Scheme and Syllabus of I & II Semesters
(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech) in
MACHINE DESIGN

DEPARTMENT OF
MECHANICAL ENGINEERING
College Vision & Mission
(To be included from our side)
Scheme and Syllabus of I & II Semesters
(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech) in
MACHINE DESIGN

DEPARTMENT OF
MECHANICAL ENGINEERING
VISION

Quality education in Design, Materials, Thermal and Manufacturing with emphasis on research, sustainable technologies and entrepreneurship for societal symbiosis.

MISSION

- Imparting knowledge in basic and applied areas of Mechanical Engineering.
- Providing state-of-the-art laboratories and infrastructure for academics and research in the areas of design, materials, thermal engineering and manufacturing.
- Facilitating faculty development through continuous improvement programs.
- Promoting research, education and training in materials, design, manufacturing, Thermal Engineering and other multidisciplinary areas.
- Strengthening collaboration with industries, research organizations and institutes for internship, joint research and consultancy.
- Imbibing social and ethical values in students, staff and faculty through personality development programs

Program Outcomes (PO)

M. Tech. in Machine Design graduates will be able to:

PO1: An ability to independently carry out a research / investigation and development work to solve practical problems related to machine design.
PO2: An ability to write and present a substantial technical report / document
PO3: An ability to demonstrate a degree of mastery over the areas of machine design. The mastery should be at a level higher than the requirements in the BE Mechanical Engineering and allied programs
PO4: An ability to use modern tools for the design and analysis of static and dynamic systems and mechanisms
PO5: An ability to adapt technical, safety, ethical and environmental factors in the design of system and mechanism
PO6: An ability to perform in multidisciplinary teams with sound interpersonal and management skills with a commitment to lifelong learning
### ABBREVIATIONS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Abbreviation</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>1.</td>
<td>VTU</td>
<td>Visvesvaraya Technological University</td>
</tr>
<tr>
<td>2.</td>
<td>BS</td>
<td>Basic Sciences</td>
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<tr>
<td>3.</td>
<td>CIE</td>
<td>Continuous Internal Evaluation</td>
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<td>4.</td>
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<td>Semester End Examination</td>
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<td>5.</td>
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<td>6.</td>
<td>GE</td>
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<td>7.</td>
<td>HSS</td>
<td>Humanities and Social Sciences</td>
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<td>9.</td>
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<td>10.</td>
<td>EE</td>
<td>Electrical &amp; Electronics Engineering</td>
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<td>11.</td>
<td>EC</td>
<td>Electronics &amp; Communication Engineering</td>
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<td>IM</td>
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<td>13.</td>
<td>EI</td>
<td>Electronics &amp; Instrumentation Engineering</td>
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<td>14.</td>
<td>CH</td>
<td>Chemical Engineering</td>
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<td>15.</td>
<td>CS</td>
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<tr>
<td>16.</td>
<td>TE</td>
<td>Telecommunication Engineering</td>
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<td>IS</td>
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<tr>
<td>18.</td>
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<td>Biotechnology</td>
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<td>19.</td>
<td>AS</td>
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<tr>
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### INDEX

#### I Semester

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<td>18MAT11A</td>
<td>Applied Mathematics</td>
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<td>18MMD12</td>
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<td>18MMD13</td>
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**GROUP A: CORE ELECTIVES**

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<td>18MMD1A2</td>
<td>Tribology</td>
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<tr>
<td>3.</td>
<td>18MCM1A3</td>
<td>Design of Hydraulic &amp; Pneumatic Systems</td>
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**GROUP B: CORE ELECTIVES**

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<td>18MCM1B3</td>
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<td>2.</td>
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## FIRST SEMESTER CREDIT SCHEME

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<td>Kinematics and Dynamics of Mechanisms</td>
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Total number of Credits 19 01 02 22

Total Number of Hours / Week

## SECOND SEMESTER CREDIT SCHEME

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<td>Advanced Solid Mechanics</td>
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<td>2</td>
<td>18MMD22</td>
<td>Advance Theory of Vibrations</td>
<td>ME</td>
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<td>18IM23</td>
<td>Research Methodology</td>
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<td>Minor Project</td>
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Total number of Credits 21 01 03 25

Total Number of Hours / Week
### I Semester

#### GROUP A: CORE ELECTIVES

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<tr>
<td>1.</td>
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<td>2.</td>
<td>18 MMD1A2</td>
<td>Tribology</td>
</tr>
<tr>
<td>3.</td>
<td>18 MCM1A3</td>
<td>Design of Hydraulic &amp; Pneumatic Systems</td>
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#### GROUP B: CORE ELECTIVES

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<td>3.</td>
<td>18 MCM1B3</td>
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### II Semester

#### GROUP C: CORE ELECTIVES

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<td>1.</td>
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<td>Theory of Plates and Shells</td>
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<td>2.</td>
<td>18MPD2C2</td>
<td>Design for Manufacture and Assembly</td>
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<td>18MCM2C3</td>
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#### GROUP D: CORE ELECTIVES

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<td>2.</td>
<td>18MCM2D2</td>
<td>Robotics and Automation</td>
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#### GROUP E: GLOBAL ELECTIVES

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<td>CV</td>
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<td>Industrial &amp; Occupational Health and Safety</td>
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<td>3.</td>
<td>IM</td>
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<td>Modelling using Linear Programming</td>
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<td>4.</td>
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<td>18IM2G04</td>
<td>Project Management</td>
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<td>Energy Management</td>
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<td>ME</td>
<td>18ME2G06</td>
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<td>Advanced Materials</td>
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<td>9.</td>
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<td>10.</td>
<td>MAT</td>
<td>18MAT2G10</td>
<td>Advanced Statistical Methods</td>
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Semester: I

APPLIED MATHEMATICS
(Common to MPD, MMD, MCM, MPE, MBT, MBI, MCH, MST, MHT)

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<td>Hours</td>
<td>52L</td>
<td>SEE Duration</td>
<td>3 Hrs</td>
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Unit – I 10 Hrs

STATISTICS
Method of least squares, fitting of straight line, linearization of nonlinear laws, curve fitting by polynomials, correlation, coefficient of correlation, lines of regression, Spearman rank correlation.

Unit – II 10 Hrs

PROBABILITY DISTRIBUTIONS
Introduction to probability, Random variables-discrete and continuous random variables, important measures and moment generating functions, Standard distributions-Binomial, Exponential, Normal and Gamma distributions.

Unit – III 10 Hrs

SYSTEM OF LINEAR EQUATIONS AND EIGEN VALUE PROBLEMS

Unit – IV 11 Hrs

NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS

Unit – V 11 Hrs

CONCEPTS OF ENGINEERING OPTIMIZATION
Engineering applications of optimization, statement of an optimization problem-design vector, design constraints, constraint surface, objective function and objective function surface. Multivariable optimization with inequality constraints-Kuhn-Tucker conditions, Constraint qualification, Genetic operators, Neural-Network-based Optimization. Optimization of Fuzzy systems.

Course Outcomes:
After going through this course the student will be able to:

CO1: Identify and interpret the fundamental concepts of statistics, distributions, linear algebra, differential equations and optimization arising in various field engineering.

CO2: Apply the knowledge and skills of statistical/numerical/optimization techniques to solve problems of least squares, probability distributions, linear equations, eigen value problems and differential equations.

CO3: Analyze the physical problem to establish a statistical / mathematical model and use an appropriate method to solve and optimize the solution.

CO4: Distinguish the overall mathematical knowledge gained to demonstrate the problems of least squares, probability distributions, linear equations, eigen value problems, differential equations and optimization arising in practical situations.
### Reference Books:

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
<th>ISBN</th>
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<tr>
<td>1</td>
<td>Theory and Problems of probability</td>
<td>Seymour Lipschutz and Marc Iars Lipson</td>
<td>Schaum’s Outline Series</td>
<td>2nd</td>
<td>0-07-118356-6</td>
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<tr>
<td>2</td>
<td>Introductory method of numerical analysis</td>
<td>S. S. Sastry</td>
<td>Prentice-Hall India Pvt. Ltd.</td>
<td>4th</td>
<td>81-203-1266-X</td>
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### Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

**Total CIE (Q+T+A) is 20+50+30=100 Marks.**

### Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
### Semester: I

**MECHANICS OF COMPOSITE MATERIALS**
*(Theory & Practice)*

<table>
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<tbody>
<tr>
<td>52L+26P</td>
<td>3 Hrs</td>
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**Unit – I  10 Hrs**

**Introduction to Composite Materials:** Definition, Classification, Types of matrices material and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepregs, and sandwich construction. Metal Matrix Composites: Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications

**Macro Mechanics of a Lamina:** Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems.Invariant properties.Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

**Unit – II  11 Hrs**

**Micro Mechanical Analysis of a Lamina:** Introduction, Evaluation of the four elastic moduli, Rule of mixture, Numerical problems. Experimental Characterization of Lamina- Elastic Moduli and Strengths

**Failure Criteria:** Failure criteria for an elementary composite layer or Ply, Maximum Stress and Strain Criteria, Approximate strength criteria, Inter-laminar Strength, Tsai-Hill theory, Tsai-Wu tensor theory, Numerical problem, practical recommendations.

**Unit – III  11 Hrs**

**Macro Mechanical Analysis of Laminate:** Introduction, code, Kirchoff hypothesis, Classical Lamination Theory, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems. Shear Deformation Theory, A, B, D and E matrices (Detailed derivation)

**Unit – IV  10 Hrs**

**Analysis of Composite Structures:** Optimization of Laminates, composite laminates of uniform strength, application of optimal composite structures, composite pressure vessels, spinning composite disks, composite lattice structures

**Unit – V  10 Hrs**

**Manufacturing and Testing:** lay-up and curing - open and closed mold processing, Hand lay-up techniques, Bag molding and filament winding, Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests – Purpose, Types of defects, NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method.

**Applications:** Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.

**Unit –VI Composites Lab  26 Hrs**

1. Identify the different ASTM Standards used for characterization of advanced materials.
2. Synthesis of thermosetting and thermoplastic composites
3. Conduct the physical and mechanical properties of the advanced engineering materials
4. Manufacturing and testing of Nano-composite
5. Ageing hardening of Al alloy

**Course Outcomes:**

After going through this course the student will be able to:

**CO1:** Explain the manufacturing process involved thermoplastic, thermoset and ceramic materials

**CO2:** Apply rule of mixtures to evaluate mechanical properties of composites

**CO3:** Describe Manufacturing and testing of composites

**CO4:** Evaluate the design considerations based on material & process
Reference Books:

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author, Publisher, Edition, ISBN</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>ISBN 13: 9780070557437</td>
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</table>

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE); Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150
Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)
### Semester: I

<table>
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#### Unit – I [10 Hrs]
**Geometry of Motion:** Introduction, analysis and synthesis, Mechanism terminology, planar, spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms: Development of different mechanisms and its inversions like four bar chain mechanism, slider crank mechanism, double slider cranks, mechanism.

#### Unit – II [11 Hrs]

#### Unit – III [11 Hrs]
**Analytical Methods of Dimensional Synthesis:** Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle

#### Unit – IV [10 Hrs]
**Graphical Methods of Dimensional Synthesis:** Two position synthesis of crank and rocker mechanisms, Three position synthesis, Four position synthesis (point precision reduction) Overlay method, Coupler curve synthesis, Cognate linkages. Analytical Methods of 32 Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.

#### Unit – V [10 Hrs]
**Spatial Mechanisms:** Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles.

#### Unit – VI Kinematics and Dynamics of Mechanisms Lab [26 Hrs]

Modeling and functional simulation of:
1. Freely falling body
2. Inclined Plane
3. Lift Mechanism - Geometry
4. Lift Mechanism - Simulation
5. One-degree-of-freedom Pendulum
6. Projectile
7. Spring Damper - Part 1
8. Spring Damper - Part 2
9. Suspension System 1
10. Suspension System 2
11. Four Bar Mechanism
12. Cam-Follower
13. Crank Slider
Course Outcomes:
After going through this course the student will be able to:

CO1: Describe the fundamental concepts of kinematics and dynamics
CO2: Design and analyze mechanism and kinematic linkages
CO3: Identify, formulate and solve engineering dynamic problems
CO4: Determine forces acting on the parts of machines used in Industries

Reference Books:

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Authors</th>
<th>Publisher</th>
<th>Year</th>
<th>ISBN</th>
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<tbody>
<tr>
<td>1</td>
<td>Kinematics, Dynamics and Design of Machinery</td>
<td>K.J.Waldron &amp; G.L.Kinzel</td>
<td>Wiley India,</td>
<td>2007</td>
<td>0471244171</td>
</tr>
<tr>
<td>2</td>
<td>Classical Dynamics</td>
<td>Greenwood</td>
<td>Prentice Hall of</td>
<td>1988</td>
<td>0486696904</td>
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<tr>
<td>4</td>
<td>Mechanism and Machine Theory</td>
<td>A. G. Ambekar</td>
<td>PHI</td>
<td>2007</td>
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Continuous Internal Evaluation (CIE); Theory (100 Marks)
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The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150
Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)
Semester: I  
PROFESSIONAL SKILL DEVELOPMENT  
(Common to all Programs)  

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<td>Hours</td>
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Unit – I  
03 Hrs  

Resume Writing: Understanding the basic essentials for a resume, Resume writing tips Guidelines for better presentation of facts. Theory and Applications.

Unit – II  
08 Hrs  


Analytical Reasoning - Single & Multiple comparisons, Linear Sequencing.

Logical Aptitude - Syllogism, Venn-diagram method, Three statement syllogism, Deductive and inductive reasoning. Introduction to puzzle and games organizing information, parts of an argument, common flaws, arguments and assumptions.

Verbal Analogies/Aptitude – introduction to different question types – analogies, Grammar review, sentence completions, sentence corrections, antonyms/synonyms, vocabulary building etc. Reading Comprehension, Problem Solving

Unit – III  
03 Hrs  
Interview Skills: Questions asked & how to handle them, Body language in interview, and Etiquette – Conversational and Professional, Dress code in interview, Professional attire and Grooming, Behavioral and technical interviews, Mock interviews - Mock interviews with different Panels. Practice on Stress Interviews, Technical Interviews, and General HR interviews

Unit – IV  
03 Hrs  
Interpersonal and Managerial Skills: Optimal co-existence, cultural sensitivity, gender sensitivity; capability and maturity model, decision making ability and analysis for brainstorming; Group discussion (Assertiveness) and presentation skills

Unit – V  
07 Hrs  
Motivation: Self-motivation, group motivation, Behavioral Management, Inspirational and motivational speech with conclusion. (Examples to be cited).

Leadership Skills: Ethics and Integrity, Goal Setting, leadership ability.

Course Outcomes:
After going through this course the student will be able to:
CO1: Develop professional skill to suit the industry requirement.
CO2: Analyze problems using quantitative and reasoning skills
CO3: Develop leadership and interpersonal working skills.
CO4: Demonstrate verbal communication skills with appropriate body language.
Reference Books:


Scheme of Continuous Internal Examination (CIE)
Evaluation of CIE will be carried out in TWO Phases.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Activity</th>
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<tbody>
<tr>
<td>I</td>
<td>After the completion of Unit 1 and Unit 2, students are required to undergo a test set for a total of 50 marks. The structure of the test will have two parts. Part A will be quiz based, evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).</td>
</tr>
<tr>
<td>II</td>
<td>Students will have to take up second test after the completion Unit 3, Unit 4 and Unit 5. The structure of the test will have two parts. Part A will be quiz based evaluated for 15 marks and Part B will be of descriptive type, set for 50 Marks and reduced to 35 marks. The total marks for this phase will be 50 (15 + 35).</td>
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</table>

FINAL CIE COMPUTATION
Continuous Internal Evaluation for this course will be based on the average of the score attained through the two tests. The CIE score in this course, which is a mandatory requirement for the award of degree, must be greater than 50%. The attendance will be same as other courses.
Semester: I

PRODUCT DESIGN FOR QUALITY
(Group A: Core Elective)

<table>
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<tr>
<th>Course Code</th>
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<td>100</td>
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Unit – I 07 Hrs


Unit – II 08 Hrs

**Quality Function Deployment** – Introduction, QFD team, benefits, voice of customer, organisation of information, house of quality, QFD process

**Design of Experiments**: Basic methods- Two factorial experiments- Extended method reduced tests and fractional experiments, orthogonality, base design method, higher dimensional fractional factorial design

Unit – III 08 Hrs

**Failure Mode Effect Analysis**: Refining geometry and layout, Failure tree analysis, Defects and failure modes Techniques of failure analysis, Filed inspection of failure, Macroscopic and Microscopic examination, Additional tests, Analysis of data and report of failure.

Unit – IV 08 Hrs

**Statistical Consideration in Product Design and Development**
Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams-Cause and Effect diagrams-Box plots- Probability distribution- Statistical Process control–Scatter diagrams – Multivariable charts

Unit – V 08 Hrs

**Six Sigma** – Overview, Basics and history of the approach for six sigma, Methodology and focus, the application of Six Sigma in production and in service industries, Relationship of Six Sigma and Lean Management, linking Six Sigma project goals with organizational strategy

Course Outcomes:
After going through this course the student will be able to:

CO1: Identify the importance of various principles of quality in product or service

CO2: Use statistical tools in product development

CO3: Apply basic risk analysis and experiment design techniques into practical cases

CO4: Demonstrate knowledge about Six sigma, Design of Experiments

Reference Books:

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project. 

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
**Semester: I**

**TRIBOLOGY**

(Group A: Core Elective)

<table>
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<th>Course Code</th>
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<tbody>
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<td>39L+26T</td>
<td>3 Hrs</td>
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</table>

**Unit – I**

07 Hrs


**Unit – II**

08 Hrs

**Hydrodynamic Lubrications:** Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on performance, Numerical problems.

**Journal Bearings:** Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Somerfield number and its significance, partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.

**Unit – III**

08 Hrs

**Hydrostatic Bearings:** Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems.

**Antifriction bearings:** Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.

**Unit – IV**

08 Hrs

**EHL Contacts:** Introduction to Elasto - hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.

**Porous Bearings:** Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages.

**Unit – V**

08 Hrs

**Magnetic Bearings:** Introduction to magnetic bearings, Active magnetic bearings. Different equations used in magnetic bearings and working principal. Advantages and disadvantages of magnetic bearings, Electrical analogy, Magneto-hydrodynamic bearings

**Course Outcomes:**

**After going through this course the student will be able to:**

**CO1:** Demonstrate fundamentals of tribology, lubricants and methods of lubrication

**CO2:** Analyze bearings for load carrying capacity, frictional force and power loss

**CO3:** Illustrate the different modes of lubrication system for various applications.

**CO4:** Design the different bearing system such as antifriction bearings, magnetic bearings and porous bearings for various applications
<table>
<thead>
<tr>
<th>Reference Books:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Theory and practice of Lubrication for Engineers, Dudley D.Fuller, New York Company, 1998</td>
</tr>
<tr>
<td>2 Principles and applications of Tribology, Moore, Pergamon press, 1975</td>
</tr>
<tr>
<td>4 Lubrication of Bearings - Theoretical principles and design, Radzimovsky, Oxford press Company, 2000</td>
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Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: I

DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS
(Group A: Core Elective)

<table>
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<td>Hours</td>
<td>39L+26T</td>
<td>SEE Duration</td>
<td>3 Hrs</td>
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Unit – I
07 Hrs


Unit – II
08 Hrs

Maintenance of Hydraulic Systems: Prime function of hydraulic fluids, desirable properties of hydraulic fluids, general types of fluids, factors affecting the selection of fluids, sealing devices, reservoir systems, filters and strainers, heat exchangers, pressure switch, wear of moving parts, troubleshooting of hydraulic systems.

Unit – III
08 Hrs

Hydraulic circuit Design and Analysis: Control of a single acting cylinder, double acting cylinder, regenerative circuit, counter balance valve applications, Hydraulic cylinder sequencing circuits, automatic cylinder reciprocating systems, Locked cylinder using pilot check valves, cylinder synchronizing circuits, fail safe circuits.

Unit – IV
08 Hrs

Pneumatic Concepts: Introduction, comparison of hydraulics/pneumatics/and electrical system, air compressor system, types of compressors, compressed air behavior, pneumatic actuators, direction control valves, building a pneumatic circuits, application of logic valves.

Design of Pneumatic Circuits: Speed control circuits, Application of time delay valves. Position sensing in pneumatic cylinders, roller lever valve, pressure sensing in pneumatic circuits, pressure sequence valve, two cylinder movement, cascade method.

Unit – V
08 Hrs


Servo System and PLC Applications in Pneumatics: Closed loop control with servo system, Hydro-mechanical servo system, Electro-hydraulic servo system, Conventional valve vs proportional valve, Proportional valve in hydraulic circuits, characteristics of proportional valve and servo valve. PLC application in fluid power, logic in ladder logic diagram and Mnemonics, Timer- on delay and off delay.

Course Outcomes:
After going through this course the student will be able to:
CO1: Describe the constructional features of hydraulic and pneumatic components
CO2: Apply hydraulic and pneumatic controls in the design of automated controls.
CO3: Evaluate the design of hydraulic and pneumatic components for building a circuit
CO4: Design the hydraulic and pneumatic based systems for industrial applications.
**Reference Books:**

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**Scheme of Semester End Examination (SEE) for 100 marks:**

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<td>Hours</td>
<td>52L</td>
<td>SEE Duration</td>
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</table>

**Unit – I**

10 Hrs

Centralized systems: Client Server Systems, Parallel Systems, Distributed Systems, Network Types, Parallel Database, Distributed Database, Security and Integrity, Standardization views.

Product Data Management: Complexity in Product Development, General Description of PDM Basic functionality of PDM: Information architecture, PDM System architecture, Applications used in PDM systems. Trends in PDM

**Unit – II**

11 Hrs


**Unit – III**

11 Hrs


**Unit – IV**

10 Hrs

Creating Product Structures: Part centric approach, CAD centric approach, Product Structure configuration, Managing Product Structures, PDM resources on the Internet.

**Unit – V**

10 Hrs

PDM Implementation Case Studies: Matrix One, Team Center, Windchill, Enovia. Standards in PDM, CM, SCM and CMM.

**Course Outcomes:**

*After going through this course the student will be able to:*

**CO1:** Understanding the Product data base systems

**CO2:** Select the Product data base systems based on material and product

**CO3:** Analyzing the Product data base and Product life cycle for new products

**CO4:** Evaluate the parameters for Product data base considerations based on process

**Reference Books:**

Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Semester: I

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<td>4:0:0</td>
<td>100</td>
<td>52L</td>
<td>3 Hrs</td>
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</table>

**Overview of Artificial Intelligence:** Artificial Intelligence and its Application areas;

**Knowledge Representation and Search:** The Predicate Calculus: The Propositional Calculus, The Predicate Calculus, Using Inference Rules to Produce Predicate Calculus Expressions, Application: A Logic-Based Financial Advisor;

**Structures and strategies for state space search:** Introduction, Structures for state space search, Strategies for State Space Search, Using the State Space to Represent Reasoning with the Predicate Calculus; And/or Graphs.

**Heuristic Search:** Introduction, Hill Climbing and Dynamic Programming, The Best-First Search Algorithm, Admissibility, Monotonicity and Informedness, Using Heuristics in Games, Complexity Issues.

**Control and Implementation of State Space Search:** Introduction, Recursion-Based Search, Production Systems, The Blackboard Architecture for Problem Solving.

**Other Knowledge Representation Techniques:** Semantic Networks, Conceptual Dependencies, Scripts and Frames, Conceptual Graphs.

**Knowledge Intensive Problem Solving:** Overview of Expert System Technology, Rule-Based Expert Systems, Model-Based, Case Based, and Hybrid Systems

**Planning:** Introduction to Planning, Algorithms as State-Space Search, Planning graphs.

**Automated Reasoning:** Introduction to Weak Methods in Theorem Proving, The General Problem Solver and Difference Tables, Resolution Theorem Proving;

**Uncertain Knowledge and Reasoning:** Introduction to Uncertainty, Inference using Full-Joint Distribution, Independence, Bayes’ Rule and its use.

**Representing Knowledge in Uncertain Domain:** Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Exact Inference in Bayesian Network, Approximate Inference in Bayesian Network

**Artificial Neural Networks:** ANN Structures, Single Layer feed-forward neural networks, Multi-Layer feed-forward neural networks, Learning in multilayer networks, networks.

**Artificial Intelligence Current Trends:** The Science of Intelligent Systems, AI: Current Challenges and Future Directions;
Course Outcomes:
After going through this course the student will be able to:

CO1: Explore various Artificial Intelligence problem solving techniques.

CO2: Identify and describe the different AI approaches such as Knowledge representation, Search strategies, learning techniques to solve uncertain imprecise, stochastic and nondeterministic nature of AI problems.

CO3: Apply the AI techniques to solve various AI problems.

CO4: Analyse and compare the relative challenges pertaining to design of Intelligent Systems

Reference Books:

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<tr>
<td>3</td>
<td>Artificial Intelligence, Elaine Rich, Kevin Knight</td>
<td>Tata McGraw Hill</td>
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Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project. 
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: I

NON-TRADITIONAL MACHINING & TESTING
(Group B: Core Elective)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>CIE Marks</th>
<th>Credits L: T: P</th>
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<th>Hours</th>
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<td>100</td>
<td>52L</td>
<td>3 Hrs</td>
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</table>

**Unit – I**

**Introduction**: Need for unconventional machining processes, classification of non-traditional machining processes.

**Abrasive Jet Machining (AJM)**: Abrasive Jet Machining Setup – Gas propulsion System, Abrasive feeder, Machining Chamber, AJM Nozzle; Parametric Analysis – Stand-off-distance, Abrasive flow rate, Nozzle pressure, Mixing ratio; Process Capabilities.

**Ultrasound Machining (USM)**: Ultrasonic Machining System, Mechanics of cutting, Model proposed by Shaw – Grain Throwing Model, Grain Hammering Model; Parametric Analysis, Process Capabilities.

**Unit – II**


**Abrasive Flow Machining (AFM)**: Working Principle of Abrasive flow Machining System Process Variables,


**Unit – III**


**Unit – IV**


Unit V


**Course Outcomes:**

After going through this course the student will be able to:

**CO1:** Explain the principle, mechanism of metal removal of various unconventional machining processes.

**CO2:** Analyses the process parameters and their effect on the component machined on various unconventional machining processes and tested using NDT techniques.

**CO3:** Apply the concept for different NTM and NDT concepts industry.

**CO4:** Evaluate appropriate NTM and non-destructive techniques.

**Reference Books:**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Non Traditional Machining Techniques, Bennedict, G. F., Marcel Decker, New York, 1990 ISBN 9780824773526</td>
</tr>
</tbody>
</table>

**Continuous Internal Evaluation (CIE); Theory (100 Marks)**

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**Total CIE (Q+T+A) is 20+50+30=100 Marks.**

**Scheme of Semester End Examination (SEE) for 100 marks:**

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
## SECOND SEMESTER
### Semester: II

#### ADVANCED SOLID MECHANICS
(Theory & Practice)

<table>
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<tr>
<td>Hours</td>
<td>52L+26P</td>
<td>SEE Duration</td>
<td>3 Hrs</td>
</tr>
</tbody>
</table>

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**Unit – I**  
**10 Hrs**

**Introduction to general theory of elasticity:** assumptions and applications of linear elasticity. Analysis of stress, stress tensors. State of stress at a point, principal stresses in two dimensions, Cauchy's stress principle, direction cosines, stress components on an arbitrary plane with stress transformation. Principal stresses in three dimensions, stress invariants, Equilibrium equations, octahedral stresses, Mohr's stress circle, construction of Mohr’s Circle for two and three dimensional stress systems, equilibrium equations in polar coordinates for three-dimensional state of stresses.

**Unit – II**  
**11 Hrs**

**Introduction to analysis of strain,** types of strain, strain tensors, strain transformation. Principal strains, strain invariants, octahedral strains, Mohr's Circle for Strain, equations of Compatibility for Strain, strain rosettes. Stress-strain relations, the generalised Hooke's law, compatibility conditions, the transformation from Strain components to stress components. Strain energy in an elastic body, St. Venant's principle, uniqueness theorem.

**Unit – III**  
**11 Hrs**

**Theories of Failure and Energy Methods:** Introduction, Theories of Failure, Use of Factor of Safety in Design, Mohr’s theory of Failure, Ideally Plastic Solid, Stress space and Strain space, General nature of Yield locus, Yield Surfaces of Tresca and Von Mises, Stress- Strain relation (Plastic Flow), PrandtlReuss theory, Saint venant – Von mises equations.


**Unit – IV**  
**10 Hrs**

**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, Bending of curved beams, Deflection of thick curved bars.

**Unit – V**  
**10 Hrs**

**Torsion:** Introduction, Torsion of general prismatic bars – Solid sections, Torsion of Circular and Elliptical bars, Torsion of equivalent triangular bar, Torsion of rectangular bars, Membrane analogy, Torsion of thin walled tubes, Torsion of thin walled multiple cell closed sections, Multiple connected sections, Centre of twist and flexure centre

**Unit – VI** Advanced Solid Mechanics Lab  
**26 Hrs**

**Exercises:**
1. Basic Stress analysis
2. Deflection and Stress Analysis in beams
3. Nonlinear plastic Deformation and buckling Analysis
4. Two dimensional problems (Plane stress & Plane strain problems)
5. Analysis of Composite materials
6. Analysis of pressure vessels
7. Three dimensional FE analysis
Course Outcomes:
After going through this course the student will be able to:

CO1: Identify the stress-strain relations in elastic and plastic conditions

CO2: Examine bodies subjected to three dimensional stresses for the onset of failure based on failure criteria.

CO3: Analyze deflections in beams subjected to different types of loads for elastic, elastoplastic and plastic conditions

CO4: Evaluate stresses in bars subjected to torsion for elastic, elastoplastic and plastic conditions

Reference Books:

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>Edition</th>
<th>ISBN</th>
</tr>
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Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of Quizzes (Q), Tests (T) and Assignments (A). A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) Solving innovative problems 2) Seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Continuous Internal Evaluation (CIE); Practical (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Total marks: 100+50=150
Theory (100 Marks) + Practical (50 Marks) =Total Marks (150)
<table>
<thead>
<tr>
<th>Unit – I</th>
<th>07 Hrs</th>
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<tbody>
<tr>
<td>Review of Mechanical Vibrations: Basic concepts; free vibration of single degree of freedom systems with and without damping, forced vibration of single DOF-systems, Natural frequency. Transient Vibration of single Degree-of freedom systems: Impulse excitation, Arbitrary excitation</td>
<td></td>
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<table>
<thead>
<tr>
<th>Unit – II</th>
<th>08 Hrs</th>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Unit – III</th>
<th>08 Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modal analysis: Dynamic Testing of machines and Structures, Experimental Modal analysis.</td>
<td></td>
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</tbody>
</table>

| Vibrations of beams: equation of motion, modal analysis, approximate methods, initial value problem, forced vibrations, special problems, wave propagation Vibrations of membranes: equations of motion, modal analysis, approximate methods. |

<table>
<thead>
<tr>
<th>Unit – IV</th>
<th>08 Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Vibrations : Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response.</td>
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</table>

<table>
<thead>
<tr>
<th>Unit – V</th>
<th>08 Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signature analysis and preventive maintenance, Vibration testing equipment, signal generation, measuring and conditioning instruments.</td>
<td></td>
</tr>
</tbody>
</table>

| Vibration testing equipment: Signal analysis instruments, Vibration signatures and standards |

**Course Outcomes:**

**After going through this course the student will be able to:**

- **CO1**: Construct Equations of motion based on free body diagrams
- **CO2**: Analyse systems under free and forced vibrations for natural frequency of vibration
- **CO3**: Evaluate Mechanical Systems are using modal analysis
- **CO4**: Develop solutions through testing for vibrations and signature analysis techniques

**Reference Books:**

Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
# RESEARCH METHODOLOGY

<table>
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<tr>
<td>Hours</td>
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<td>SEE Duration</td>
<td>3 Hrs</td>
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## Unit – I

**Overview of Research:** Research and its types, identifying and defining research problem and introduction to different research designs. Essential constituents of Literature Review. Basic principles of experimental design, completely randomized, randomized block, Latin Square, Factorial.

## Unit – II

**Data and data collection:** Overview of probability and data types

Primary data and Secondary Data, methods of primary data collection, classification of secondary data, designing questionnaires and schedules.

**Sampling Methods:** Probability sampling and Non-probability sampling

## Unit – III

**Processing and analysis of Data:** Statistical measures of location, spread and shape, Correlation and regression, Hypothesis Testing and ANOVA. Interpretation of output from statistical software tools

## Unit – IV

**Advanced statistical analyses:** Non parametric tests, Introduction to multiple regression, factor analysis, cluster analysis, principal component analysis. Usage and interpretation of output from statistical analysis software tools.

## Unit – V

**Essentials of Report writing and Ethical issues:** Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Ethical issues related to Research, Publishing, Plagiarism

**Case studies:** Discussion of case studies specific to the domain area of specialization

### Course Outcomes:

**After going through this course the student will be able to:**

CO1: Explain the principles and concepts of research types, data types and analysis procedures.

CO2: Apply appropriate method for data collection and analyze the data using statistical principles.

CO3: Present research output in a structured report as per the technical and ethical standards.

CO4: Create research design for a given engineering and management problem situation.

### Reference Books:


Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
### Semester: II

#### MINOR PROJECT

<table>
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</tr>
<tr>
<td>Credits</td>
<td>02</td>
<td>SEE Duration</td>
<td>3 Hrs</td>
</tr>
</tbody>
</table>

**GUIDELINES**

1. Each project group will consist of maximum of two students.
2. Each student/group has to select a contemporary topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to four.
5. The minor project would be performed in-house.
6. The implementation of the project must be preferably carried out using the resources available in the department/college.

**Course Outcomes:**

After going through this course the students will be able to:

- **CO1:** Conceptualize, design and implement solutions for specific problems.
- **CO2:** Communicate the solutions through presentations and technical reports.
- **CO3:** Apply resource managements skills for projects
- **CO4:** Synthesize self-learning, team work and ethics.

**Scheme of Continuous Internal Examination (CIE)**

Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of FOUR members: guide, two senior faculty members and Head of the Department.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Activity</th>
<th>Weightage</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Synopsis submission, Preliminary seminar for the approval of selected topic and Objectives formulation</td>
<td>20%</td>
</tr>
<tr>
<td>II</td>
<td>Mid-term seminar to review the progress of the work and documentation</td>
<td>40%</td>
</tr>
<tr>
<td>III</td>
<td>Oral presentation, demonstration and submission of project report</td>
<td>40%</td>
</tr>
</tbody>
</table>

**Phase wise rubrics to be prepared by the respective departments**

**CIE Evaluation shall be done with weightage / distribution as follows:**

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing 25%
- Demonstration & Presentation 15%
- Report writing 25%
Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

1. Brief write-up about the project 5%
2. Presentation / Demonstration of the project 20%
3. Methodology and Experimental Results & Discussion 25%
4. Report 20%
5. Viva Voce 30%
Semester: II
THEORY OF PLATES AND SHELLS
(Group C: Core Elective)

<table>
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<tr>
<td>Hours</td>
<td>: 52L</td>
<td>SEE Duration</td>
<td>: 3 Hrs</td>
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</table>

Unit – I
10 Hrs

**General Introduction:** Review of equations of elasticity- kinematics, compatibility equations, stress measures- equations of motions- constitutive relations- transformation of stresses, strains and stiffness-energy principles and variational methods in elasticity- virtual work-external and internal virtual work variational operator- functional- Euler Lagrange equations- energy principles- Hamilton’s principle-principle of minimum total potential- applications.

Unit – II
11 Hrs

**Classical Theory Of Plates:** Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis

Unit – III
11 Hrs

**Buckling Analysis of Rectangular Plates:** Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy’s solution- buckling of plates with various boundary conditions-general formulation- finite element analysis

Unit – IV
10 Hrs

**Vibration of Plates:** Governing equations for natural flexural vibrations of rectangular plates- natural vibrations of plates simply supported on all edges- vibration of plates with two parallel sides simply supported Levy’s solution- vibration of plates with different boundary conditions- Rayleigh-Ritz method Natural vibration of plates with general boundary conditions- transient analysis of rectangular plates- finite element analysis.

Unit – V
10 Hrs

**Analysis of Thin Elastic Shells of Revolution:** Classification of shell surfaces- geometric properties of shells of revolution- general strain displacement relations for shells of revolution- stress resultants-equations of motion of thin shells, analytical solution for thin cylindrical shells- membrane theory-flexure under axisymmetric loads, shells with double curvature- geometric considerations- equations of equilibrium- bending of spherical shells- vibration of cylindrical shells- finite element analysis.

**Course Outcomes:**
After going through this course the student will be able to:
CO1: Apply the structural mechanics approximations of membrane, plates and shells.
CO2: Develop simple modifications to the membrane plate and shell theories
CO3: Describe the static, dynamic, and non-linear motion of membrane, plate and shell structures.
CO4: Analyze numerical problems in shells of revolution

**Reference Books:**
Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Scheme of Semester End Examination (SEE) for 100 marks:
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 Semester: II  
**DESIGN FOR MANUFACTURE & ASSEMBLY**  
(Group C: Core Elective)  

<table>
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<tr>
<td>Hours</td>
<td>52L</td>
<td>SEE Duration</td>
<td>3 Hrs</td>
</tr>
</tbody>
</table>

**Unit – I**  
**10 Hrs**  
**Introduction to Design for Manufacture & Assembly:** Steps in DFMA, Advantages of DFMA, Design guidelines for Manual Assembly and High Speed Automatic and Robotic Assembly.  

**Geometrical Dimensioning & Tolerance**  
Dimensions & Tolerance, Limits, Fits and Tolerances, Hole and Shaft Basis, Three datum – functional, machining and manufacturing, geometrical and form tolerance, conventional and advanced tools and techniques for measurements, numerical.

**Unit – II**  
**11 Hrs**  
**Metal Casting Processes – Gravity Die Casting**  
compute the dimensions for Pattern, Mould, based on materials to be cast – ferrous and non-ferrous alloys, influence of parting line, cast holes, special sand cores, shrinkage compensation, numericals.  
**Pressure Die Casting:**  
Die casting alloys, machine selection, operation, sub-systems, post-processing equipments, mould design, number of cavities, manufacturing and assembly of moulds, design principles.

**Unit – III**  
**11 Hrs**  
**Design for Injection Molding**  
Injection moulding systems – injection subsystem, ejection system, clamping and feeding system, machine sizing, materials for injection moulding and its properties, injection mould design – cavity and core, manufacturing processes for moulds, operation and cycle time.

**Unit – IV**  
**10 Hrs**  
**Design for Powder Metallurgy Processes:** Introduction to PM process, blending and mixing, compaction, sintering processes. Tooling materials, heat treatment, surface treatments and preparation of green compacts, Press tools for PM process – load, tooling layout, capacity; sintering furnace and influence of process and materials parameters on shrinkage.

**Unit – V**  
**10 Hrs**  
**Design for Sheet Metal Processing:**  
Design of moulds for shearing, piercing, bending, deep drawing, progressive die operation, selection of press – hydraulic and electric, sub-systems, turret operation, cycle time calculation, laser cutting of sheet metals.  
**Cost Estimation**  
for sand casting, pressure die casting, injection moulding, PM process and sheet metal processes.

**Course Outcomes:**  
After going through this course the student will be able to:  
**CO1:** Explain the concept of DFMA and GD&T  
**CO2:** Apply engineering products and suggest suitable manufacturing process  
**CO3:** Evaluate the influence of design, material and manufacturing processes on product assembly  
**CO4:** Develop appropriate manufacturing and assembly processes for a given product

**Reference Books:**  
Continuous Internal Evaluation (CIE); Theory (100 Marks)
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## Semester: II

### COMPUTER APPLICATION IN DESIGN

(Group C: Core Elective)

<table>
<thead>
<tr>
<th>Course Code</th>
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<th>Credits L: T: P</th>
<th>SEE Marks</th>
<th>Hours</th>
<th>SEE Duration</th>
</tr>
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<tbody>
<tr>
<td>18MCM2C3</td>
<td>100</td>
<td>4:0:0</td>
<td>100</td>
<td>52L</td>
<td>3 Hrs</td>
</tr>
</tbody>
</table>

### Unit – I  10 Hrs

**Points, lines and planar curves:** Vector algebra

**Shapes inside a computer:** Review of geometry and trigonometry, Points in a plane: Position vectors, Angles between lines - introducing the third dimension: Scalar products, Finding normal to planes: Vector products, Following a line: Parameters

### Unit – II  11 Hrs

**Lines in space:** Vector equations: Lines in two-dimensional space, in three-dimensional space, Different parametric forms; Lines and common curves: Parametric and Cartesian forms: Linearity and non-linearity, Functions, The parabola, The circle, The ellipse, The circular helix

**Transformations:** Matrix algebra, Tools for transformations: Matrices, Transformations, Matrices, Adding and subtracting matrices, Multiplying matrices; Moving in a plane: Scaling, reflection and rotation: Matrices as geometric operators, Scaling position vectors, Reflecting position vectors in the axes, Rotating position vectors about the origin, Transforming polygons

### Unit – III  11 Hrs

**Combining transformations:** Translations, Order in combining transformations, Specific combinations of transformations, Translations, (3x3) Matrices for transformations in a plane Sizing things up: Homogeneous vectors: Simple homogeneous vectors, General homogeneous vectors, Matrix operations using homage vectors

**Useful manoeuvres:** Non-standard rotations and reflections the viewing transformation: Standard and standard, Rotation about an arbitrary point, Reflection in an arbitrary line, The viewing transformation

**The third dimension:** Moving along rays, points at infinity and three-dimensional transformations: Geometrical insights using homogeneous vectors, Completing consideration of (3*3) matrices, Points at infinity, Three dimensional transformations, Some specific (4x4) matrices, Local scaling, Reflections in the coordinate planes, Rotations about the coordinate axes, Translation, Overall scaling, In conclusion

### Unit – IV  10 Hrs

**Points of view:** Projection and single point perspective: Projection from three dimensions onto a plane, Orthographic projection, The need for perspective, Single point perspective, Perspective projection, Tunnel perspective, To improve realism

**A greater sense of perspective:** Two point and three point perspective: Improving perspective, Translation then single point perspective, Rotation then single point perspective, giving two points perspective, Rotation, translation then single point perspective improved two point perspective, Two rotations, translation then single point perspective, giving three point perspective, The three types of perspective-projection, Vanishing points and trace points

**Space curves and surfaces:** Differentiation, Slopes of lines and planar curves: Gradient functions: Lines and curves, Slope of a straight line from its Cartesian equation, Slope of a curve from its Cartesian equation, Practical rules for differentiation, Slope of a straight line from its vector equations

**Slopes of space curves:** Tangents and normal, Space curves, The tangent vector to a space curve, Tangents and normals for curves in a plane, Tangents and normals in three dimensions

### Unit – V  10 Hrs

**Curve fitting:** Interpolation and shape function: Lines and curves from real objects, Linear interpolation, Quadratic interpolation, Uniqueness

**Planes and surfaces:** Bi parametric forms: sweeps and revolutions, Surface formulae and two parameters, Vector equations of planes, The vector equation of a plane, given two vectors in the plans,
The vector equation of a plane, given two unit vectors in the plane, The vector equation of a plane, given three points in a plane, Parameter lines and parameter planes, Plotting a plane, The implicit form of equation of a plane, Generating a swept surface, Generating a surface of revolution

**Wire frame surfaces surface Tangents and normal:** Partial differentiation: General surfaces, Forming a wire frame, Carved surfaces from the, Partial differentiation, Surface tangents and surface normal.

**Piecewise surfaces Quadrilateral patches:** Dividing up surfaces, A quadrilateral patch on a sphere, Bilinear patches, Linear Coons patches.

**Course Outcomes:**
*After going through this course the student will be able to:*

- **CO1:** Discuss the concepts of Computer Graphics in CAD in product development
- **CO2:** Apply the concepts of CAD in the manufacturing industry
- **CO3:** Analyze the concepts of computer Aided Design
- **CO4:** Evaluating the techniques involved in CAD

**Reference Books:**

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
<th>ISBN</th>
</tr>
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<tbody>
<tr>
<td>2</td>
<td>CAD/CAM Concepts and Applications</td>
<td>Chennakesava R Alavala</td>
<td>PHI, New Delhi, 2009</td>
<td>978-81-203-3340-6</td>
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**Continuous Internal Evaluation (CIE); Theory (100 Marks)**

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

**Scheme of Semester End Examination (SEE) for 100 marks:**
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Introduction: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr’s theory and modified Mohr’s theory, Numerical examples, Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features


LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean 30 stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber’s rule, Glinka’s rule, and applications of fracture mechanics to crack growth at notches.

Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.

Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosive wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength

Course Outcomes:
After going through this course the student will be able to:
CO1: Identify and explain the types of fractures of engineered materials and their characteristic features
CO2: Develop a detailed understanding of S-N curves, S-N approach & behaviour
CO3: Understand the differences in the classification of fracture mechanics (LEFM and EPFM) and how their corresponding parameters can be utilized to determine conditions under which engineering materials will be liable to fail catastrophically in service.
CO4: Appreciate the theoretical basis of the experimental techniques utilized for surface failure analysis
### Reference Books:

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<tr>
<td></td>
<td></td>
<td>Robert, Henry o. Fuchs</td>
<td></td>
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<td></td>
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<tr>
<td>4</td>
<td>Fatigue of Materials</td>
<td>S.Suresh</td>
<td>Cambridge University Press</td>
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### Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

**Total CIE (Q+T+A) is 20+50+30=100 Marks.**

### Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Unit – I

10 Hrs


Unit – II

11 Hrs


Unit – III

11 Hrs

Robotic Workspace & Motion Trajectory: Introduction, General Structures of Robotic Workspaces, Manipulations with n Revolute Joints, Robotic Workspace Performance Index, Extreme Reaches of Robotic Hands, Robotic Task Description. Robotic Motion Trajectory Design: – Introduction, Trajectory Interpolators, Basic Structure of Trajectory Interpolators, Cubic Joint Trajectories. General Design Consideration on Trajectories: 4-3-4 & 3-5-3 Trajectories, Admissible Motion Trajectories.

Unit – IV

10 Hrs


Unit – V

10 Hrs


Course Outcomes:

After going through this course the student will be able to:
CO1: Analyze the manipulator design including actuator, drive and sensor issues
CO2: Calculate the forward kinematics, inverse kinematics and Jacobian industrial robots
CO3: Solve trajectory and dynamic related robotic problems
CO4: Evaluate the different configurations and stability of autonomous robots
### Reference Books:

<table>
<thead>
<tr>
<th>#</th>
<th>Reference</th>
<th>Author(s)</th>
<th>Publisher</th>
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<tr>
<td>1</td>
<td>A Robot Engineering Textbook, Mohsen Shahinpoor</td>
<td>Harper &amp; Row publishers</td>
<td>New York.</td>
<td>006045931X</td>
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<tr>
<td>2</td>
<td>Robotics, control vision and intelligence</td>
<td>Fu, Lee and Gonzalez</td>
<td>McGraw Hill International</td>
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### Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

**Total CIE (Q+T+A) is 20+50+30=100 Marks.**

### Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: II
ADVANCED FINITE ELEMENT ANALYSIS
(Group D: Core Elective)

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<td>Hours</td>
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</table>

Unit – I
10 Hrs


Unit – II
11 Hrs


Unit – III
11 Hrs


Unit – IV
10 Hrs


Unit – V
10 Hrs

Applications in Heat Transfer & Fluid Mechanics: One dimensional heat transfer element – application to one-dimensional heat transfer problems- scalar variable problems in 2-Dimensions – Applications to heat transfer in 2- Dimension – Application to problems in fluid mechanics in 2-D

Course Outcomes:
After going through this course the student will be able to:
CO1: Explain the fundamentals of finite element methods
CO2: Develop the knowledge to analyses, structures under static and dynamic conditions.
CO3: Selection of numerical techniques for solving engineering problems
CO4: Explore the use of finite element method knowledge to implement industrial project

Reference Books:
Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
### BUSINESS ANALYTICS

**Semester: II**

<table>
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**Credits L: T: P**

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**Unit – I**

08 Hrs


Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling.

**Unit – II**

08 Hrs


**Unit – III**

08 Hrs

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 Modelling, Predictive analytics analysis.

**Unit – IV**

08 Hrs


**Unit – V**

07 Hrs


---

**Course Outcomes:**

*After going through this course the student will be able to:*

** CO1:** Explore the concepts, data and models for Business Analytics.

** CO2:** Analyze various techniques for modelling and prediction.

** CO3:** Design the clear and actionable insights by translating data.

** CO4:** Formulate decision problems to solve business applications

---

**Reference Books:**


Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
<table>
<thead>
<tr>
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| **INDUSTRIAL & OCCUPATIONAL HEALTH AND SAFETY**  
(Group G: Global Elective) |
<table>
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<table>
<thead>
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<th>UNIT – I</th>
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<tbody>
<tr>
<td><strong>Industrial safety</strong>: 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 fire fighting, equipment and methods.</td>
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<tr>
<th>UNIT – IV</th>
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<table>
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<tr>
<th>UNIT – V</th>
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</thead>
</table>
Course Outcomes:
After going through this course the student will be able to:

CO1: Explain the Industrial and Occupational health and safety and its importance.

CO2: Demonstrate the exposure of different materials, occupational environment to which the employee can expose in the industries.

CO3: Characterize the different type materials, with respect to safety and health hazards of it.

CO4: Analyze the different processes with regards to safety and health and the maintenance required in the industries to avoid accidents.

Reference Books:


Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.

Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: II

<table>
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<tr>
<td>Hours</td>
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<td>SEE Duration</td>
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**MODELING USING LINEAR PROGRAMMING**
(Group G: Global Elective)

**Unit – I**
08 Hrs

Linear Programming: Introduction to Linear Programming problem
Simplex methods: Variants of Simplex Algorithm – Use of Artificial Variables

**Unit – II**
08 Hrs

Advanced Linear Programming: Two Phase simplex techniques, Revised simplex method
Duality: Primal-Dual relationships, Economic interpretation of duality

**Unit – III**
08 Hrs

Sensitivity Analysis: Graphical sensitivity analysis, Algebraic sensitivity analysis - changes in RHS, Changes in objectives, Post optimal analysis - changes affecting feasibility and optimality

**Unit – IV**
08 Hrs

Transportation Problem: Formulation of Transportation Model, Basic Feasible Solution using North-West corner, Least Cost, Vogel’s Approximation Method, Optimality Methods, Unbalanced Transportation Problem, Degeneracy in Transportation Problems, Variants in Transportation Problems.

**Unit – V**
07 Hrs


**Course Outcomes:**
After going through this course the student will be able to:

**CO1:** Explain the various Linear Programming models and their areas of application.

**CO2:** Formulate and solve problems using Linear Programming methods.

**CO3:** Develop models for real life problems using Linear Programming techniques.

**CO4:** Analyze solutions obtained through Linear Programming techniques.

**Reference Books:**

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: II

PROJECT MANAGEMENT
(Group G: Global Elective)

<table>
<thead>
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<td>SEE Duration</td>
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Unit – I 08 Hrs


Unit – II 08 Hrs

Capital Budgeting: Capital Investments: Importance and Difficulties, phases of capital budgeting, levels of decision making, facets of project analysis, feasibility study - a schematic diagram, objectives of capital budgeting

Unit – III 08 Hrs


Unit – IV 08Hrs

Tools & Techniques of Project Management: Bar (GANTT) chart, bar chart for combined activities, logic diagrams and networks, Project evaluation and review Techniques (PERT) Critical Path Method (CPM), Computerized project management

Unit-V 07 Hrs

Project Management and Certification: An introduction to SEI, CMMI and project management institute USA – importance of the same for the industry and practitioners. PMBOK 6 - Introduction to Agile Methodology, Themes / Epics / Stories, Implementing Agile.

Domain Specific Case Studies on Project Management: Case studies covering project planning, scheduling, use of tools & techniques, performance measurement.

Course Outcomes:
After going through this course the student will be able to:

CO1: Explain project planning activities that accurately forecast project costs, timelines, and quality.

CO2: Evaluate the budget and cost analysis of project feasibility.

CO3: Analyze the concepts, tools and techniques for managing projects.

CO4: Illustrate project management practices to meet the needs of Domain specific stakeholders from multiple sectors of the economy (i.e. consulting, government, arts, media, and charity organizations)

Reference Books:


Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project.
Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: II
ENERGY MANAGEMENT
(Group G: Global Elective)

<table>
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<tr>
<td>Hours</td>
<td>39L</td>
<td>SEE Duration</td>
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Unit-I 08 Hrs

**Energy conservation:**

Unit-II 08 Hrs

**Wet Biomass Gasifiers:**
Introduction, Classification of feedstock for biogas generation, Biomass conversion technologies: Wet and dry processes, Photosynthesis, Biogas generation, Factors affecting bio-digestion, Classification of biogas plants, Floating drum plant and fixed dome plant their advantages and disadvantages

Unit –III 08 Hrs

**Dry Biomass Gasifiers :**
Biomass energy conversion routes, Thermal gasification of biomass, Classification of gasifiers, Fixed bed systems: Construction and operation of up draught and down draught gasifiers.

Unit –IV 08 Hrs

**Solar Photovoltaic:**
Principle of photovoltaic conversion of solar energy, Types of solar cells and fabrication.

**Wind Energy:**
Classification, Factors influencing wind, WECS & classification.

Unit –V 07 Hrs

**Alternative liquid fuels:**

Course Outcomes:
After going through this course the student will be able to:
CO1: Understand the use alternate fuels for energy conversion
CO2: Develop a scheme for energy audit
CO3: Evaluate the factors affecting biomass energy conversion
CO4: Design a biogas plant for wet and dry feed

Reference Books:
Continuous Internal Evaluation (CIE); Theory (100 Marks)
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Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: II
INDUSTRY 4.0
(Group G: Global Elective)

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<tbody>
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**Unit – I** 07 Hrs
**Introduction:** Industrial, Internet, Case studies, Cloud and Fog, M2M Learning and Artificial Intelligence, AR, Industrial Internet Architecture Framework (IIAF), Data Management.

**Unit – II** 08 Hrs

**Unit – III** 08 Hrs
**Data Analytics in Manufacturing:** Introduction, Power Consumption in manufacturing, Anomaly Detection in Air Conditioning, Smart Remote Machinery Maintenance Systems with Komatsu, Quality Prediction in Steel Manufacturing.


**Unit – IV** 08 Hrs


**Unit – V** 08 Hrs
**Augmented Reality:** The Role of Augmented Reality in the Age of Industry 4.0, Introduction, AR Hardware and Software Technology, Industrial Applications of AR, Maintenance, Assembly, Collaborative Operations, Training.

Smart Factories: Introduction, Smart factories in action, Importance, Real world smart factories, The way forward.


**Course Outcomes:**
**After going through this course the student will be able to:**

**CO1:** Understand the opportunities, challenges brought about by Industry 4.0 for benefits of organizations and individuals

**CO2:** Analyze the effectiveness of Smart Factories, Smart cities, Smart products and Smart services

**CO3:** Apply the Industrial 4.0 concepts in a manufacturing plant to improve productivity and profits

**CO4:** Evaluate the effectiveness of Cloud Computing in a networked economy
Reference Books:

<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Author(s)</th>
<th>Publisher</th>
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<tbody>
<tr>
<td>1</td>
<td>INDUSTRY 4.0 THE INDUSTRIAL INTERNET OF THINGS</td>
<td>Alasdair Gilchrist</td>
<td>Apress</td>
<td>978-1-4842-2046-7</td>
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<tr>
<td>2</td>
<td>Industry 4.0: Managing The Digital Transformation</td>
<td>Alp Ustundag, Emre Cevikcan</td>
<td>Springer</td>
<td>978-3-319-57869-9</td>
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<td>3</td>
<td>Designing the industry - Internet of things connecting the physical,</td>
<td>Ovidiu Vermesan and Peer Friess</td>
<td>Rivers Publishers</td>
<td>978-87-93379-81-7</td>
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<td>digital and virtual worlds,</td>
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<td>4</td>
<td>The concept Industry 4.0- An Empirical Analysis of Technologies and</td>
<td>Christoph Jan Bartodziej</td>
<td>Springer Gabler</td>
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<td>Applications in Production Logistics</td>
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Continuous Internal Evaluation (CIE); Theory (100 Marks)

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Total CIE (Q+T+A) is 20+50+30 = 100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: II
ADVANCED MATERIALS
(Group G: Global Elective)

<table>
<thead>
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<td>100</td>
<td>3:0:0</td>
<td>100</td>
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<td>3 Hrs</td>
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</table>

**Unit – I**
07 Hrs


**Unit – II**
08 Hrs


**Unit – III**
08 Hrs

High Strength Materials: Methods of strengthening of alloys, Materials available for high strength materials, Applications of high strength materials

**Unit – IV**
08 Hrs

Low & High Temperature Materials
Properties required for low temperature applications, Materials available for low temperature applications, Requirements of materials for high temperature applications, Materials available for high temperature applications, Applications of low and high temperature materials.

**Unit – V**
08 Hrs

Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials

Course Outcomes:
After going through this course the student will be able to:
CO1: Describe metallic and non-metallic materials
CO2: Explain preparation of high strength Materials
CO3: Integrate knowledge of different types of advanced engineering Materials
CO4: Analyse problem and find appropriate solution for use of materials.

Reference Books:
Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. Three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) Minor project. Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: II

COMPOSITE MATERIALS SCIENCE AND ENGINEERING
(Group G: Global Elective)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>CIE Marks</th>
<th>Credits L: T: P</th>
<th>SEE Marks</th>
<th>Credits L: T: P</th>
<th>Hours</th>
<th>SEE Duration</th>
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<tr>
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<td>100</td>
<td>3:0:0</td>
<td>39L</td>
<td>3 Hrs</td>
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Unit-I

**Introduction to composite materials**
Fundamentals of composites – need for composites – Enhancement of properties – Classification based on matrix- Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC) – Constituents of composites, Interfaces and Interphases, Distribution of constituents, Types of Reinforcements, Particle reinforced composites, Fibre reinforced composites. Fiber production techniques for glass, carbon and ceramic fibers Applications of various types of composites.

Unit – II

**Polymer matrix composites (PMC)**

Unit -III

**Ceramic matrix composites and special composites**

Unit –IV

**Metal matrix composites**

Unit –V

**Polymer nano composites**
Course Outcomes:
After going through this course the student will be able to:

CO1: Understand the purpose and the ways to develop new materials upon proper combination of known materials.

CO2: Identify the basic constituents of a composite materials and the list the choice of materials available

CO3: Will be capable of comparing/evaluating the relative merits of using alternatives for important engineering and other applications.

CO4: Get insight to the possibility of replacing the existing macro materials with nanomaterials.

Reference Books:

<table>
<thead>
<tr>
<th></th>
<th>Title</th>
<th>Author</th>
<th>Edition</th>
<th>Publisher</th>
<th>ISBN</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Composite Materials Science and Engineering</td>
<td>Krishan K Chawla</td>
<td>3rd</td>
<td>Springer - verlag GmbH</td>
<td>978-0387743646</td>
</tr>
<tr>
<td>2</td>
<td>The Science and Engineering of Materials</td>
<td>K Balani, Donald R Askeland</td>
<td>6th</td>
<td>Cengage</td>
<td>978-8131516416</td>
</tr>
<tr>
<td>3</td>
<td>Polymer Science and Technology</td>
<td>Joel R Fried</td>
<td>2nd</td>
<td>Prentice Hall</td>
<td>978-0137039555</td>
</tr>
<tr>
<td>4</td>
<td>Nanomaterials and nanocomposites</td>
<td>Rajendra Kumar Goyal</td>
<td>2nd</td>
<td>CRC Press-Taylor &amp; Francis</td>
<td>9781498761666, 1498761666</td>
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Total CIE (Q+T+A) is 20+50+30=100 Marks.

Scheme of Semester End Examination (SEE) for 100 marks:
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one full question from each unit.
Semester: II

PHYSICS OF MATERIALS
(Group G: Global Elective)

<table>
<thead>
<tr>
<th>Course Code</th>
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Unit – I

Crystal Structure
Discussion of lattice and lattice parameters, seven crystals systems, crystal planes, Miller indices, Interplanar distance, Packing fraction, Structure of different crystals-NaCl and Diamond, Bragg’s law, Powder method, Bragg’s spectrometer, Qualitative Analysis of Crystal structure using XRD, Reciprocal lattice, Crystal defects-Point, Line, Planar and Volume defects.

Unit – II

Dielectric Materials
Basic concepts, Langevin’s Theory of Polarisation, Types of Polarisation, Dipolar relaxation, Frequency Dependence of total polarization (polariability as a function of frequency), Qualitative discussion of Internal Field and Claussius Mossotti, Dielectric loss spectrum, Dielectric strength, Dielectric Breakdown, Breakdown mechanisms in solid dielectrics, Applications of Solid Insulating materials in capacitors and Liquid insulating materials in Transformers, Dielectric Heating, Piezoelectricity, Direct and Inverse Piezoelectric effect, Coupling factor, spontaneous polarization, Piezoelectricity in Quartz, Various piezoelectric materials- PZT, PVDF, Ferroelectricity, Barium titanate, Poling in Ceramics.

Unit – III

Magnetic Materials
Review of Dia, Para and Ferromagnetic materials, Weiss theory of Ferromagnetism, Hysteresis effect, Magnetostriction, Anti-ferromagnetism, Ferrimagnetsim, Soft and Hard magnetic materials, examples and applications in Transformer cores and Magnetic storage devices, Superconductors, properties, Types of Superconductors, BCS theory, High Temperature Superconductors, Applications in Cryotron and SQUID.

Unit – IV

Semiconducting Materials
Semiconductors-Direct and Indirect band gap semiconductors, Importance of Quantum confinement-quantum wires and dots, size dependent properties, Top down approach, Fabrication process by Milling and Lithography, Bottom up approach, fabrication process by vapour phase expansion and vapor phase condensation, Polymer semi-conductors-Photo conductive polymers, Applications.

Unit – V

Novel Materials

Biomaterials-Metallic, ceramic and polymer biomaterials, Titanium and Titanium alloys, Carbon nanotubes, Graphene- Properties and Applications.

Course Outcomes:
After going through this course the student will be able to:

CO1: Apply the principles of Physics in Engineering.

CO2: Apply the knowledge of Physics for material analysis.

CO3: Identify and Analyze Engineering Problems to achieve practical solutions.

CO4: Develop solutions for Problems associated with Technologies.
Reference Books:

<table>
<thead>
<tr>
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<th>Edition</th>
<th>Publisher</th>
<th>ISBN</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Introduction to Solid State Physics</td>
<td>C. Kittel</td>
<td>7th</td>
<td>John Wiley &amp; Sons</td>
<td>9971-51-180</td>
</tr>
<tr>
<td>3</td>
<td>Engineering Physics, Dr.M N Avadhanulu, Dr. P G Kshirsagar</td>
<td>S Chand Publishing</td>
<td>Reprint</td>
<td></td>
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<th>Unit – I</th>
<th>07 Hrs</th>
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<tbody>
<tr>
<td><strong>Sampling Techniques:</strong></td>
<td>Concepts of random sampling from finite and infinite populations, Simple random sampling (with replacement and without replacement), Sampling distribution of proportions, Expectation and standard error of sample mean and proportion, Sampling distributions of differences and sums.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Unit – II</th>
<th>08 Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Estimation:</strong></td>
<td>Point estimation, Estimator and estimate, Criteria for good estimates - unbiasedness, consistency, efficiency and sufficiency, Method of moment’s estimation and maximum likelihood estimation, Confidence intervals-population mean (large sample).</td>
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<table>
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<th>Unit – III</th>
<th>08 Hrs</th>
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<tbody>
<tr>
<td><strong>Tests of Hypothesis:</strong></td>
<td>Principles of Statistical Inference, Formulation of the problems with examples. Simple and composite hypotheses. Null and alternative hypotheses. Tests - type I and type II error, Testing of mean and variance of normal population (one sample and two samples), Exact and asymptotic tests of proportions. Chi squared test for goodness of fit (Relevant case studies).</td>
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</table>

<table>
<thead>
<tr>
<th>Unit – IV</th>
<th>07 Hrs</th>
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<tbody>
<tr>
<td><strong>Linear Statistical Models:</strong></td>
<td>Definition of linear model and types, One way ANOVA and two way ANOVA models-one observation per cell, multiple but equal number of observation per cell (Relevant case studies).</td>
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<thead>
<tr>
<th>Unit – V</th>
<th>09 Hrs</th>
</tr>
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<tbody>
<tr>
<td><strong>Linear Regression:</strong></td>
<td>Simple linear regression, Estimation of parameters, Properties of least square estimators, Estimation of error variance, Multivariate data, Multiple linear regressions, Multiple and partial correlation, Autocorrelation-introduction and plausibility of serial dependence, sources of autocorrelation, Durbin-Watson test for auto correlated variables.</td>
</tr>
</tbody>
</table>

**Course Outcomes:**

**CO1:** Identify and interpret the fundamental concepts of sampling techniques, estimates and types, hypothesis, linear statistical models and linear regression arising in various fields engineering.

**CO2:** Apply the knowledge and skills of simple random sampling, estimation, null and alternative hypotheses, errors, one way ANOVA, linear and multiple linear regressions.

**CO3:** Analyze the physical problem to establish statistical/mathematical model and use appropriate statistical methods to solve and optimize the solution.

**CO4:** Distinguish the overall mathematical knowledge gained to demonstrate the problems of sampling techniques, estimation, tests of hypothesis, regression and statistical model arising in many practical situations.
Reference Books:

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Curriculum Design Process

Academic Planning And Implementation

- Align Course Contents (Lesson Plan)
- Identify Expected Attainment Level (Threshold)
- Publish course Materials (PPT’s, Notes, Model Question Paper)
- Publish Schedule (Time Table, Test, Self Study, Lab)

Implement Program Curriculum (Course Delivery)

Formative Student Assessment (Tests, Quizzes, Lab and Through Pedagogical Initiatives)

Assess Results and Feedback to Students

Performance < Expected

No

Yes

Remedial

A

A

Cumulative Outcome Assessment

Course End Survey

Assessment Outcome Data and Students Feedback on TLP

Academic Advisory Committee

Improve Program Curriculum/Assessment Methods/Redfine CD’s
Process For Course Outcome Attainment

Course Curriculum

CO-PO Mapping

Mapping of COs to CIE QP

Weightage of COs from tests and quizzes

Students marks from tests and quizzes

Lab experiment assessment, Score and weightage

Self Study assessment score and weightage

Attainment of CO for each student

Number of students getting more than the target attainment

Final CO Attainment Process

Course (Syllabus)

Course Achievable Matrix

Mapping of COs to CIE question paper

QP Achieved (Student score from Test and Quiz)

Ratio of QP achieved to course achievable

Lab experiments mapped to COs

Self-study assessment rubrics mapped to COs

CO Attainment

Direct 90%

Indirect 10%

Course end survey mapped to COs

CIE

80%

SEE

20%

CO attainment from SEE

At the end of the course
Program Outcome Attainment Process

1. Course (Syllabus)
2. CO Attainment
3. CO–PO Mapping
4. PO Attainment DIRECT

PO Attainment

80%

20%

Alumni Survey

PO Attainment INDIRECT

Employer Survey

Senior Exit Survey