. **[L3]**

- Organize the paper logically towards a proper conclusion. **[L4]**
- Decide on the content to be included in various parts of the paper. **[L5]**
- Identify whether to use personal or impersonal style in the paper. **[L5]**
- Attract the attention of the reader by providing a suitable title and an appropriate abstract. **[L6]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 2 | | | | | | | | 1 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EAC742: DISASTER MANAGEMENT

**L T P C**
**2 0 0 0**

**Course Description:**

*This course is intended to provide fundamental understanding of different aspects of Disaster Management. It will expose the students to the concept and functions of Disaster Management and to build competencies of Disaster Management professionals and development practitioners for effective supporting environment as put by the government in legislative manner. It would also provide basic knowledge, skills pertaining to Planning, Organizing and Decision-making process for Disaster Risk Reduction.*

**Course Objectives**

- to provide students an exposure to disasters, their significance, types & Comprehensive understanding on the concurrence of Disasters and its management.
- to ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention, risk reduction and the basic understanding of the research methodology for risk reduction measures.
- equipped with knowledge, concepts, and principles, skills pertaining to Planning, Organizing, Decision-making and Problem solving methods for Disaster Management.
- to develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.

**Unit I** **5L**

**Introduction** Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the meaning, list the factors and mention the significance of disaster
- distinguish between hazard and disaster
- compare manmade and natural disaster
- list the types of disaster and describe their magnitude

**Unit II** **5L**

**Repercussions of Disasters and Hazards**: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the meaning, list the factors and mention the significance of disaster
- distinguish between hazard and disaster
- compare manmade and natural disaster
- list the types of disaster and describe their magnitude

**Unit III** **6L**

**Disaster Prone Areas in India** Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the seismic zones and their characteristics
- identify the areas prone to floods and droughts
- distinguish between landslides and avalanches
- identify areas prone to cyclonic and costal hazards
- enumerate the post disaster diseases and epidemics

**Unit IV** **6L**

**Disaster Preparedness and Management** Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, media reports: governmental and Community Preparedness.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the monitoring of phenomena triggering a disaster/hazard
- evaluate the risk with the use of remote sensing and meteorological data
- list the governmental and community measures for disaster preparedness

**Unit V** **6L**

**Risk Assessment** Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define and list the elements of disaster risk
- enumerate the measures for risk reduction
- apply the techniques of risk assessment
- identify the means of people's participation in risk assessment

**Text Book(s):**


1. R. Nishith, Singh A.K., Disaster Management in India: Perspectives, issues and strategies, New Royal Book Company., 2008.
2. Sahni, Pardeep, Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi., 2012
3. Goel S. L., Disaster Administration and Management Text and Case Studies", Deep and Deep Publication, 2007.

**Course Outcomes**

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

- Identify management activities in pre, during and post phases of Disasters.
- Plan disaster management activities and specify measure for risk reduction
- apply risk assessment techniques in real life disaster scenarios
- evaluate the risk with the use of remote sensing and meteorological data
- identify the means of people's participation in risk assessment

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 1 | | | | | | | | 1 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EAC743: SANSKRIT FOR TECHNICAL KNOWLEDGE

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 0 |

**Course Description:**

*This course is intended to expose the student to the fundamentals of Sanskrit language and its technical utility in forming the core principles of many engineering branches. Students taking this course shall be able to relate the core principles of engineering branches to semantics of Sanskrit language*

**Course Objectives**

- to provide the knowledge of Sanskrit alphabets
- to expose the students to the basic grammar and sentence formation in past/present/future tenses
- to provide a classification of Sanskrit literature and its associated roots
- to demonstrate the relation of core engineering principles to the roots of Sanskrit literature

**Unit I** **9L**

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define and list the elements of disaster risk
- enumerate the measures for risk reduction
- apply the techniques of risk assessment

**Unit II** **9L**

Order, Introduction of roots, Technical information about Sanskrit Literature.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- classify the different branches of Sanskrit literature
- describe the order and roots of Sanskrit literature
- relate the applicability of Sanskrit literature to technical principles

**Unit III** **9L**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

**Learning Outcomes**

After the completion of this unit, the student will be able to

- relate the technical concepts of engineering to principles of electrical technology
- relate the technical concepts of engineering to principles of mechanical engineering
- apply the use of Sanskrit knowledge to describe the mathematical principles

**Text Book(s):**

1. Dr.Vishwas, Abhyaspustakam, Samskrita Bharti Publication, New Delhi, 2005.

2. Vempati Kutumb Shastri, Teach Yourself Sanskrit, Prathama Deeksha, Rashtriya Sanskrit Sansthanam, New Delhi Publication, 2003.
3. Suresh Soni, India's Glorious Scientific Tradition, Ocean books, New Delhi, 2011.

**Course Outcomes**

After successful completion of the course, the student will be able to

- get a working knowledge in illustrious Sanskrit, the scientific language in the world
- get a Learning of Sanskrit to improve brain functioning
- develop the logic in mathematics, science & other subjects with principles of sanskrit
- explore the huge knowledge from ancient literature with the help of Sanskrit
- apply the use of Sanskrit knowledge to describe the mathematical principles

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 2 | | | | | | | | 1 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EAC744: VALUE EDUCATION

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 0 |

**Course Description:**

*This course is intended to expose the student to the need for human values and methods to cultivate them for leading an ethical life with good moral conduct. Students taking this course will be able to experience a change in personal and professional behavior with these ethical principles guiding him throughout life*

**Course Objectives**

- to expose the student to need for values, ethics, self-development and standards
- to make the student understand the meaning of different values including duty, devotion, self-reliance etc.
- to imbibe the different behavioral competencies in students for leading an ethical and happy life
- to expose the student to different characteristic attributes and competencies for leading a successful, ethical and happy profession life.

**Unit I** **7L**

Values and self-development –social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the social values and individual attitudes for self development
- describe the Indian vision of humanism
- distinguish between moral and non-moral acts
- list the standards and value principles for moral conduct

**Unit II** **7L**

Importance of cultivation of values. Sense of duty. Devotion, self-reliance. Confidence, concentration. Truthfulness, cleanliness. Honesty, humanity. Power of faith, national unity. Patriotism, love for nature, discipline.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the importance of cultivating values
- list the different traits of self-developed individual
- explain the need for loving nature/country/humanity

**Unit III** **7L**

Personality and Behaviour Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth.

Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

**Learning Outcomes**
After the completion of this unit, the student will be able to

- describe the benefits of positivie thinking, integrity and discipline
- list the different methods for avoiding fault finding, anger
- explain the methods to overcome suffering, religious intolerance, self-destructive habits

**Unit IV** **7L**

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

**Learning Outcomes**
After the completion of this unit, the student will be able to

- describe the science of reincarnation
- explain the relation between self-management and good health
- elaborate the role of different religions in reaching the common goal
- list the different techniques for mind-control to improve personality and studies

**Text Book(s):**

1. Chakroborty S.K., "Values and ethics for organizations: Theory and Practice", Oxford University Press, 1998.

**Course Outcomes**
After successful completion of the course, the student will be able to

- appreciate the need for human values and methods for self development
- elaborate the different traits and benefits of a self-developed individual
- list the different attributes of self-developed individual
- elaborate the role and scope of books/faith/health/religions in character building and competence development
- explain the relation between self-management and good health

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 2 | | | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EAC745: CONSTITUTION OF INDIA

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 0 |

**Course Description:**

*This course is intended to expose the student to the philosophy of Indian constitution. Students will be able to understand their fundamental rights/duties and governance structure. Students also appreciate the role of election commission in establishing a democratic society.*

**Course Objectives**

- to familiarize the student about the need for a constitution
- to make the student understand the role of constitution in a democratic society
- to acquaint the student with key constitutional features and fundamental rights of a citizen
- to impart the organs of governance and local administration hierarchy and their responsibilities
- to familiarize the student with the role, responsibilities and administration hierarchy of election commission

**Unit I** **5L**

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working). **Philosophy of the Indian Constitution**: Preamble, Salient Features

**Learning Outcomes**

After the completion of this unit, the student will be able to

- list the outline of drafting committee and their roles in the making of Indian constitution
- describe the need and role of a constitution in a democratic society
- elaborate the salient features of Indian constitution

**Unit II** **5L**

**Contours of Constitutional Rights & Duties:** Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- list the fundamental rights of a citizen
- explain the intricacies in the different rights
- elaborate the fundamental duties of a citizen
- describe the principles of state policy

**Unit III** **6L**

**Organs of Governance:** Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

**Learning Outcomes**

After the completion of this unit, the student will be able to

- present the hierarchy of governance
- list the role/responsibilities/powers of different organs of governance

- elaborate the guidelines for appointment/transfer of judges

**Unit IV** **6L**

**Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the administrative organizational hierarchy of municipalities and panchayats
- appreciate the role/responsibilities/powers of mayor, CEO, elected officials
- appreciate the importance of grass root democracy

**Unit V** **6L**

**Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the administrative hierarchy of election commission
- elaborate the roles/responsibilities/powers of election commissioners at different levels of hierarchy
- outline the welfare activities of SC/ST/OBC/Women by different bodies

**Text Book(s):**


1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. S. N. Busi, Dr. B. R. Ambedkar, Framing of Indian Constitution, 1/e, 2015.
3. M. P. Jain, Indian Constitution Law, 7/e, Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.


**Course Outcomes**

After successful completion of the course, the student will be able to

- describe the philosophy and salient features of Indian constitution
- list the constitutional rights and duties of a citizen
- elaborate the central and local administrative hierarchy and their roles
- describe the roles/responsibilities/powers of different governing and administrative bodies
- explain the structure/functioning and power of election commission

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 2 | | | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EAC746: PEDAGOGY STUDIES

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 0 |

**Course Description:**

*This course is aimed to familiarizing the student with pedagogical principles, practices and methodologies. This course is intended for students interested in pursuing a career in teaching and research.*

**Course Objectives**

- to familiarize the student about the need for pedagogy studies, background and conceptual framework
- to expose the student to pedagogical practices in formal/informal classrooms
- to acquaint the student with type of curriculum and guidance materials for effective pedagogy
- to familiarize the student with classroom practices and curriculum assessment procedures
- to make the student understand the effect of undertaking research on teaching quality

**Unit I** **5L**

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the aim and rationale behind teacher education
- classify the different theories of learning
- elaborate the need and role of curriculum, teacher education

**Unit II** **5L**

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the different pedagogical practices used by teachers in formal and informal classrooms
- explain the pedagogical practices employed in developing countries
- enumerate the duties of faculty in terms of teaching, research, consultancy, administration

**Unit III** **6L**

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- list the measures for effective pedagogy
- identify the different documentation required to formalize curriculum implementation and quality assessment
- describe the teachers attitudes and beliefs in pedagogic strategies

**Unit IV** **6L**

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the organizational hierarchy in a school administration system
- list the different barriers to learning
- enumerate the methods to overcome limited resources and handle large class sizes
- describe the follow-up support and peer-support in classroom practices

**Unit V** **6L**

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- explain the need for and role of research in teaching profession
- list the different research activities to be taken up by teachers
- describe the impact of research on teaching quality and learning process

**Text Book(s):**


1. Ackers J, Hardman F, Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261, 2001
2. Agrawal M, Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379, 2004.
3. Akyeampong K, Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID., 2003.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J, Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282., 2013.
5. Alexander RJ, Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell., 2001.
6. Chavan M, Read India: A mass scale, rapid, ‘Learning to Read’ campaign., 2003.

**Course Outcomes**

After successful completion of the course, the student will be able to

- describe the theories of learning and conceptual framework of pedagogy
- explain the pedagogical practices used by teachers in formal and informal classrooms
- visualize the administrative hierarchy of schools and colleges and define the role
- appreciate the need for research and define the future direction of teaching career
- describe the impact of curriculum and assessment on the teaching learning process of a student

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 2 | | | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 1 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EAC747: STRESS MANAGEMENT BY YOGA

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 0 |

**Course Description:**

*This course is aimed to familiarize the student with basic principles of yoga and different physical/mental practices for managing mind and body. This course helps the student in managing stress during education, home and workplace. Further, principles learnt in this course help in building overall personality for a stress-free, happy and independent life.*

**Course Objectives**

- to familiarize the student about eight parts of yoga and their significance
- to expose the student to the importance and meaning of Yam and Niyam
- to make the student understand the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc
- to introduce the different yogic poses with a knowledge of their benefits for mind and body
- to familiarize the effect of different types of breathing techniques in concept and in activity

**Unit I** **9L**

Definitions of Eight parts of yoga (Ashtanga).

**Learning Outcomes**

After the completion of this unit, the student will be able to

- list the eight parts of yoga
- describe the effects of different parts of yoga on mind and body
- elaborate the importance of yoga in stress management and personality development

**Unit II** **9L**

Yam and Niyam.

Do`s and Don't's in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- elaborate the importance of Yam and Niyam
- describe the meaning and significance of Ahinsa, satya, astheya etc
- explain the need for shaucha, santosh, tapa, swadhyay in leading a healthy and fruitful life

**Unit III** **9L**

Asan and Pranayam

i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its Effects-Types of pranayam.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- demonstrate the different physical asanas and explain their physical and phychological effects
- demonstrate the different breathing techniques and describe their physical and mental effects
- distinguish between different types of pranayamam

**Text Book(s):**

1. Janardan, Yogic Asanas for Group Tarining-Part-I, Swami Yogabhyasi Mandal, Nagpur
2. Swami Vivekananda, "Rajayoga or conquering the Internal Nature", Advaita Ashrama, Kolkata

**Course Outcomes**

After successful completion of the course, the student will be able to

- describe the eight parts of yoga and their significance
- explain the the importance and meaning of Yam and Niyam
- define the meaning and importance of yogic principles including Ahimsa, Satya, Astheya etc
- demonstrate the different yogic poses and explain their benefits for mind and body
- demonstrate the different types of breathing techniques and explain their physical and mental benefits

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 2 | | | | | | | | 1 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 1 | | 1 | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EAC748: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

| L | T | P | C |
|---|---|---|---|
| 2 | 0 | 0 | 0 |

**Course Description:**

*This course is aimed to familiarize the student with life enlightenment skills for personality development. This course helps the student in building his holistic personality through human values, ethics and spiritual attributes.*

**Course Objectives**

- to familiarize the student to good personality traits through moral stories
- to make the student understand the goal of human life and importance of good personality in reaching the goal
- to expose the student to the study of Shrimad-Bhagwad-Geeta for developing his/her personality and achieve the highest goal in life
- to familiarize the student to leadership skills for driving nation and mankind to peace and prosperity
- to expose the role of Neetishatakam for developing versatile personality of students.

**Unit I** **9L**

Neetisatakam-Holistic development of personality
Verses- 19,20,21,22 (wisdom)
Verses- 29,31,32 (pride & heroism)
Verses- 26,28,63,65 (virtue)
Verses- 52,53,59 (dont's)
Verses- 71,73,75,78 (do's).

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the moral stories illustrating the traits of good personality
- define the meaning and importance of wisdom, pride, heroism, virtue etc
- identify do and donts in life from the foundations of human morals/ethics

**Unit II** **9L**

Approach to day to day work and duties.
Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48,
Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
Chapter 18-Verses 45, 46, 48.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the characteristics and principles of bhakti yogam, jnana yogam and karma yogam
- identify the use of different yogic characteristics in different activities of daily life/duties

- apply the use of yogic principles for leading a stress-free, happy and fruitful life with good developed personality

**Unit III** **9L**

Statements of basic knowledge.
Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68
Chapter 12 -Verses 13, 14, 15, 16,17, 18
Personality of Role model. Shrimad BhagwadGeeta:
Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
Chapter 4-Verses 18, 38,39
Chapter18 – Verses 37,38,63

**Learning Outcomes**

After the completion of this unit, the student will be able to

- list the characteristics of role model proposed by verses of bhagavad gita
- explain the methods for obtaining life enlightenment through the practice of four yoga appropriately
- describe the characteristics of karma yogi/jnana yogi for developing leadership personality

**Text Book(s):**

1. Swami Swarupananda, "Srimad Bhagavad Gita", Advaita Ashram (Publication Department), Kolkata
2. P. Gopinath, Bhartrihari's Three Satakam (Niti-Sringar-vairagya), Rashtriya Sanskrit Sansthanam, New Delhi.

**Course Outcomes**

After successful completion of the course, the student will be able to

- List the different parables of neethisathakam and identify their morals
- enumerate the different traits of human personality for life enlightenment
- describe the leadership attributes for driving nation and mankind to peace and prosperity
- explain the applicability of different types of yoga to day-to-day work and duties resulting in responsible personality
- describe the characteristics of karma yogi/jnana yogi for developing leadership personality

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 1 | | | | | | | | 1 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EAC750: DEVELOPING SOFT SKILLS AND PERSONALITY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 0 |

**Course Description:**

*Soft skills comprise pleasant and appealing personality traits as self-confidence, positive attitude, emotional intelligence, social grace, flexibility, friendliness and effective communication skills. The course aims to cause a basic awareness within the students about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality.*

**Course Objectives**

- to familiarize the student to the criteria for self assessment and significance of self-discipline
- to expose the student to attitudes, mindsets, values and beliefs
- to acquaint the student to plan career and goals through constructive thinking
- to enable the student to overcome barriers for active listening and persuasive speaking
- to familiarize the skill of conducting meetings, writing minutes and involving in active group discussions

**Unit I** **(8L)**

Self-Assessment; Identifying Strength & Limitations; Habits, Will-Power and Drives; Developing Self-Esteem and Building Self-Confidence, Significance of Self-Discipline

**Learning Outcomes**

After the completion of this unit, the student will be able to

- identify strengths & limitations through self-assessment(L3)
- list the attributes of personalities will good will-power and self-drives(L1)
- describe the reasons for building self-esteem and self-confidence(L2)
- explain the significance of self discipline(L2)

**Unit II** **(8L)**

Understanding Perceptions, Attitudes, and Personality Types: Mind-Set: Growth and Fixed; Values and Beliefs

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the characteristics of different perceptions, attitudes and personality types(L1)
- distinguish between fixed and growing mindsets(L3)
- define the importance and meaning of values and beliefs(L2)

**Unit III** **(8L)**

Motivation and Achieving Excellence; Self-Actualisation Need; Goal Setting, Life and Career Planning; Constructive Thinking

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the need for having high motivation and achieving excellence(L2)
- define the need for self-actualization(L1)

- plan the life and career goals based on self assessment(L4)
- explain the attributes of constructive thinking(L2)

**Unit IV** **(8L)**

Communicating Clearly: Understanding and Overcoming barriers; Active Listening; Persuasive Speaking and Presentation Skills.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- self-assess the barriers for communicating clearly (L4)
- list the attributes of active listening(L1)
- describe the minimal aspects of effective presentation(L2)
- organize ideas resulting a persuasive talk(L3)

**Unit V** **(8L)**

Conducting Meetings, Writing Minutes, Sending Memos and Notices; Netiquette: Effective E-mail Communication; Telephone Etiquette; Body Language in Group Discussion and Interview.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the format and structure of writing meeting minutes(L2)
- identify the essential components of memos and notices(L3)
- explain the principles of effective email communication(L2)
- list the basic etiquette of telephone conversation(L1)
- describe the effective body traits during group discussion and interviews(L2)

**Text Book(s):**


1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Klaus, Peggy, Jane Rohman& Molly Hamaker. The Hard Truth about Soft Skills. London: HarperCollins E-books, 2007.
4. Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.
5. Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.


**Course Outcomes**

After successful completion of the course, the student will be able to

- carry out self assessment and describe the significance of self-discipline. **[L4]**
- define, classify and compare attitudes, mindsets, values and beliefs. **[L3]**
- plan career and goals through constructive thinking and personal assessment. **[L4]**
- overcome barriers for active listening and persuasive speaking. **[L5]**

- conduct meetings, write minutes and involve in active group discussions. **[L3]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 2 | | | | | | | | 1 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EOE742: BUSINESS ANALYTICS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course introduces students to the science of business analytics. The goal is to provide students with the foundation needed to apply data analytics to real-world challenges they confront daily in their professional lives. Students will learn to identify the ideal analytic tool for their specific needs; understand valid and reliable ways to collect, analyze, and visualize data; and utilize data in decision making for managing agencies, organizations or clients in their workspace*

**Course Objectives**

- To familiarize the scope, process and advantages of business analytics
- To acquaint the student with the modeling and problem solving skills in business analytics
- To impart the organization and management of business analytics
- To introduce the forecasting models and techniques used in analytics
- To expose the formulation and decision strategies used in business analytics

**Unit I** **8L**

**Business analytics:** Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the scope and process of business analytics (L1)
- choose an organizational structure to implement a business analytics process (L4)
- describe the statistical tools and methods used for data modeling and analysis (L2)
- identify the sampling and estimation requirements for data analysis (L1)

**Unit II** **8L**

**Trendiness and Regression Analysis:** Modeling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- identify the relationships and trends in data (L1)
- utilize linear regression methods for identifying data relationships (L4)
- list the types of data and their models used for business analytics (L1)
- describe the methods for visualization and exploration of data (L2)

**Unit III** **8L**

**Organization Structures of Business analytics:** Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modeling,

Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the management issues in the organization structures (L2)
- define the designing information policy and its usage (L1)
- list the methods for ensuring data quality measuring contribution (L1)
- explain the use of data mining methodologies for predictive analytics analysis (L3)
- describe the use of prescriptive analytics methods in business analytics process (L2)

**Unit IV** **10L**

**Forecasting Techniques:** Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- classify and describe the use of forecasting models (L3)
- model the use of regression forecasting with casual variables (L5)
- identify the appropriate forecasting model for a given data (L5)
- explain the use of montecarlo simulation for forecasting and identify the involved risk (L2)

**Unit V** **8L**

**Decision Analysis:** Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- formulate decision problems (L2)
- list the decision strategies with and without probabilities (L1)
- use the decision trees for analysis (L4)
- describe the value of information, utility and its use in decision making (L4)

**Textbook(s):**


1. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications Pearson FT Press, 2014.
2. James Evans, Business Analytics, Pearson Education, 2013.


**Course Outcomes**

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

- define the scope, process and advantages of business analytics. (L1)
- explain the modeling and problem solving skills in business analytics (L2)
- describe the organization and management of business analytics (L3)
- utilize the forecasting models and techniques used in analytics (L4)
- enumerate and utilize the formulation and decision strategies (L2)

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 1 | | | | | | | | 1 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 1 | | 1 | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EOE744: INDUSTRIAL SAFETY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*Safety by design or prevention through design is in the core for maintaining engineering systems safe. The students will be equipped with concepts of engineering systems safety, dimensions of engineering systems safety, safety design and analysis mathematics, design for engineering systems safety and control for safety, and integrating safety with other operational goals such as quality and reliability*

**Course Objectives**

- to impart knowledge on different facets and aspects of industrial systems safety
- to familiarize the student with tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings
- to impart the knowledge of definition, function and types of maintenance activities
- to familiarize the different wear and corrosion mechanisms and their prevention methods
- to expose the students to different faults and their tracing mechanisms
- to impart the art of planning periodic and preventive maintenance mechanisms

**Unit I** **8L**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- list the different types of mechanical and electrical hazards in industrial systems (L1)
- enumerate the salient points of factories act 1948 (L2)
- describe the health and safety measures to be enforced for industrial safety (L3)
- elaborate the different fire prevention and firefighting arrangements to be made (L2)

**Unit II** **8L**

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the meaning and aim of maintenance engineering(L1)
- elaborate the primary and secondary functions of maintenance department(L2)
- classify the different types and applications of maintenance(L3)
- relate the replacement economy with maintenance cost(L5)
- estimate the service life of equipment from the specifications of individual components(L4)

**Unit III** **8L**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- explain the different types, causes and effects of Wear(L2)
- elaborate the different methods for reducing wear(L2)
- list the different types of lubricants and mention their applications(L1)
- define the principle and factors affecting corrosion(L1)
- classify the different types of corrosion and identify their prevention methods(L3)

**Unit IV** **8L**

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler,vi. Electrical motors, Types of faults in machine tools and their general causes.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- explain the different types, causes and effects of Wear(L2)
- use the concept of decision tree for fault tracing in machine tools(L4)
- build decision trees for different machine tools including pump, air compressor etc(L4)
- classify the different types of faults in machine tools and their causes(L3)

**Unit V** **10L**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing,
cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

**Learning Outcomes**

After the completion of this unit, the student will be able to

- explain the concept of periodic inspection and its need(L2)
- list the common troubles and remedies of electric motor(L1)
- define the need for preventive maintenance and list its steps(L3)
- elaborate the steps/procedure of periodic and preventive maintenance of diesel generating sets, pumps etc(L2)

**Text Book(s):**


1. Lindley R. Higgins, Lester Coridon Morrow, Maintenance Engineering Handbook, Da Information Services, 1977.
2. H. P. Garg, Maintenance Engineering, S. Chand and Company, 1987.
3. Audels, Pump-hydraulic Compressors, Mc Graw Hill Publication, 1992.
4. Winterkorn, Hans, Foundation Engineering Handbook, Chapman & Hall London, 1975


**Course Outcomes**

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

- describe the different facets and aspects of industrial systems safety(L2)
- demonstrate the use of tools, techniques and methodologies needed for prevention of occurrences of unsafe operations and accidents under different industrial settings(L4)
- define the function and list the types of maintenance activities(L1)
- describe the concept of wear and corrosion mechanisms and their prevention methods(L2)
- enumerate the different faults and their tracing mechanisms (L3)

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 2 | | | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EOE746: OPERATIONS RESEARCH

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*Optimization problems arise in all walks of human activity- particularly in engineering, business, finance and economics. The simplest optimization problems are linear in nature which may be subject to a set of linear constraints. This course will equip the student with the expertise to mathematically model real life optimization problems as Linear Programming (Optimization) Problems and subsequently educate the student to solve these models with the help of the available methods.*

**Course Objectives**

- To impart knowledge on developing mathematical formulation for linear programming and transportation problem
- To familiarize the student in the construction of the required activities in an efficient manner to complete it on or before a specified time limit and at the minimum cost.
- To expose the development of mathematical model for interactive decision-making situations, where two or more competitors are involved under conditions of conflict and competition.
- To illustrate PERT and CPM techniques for planning and implementing projects.
- To impart the knowledge of formulating and analysis of real life problems using advanced tools and techniques for resource optimization
- To provide frameworks for analyzing waiting lines using advanced queuing theory concepts

**Unit I** **8L**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

**Learning Outcomes**

After completing this unit, the student will be able to

- identify and develop operational research models from the verbal description of the real system. **[L4]**
- understand the classification systems of effective Inventory control models**[L2]**

**Unit II** **8L**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

**Learning Outcomes**

After completing this unit, the student will be able to

- translate a real-world problem, given in words, into a mathematical formulation. **[L2]**
- utilize the mathematical tools that are needed to solve optimization problems. **[L2]**

**Unit III** **8L**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

**Learning Outcomes**

After completing this unit, the student will be able to

- describe the need and origin of the optimization methods**[L2]**
- classify optimization problems to suitably choose the method needed to solve the particular type of problem**[L3]**

**Unit IV** **8L**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

**Learning Outcomes**

After completing this unit, the student will be able to

- choose linear programming problems to suitably choose the method needed to solve the particular type of problem**[L1]**
- identify industrial problems involved in inventory, MRP and scheduling**[L2]**

**Unit V** **8L**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

**Learning Outcomes**

After completing this unit, the student will be able to

- identify the values, objectives, attributes, decisions, uncertainties, consequences, and trade-offs in a real decision problem**[L2]**
- Apply the models to incorporate rational decision-making process in real life situations.**[L3]**
- Analyze various modeling alternatives & select appropriate modeling techniques for a given situation.. **[L3]**

**Text Book(s):**


1. H.A. Taha, Operations Research, An Introduction, Prentice Hall of India, 2008
2. H.M. Wagner, Principles of Operations Research, Prentice Hall of India, Delhi, 1982.
3. J.C. Pant, Introduction to Optimization: Operations Research, Jain Brothers, 2008
4. Hitler Libermann Operations Research: McGraw Hill Publishers, 2009
5. Pannerselvam, Operations Research: Prentice Hall of India, 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India, 2010


**Course Outcomes**

After the successful completion of the course, the students will be able to:

- Understand the basic concepts of different advanced models of operations research and their applications. **[L2]**
- Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action. **[L4]**
- Apply the models to incorporate rational decision-making process in real life situations. **[L4]**
- Analyze various modeling alternatives & select appropriate modeling techniques for a given situation. **[L3]**
- Validate output from model to check feasibility of implementations. **[L5]**

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 2 | 1 | | | 1 | | 2 | | 2 | 1 | 1 | | 2 |
| CO2 | | 2 | | 2 | | | | | | | | 1 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 2 | 1 | 2 | 1 | | 1 |
| CO4 | 1 | 2 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 2 | |
| CO5 | | 1 | 1 | 2 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EOE748: COST MANAGEMENT OF ENGINEERING PROJECTS

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course will equip the student with the expertise to mathematically model engineering projects and use effective methods and techniques to plan and execute engineering activities.*

**Course Objectives**

- to introduce the basic principles of strategic cost management and the related terminology
- to familiarize the project planning and execution process involving technical/nontechnical activities
- to acquaint the student with detailed engineering activities and their cost management analysis
- to impart the knowledge of cost analysis and profit planning of engineering projects
- to familiarize the quantitative techniques for optimization of budget allocation

**Unit I** **8L**

Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the cost concepts in decision making(L2)
- define the various costs involved in the cost management process(L2)
- list the objectives of cost control(L2)
- identify the different fields of a database for operational control(L2)

**UnitII** **8L**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define the meaning of a project and list the different types(L2)
- identify the measures to manage cost overruns(L2)
- describe the various stages of project execution from conception to commissioning(L2)
- plan the proper order of technical/nontechnical activities as part of project execution(L2)

**Unit III** **8L**

Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- identify the different clearance norms required in the pre-project execution phase(L2)
- describe the hierarchy of project team and identify the role of each member(L2)
- list the different contents of project contracts(L2)
- present the project cost control and planning through bar charts, network diagrams etc(L2)

**Unit IV** **8L**

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- describe the cost behavior and profit planning(L2)
- distinguish between marginal costing and absorption costing(L2)
- analyze the variance of standard costing(L2)
- analyze the pricing strategies in project costing(L2)
- identify the quality measures satisfying the appropriate constraints(L2)

**Unit V** **10L**

Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory

**Learning Outcomes**

After the completion of this unit, the student will be able to

- define and compare the different budgeting strategies(L2)
- model the cost management as a linear programming problem(L2)
- measure the divisional profitability and decide the appropriate pricing(L2)

**Textbook(s):**

1. Charles T. Horngren, Srikant M. Datar, George Foster, Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2006.

**References:**

1. Charles T. Horngren, George Foster, Advanced Management Accounting, Greenwood Publishing, 2001.
2. Robert S Kaplan, Anthony A. Alkinson, Management & Cost Accounting, 1998.
3. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting, Wheeler Publisher, 2004.
4. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book, 2006.

**Course Outcomes**

After the successful completion of the course, the students will be able to

- list the basic principles of strategic cost management and define the related terminology(L1)
- plan the project execution process involving technical/nontechnical activities(L4)
- describe the detailed engineering activities and their cost management analysis(L2)
- carry out the cost analysis and profit planning of engineering projects(L5)
- utilize quantitative techniques for optimization of budget allocation(L6)

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 1 | | | | | | | | 1 | | | | 2 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 1 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 1 | | 1 | | | | | | | | 1 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EOE752: WASTE TO ENERGY

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Course Description:**

*This course introduces the basic principles and different technologies of converting waste to energy. Student will be able to appropriately identify the methods and build biomass gasification systems of different capacities depending on application requirements.*

**Course Objectives**

- to introduce the classification of waste for its usefulness in preparing different fuels
- to familiarize the biomass pyrolysis process and its yield issues
- to acquaint the student with biomass gasification processes and construction arrangements
- to impart the types and principles of biomass combustors
- to familiarize the calorific values and composition of biogas resources

**Unit I** **8L**

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

**Learning Outcomes**

After the completion of this unit, the student will be able to

- distinguish between different types of waste (L1)
- classify the different types of waste for manufacturing different types of fuel (L3)
- identify the different conversion devices and their applications(L4)

**Unit II** **8L**

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- classify the different types of pyrolysis methods based on speed(L1)
- describe the different methods of manufacturing charcoal (L2)
- explain the chemical processes involved in the manufacture of pyrolytic oils and gases(L2)

**Unit III** **8L**

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- explain the design, construction and operation of different gasifiers(L2)
- describe the burner arrangement for thermal heating(L2)
- elaborate the gasifier engine arrangement for equilibrium and kinetic considerations(L3)

**Unit IV** **8L**

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- explain the basic principle of biomass combustors(L2)
- classify different combustors based on their capacity and efficiency(L3)
- describe the construction and operation of fixed bed inclined grate, fluidized bed combustors (L2)

**Unit V** **10L**

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**Learning Outcomes**

After the completion of this unit, the student will be able to

- list the properties of biogas(L1)
- elaborate the design, construction and operation of biogas plant(L2)
- classify the different biomass resources and their conversion process(L3)
- distinguish between different biogas plants and identify their applications(L5)

**Text Book(s)**


1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.


**Course Outcomes**

After the successful completion of the course, the student will be able to

- classify different types of waste for their usefulness in preparing different fuels(L3)
- describe the biomass pyrolysis process and its yield issues(L2)
- outline the different biomass gasification processes and their construction arrangements(L3)
- explain the types and principles of biomass combustors(L2)
- analyze the calorific values and composition of biogas resources(L5)

| | Programme Objectives (POs) | | | | | | | | | | PEOs | | | | PSOs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 1 | 2 | 3 | 4 | 1 | 2 | 3 |
| CO1 | 1 | 1 | | 1 | 1 | 1 | | | 1 | | 1 | | 1 | 1 | 1 | | 1 |
| CO2 | | 1 | | 1 | | | | | | | | 1 | | | | 1 | |
| CO3 | 1 | | 1 | | 1 | 1 | | | 1 | | | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 1 | 1 | 2 | 1 | 1 | | | | | | 1 | 1 | | | | 1 | |
| CO5 | | 1 | 1 | 1 | | 1 | | | | | | | | 2 | | | |

*1-Low, 2- Medium and 3- High Correlation*

## 19EME792: TECHNICAL SEMINAR

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 4 | 2 |

Each student shall survey a technical topic related to a chosen specialization and prepare/submit a report in a specified format. It is advisable for students to choose a topic of interest to be continued as M.Tech Project in the 3rd & 4th Semester. The guidelines to carry out the research shall include the following:

1. Literature Review
2. Identification of Gap
3. Objectives and Expected Outcomes
4. Methodology / Innovative solution

Each student has to prepare a power point presentation on a selected technical topic with a novelty and get it evaluated by the faculty assigned for this purpose.

## 19EME891: PROJECT WORK I

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 26 | 13 |

Each student is required to submit a report of first part of project work i.e. about the problem definition, literature review and methodology to be adopted including experiments and tests to be performed on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester end.

## 19EME892: PROJECT WORK II

| L | T | P | C |
|---|---|---|---|
| 0 | 0 | 26 | 13 |

Each student is required to submit a detailed project report about the work on topic of project as per the guidelines decided by the department. The project work is to be evaluated through Presentations and Viva-Voce during the semester and Final evaluation will be done at the end of semester as per the guidelines decided by the department from time to time. The candidate shall present/publish one paper in national/international conference/seminar/journal of repute. However candidate may visit research labs/institutions with the due permission of chairperson on recommendation of supervisor concerned.