30.08.2022

**Choice Based Credit System (CBCS) and Outcome-Based Education (OBE)**

**SEMESTER - III**

| TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES | | | |
|---|---|---|---|
| Course Code | 21MAT 31 | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P:S) | 2:2:0:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:** The goal of the course Transform Calculus, Fourier series and Numerical techniques 21MAT 31 is

- To have an insight into solving ordinary differential equations by using Laplace transform techniques
- Learn to use the Fourier series to represent periodical physical phenomena in engineering analysis.
- To enable the students to study Fourier Transforms and concepts of infinite Fourier Sine and Cosine transforms and to learn the method of solving difference equations by the z-transform method.
- To develop proficiency in solving ordinary and partial differential equations arising in engineering applications, using numerical methods

**Teaching-Learning Process (General Instructions):**

TheseareSampleStrategies,whichteacherscanusetoacceleratetheattainmentofthevariouscourse outcomes.

1. Inadditiontothetraditionallecturemethod,differenttypesofinnovativeteachingmethodsmay be adopted so that the delivered lessons shall develop students' theoretical and applied mathematicalskills.
2. StatetheneedforMathematicswithEngineeringStudiesandProvidereal-lifeexamples.
3. Supportandguidethestudentsforself–study.
4. Youwillalsoberesponsibleforassigninghomework,gradingassignmentsandquizzes,and documenting students'progress.
5. Encouragethestudentsforgrouplearningtoimprovetheircreativeandanalyticalskills.
6. Showshortrelatedvideolecturesinthefollowingways:
   - Asanintroductiontonewtopics(pre-lectureactivity).
   - As a revision of topics (post-lectureactivity).
   - As additional examples (post-lectureactivity).
   - Asanadditionalmaterialofchallengingtopics(pre-andpost-lectureactivity).
   - Asamodelsolutionforsomeexercises(post-lectureactivity).

**Module-1: Laplace Transform (8 Hours)**

Definition and Laplace transforms of elementary functions (statements only). Problems on Laplace's Transform of $e^{at}f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. Laplace transforms of Periodic functions (statement only) and unit-step function – problems. Inverse Laplace transforms definition and problems, Convolution theorem to find the inverse Laplace transforms (without Proof) problems. Laplace transforms of derivatives, solution of differential equations. **(8 Hours)**

**Self-study:** Solution of simultaneous first-order differential equations.

**(RBT Levels: L1, L2 and L3 )**

| Teaching-Learning Process | Chalk and talk method / PowerPoint Presentation |
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**Module-2: Fourier Series (8 Hours)**

Introduction to infinite series, convergence and divergence. Periodic functions, Dirichlet's condition. Fourier series of periodic functions with period $2\pi$ and arbitrary period. Half range Fourier series. Practical harmonic analysis.

**Self-study:** Convergence of series by D'Alembert's Ratio test and, Cauchy'sroot test.

**(RBT Levels: L1, L2 and L3)**

| Teaching-Learning Process | Chalk and talk method / PowerPoint Presentation |
|---|---|

**Module-3: Infinite Fourier Transforms and Z-Transforms (8 Hours)**

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| Infinite Fourier transforms definition, Fourier sine and cosine transforms. Inverse Fourier transforms, Inverse Fourier cosine and sine transforms. Problems.<br>Difference equations, z-transform-definition, Standard z-transforms, Damping and shifting rules, Problems. Inverse z-transform and applications to solve difference equations<br>**Self Study**: Initial value and final value theorems, problems.<br>**(RBT Levels: L1, L2 and L3)** |
| **Teaching-Learning Process** \| Chalk and talk method / PowerPoint Presentation |
| **Module-4: Numerical Solution of Partial Differential Equations (8 Hours)** |
| Classifications of second-order partial differential equations, finite difference approximations to derivatives, Solution of Laplace's equation using standard five-point formula. Solution of heat equation by Schmidt explicit formula and Crank-Nicholson method, Solution of the Wave equation. Problems.<br>**Self Study**: Solution of Poisson equations using standard five-point formula.<br>**(RBT Levels: L1, L2 and L3)** |
| **Teaching-Learning Process** \| Chalk and talk method / PowerPoint Presentation |
| **Module-5: Numerical Solution of Second-Order ODEs and Calculus of Variations** |
| Second-order differential equations - Runge-Kutta method and Milne's predictor and corrector method. (No derivations of formulae).<br>Calculus of Variations: Functionals, Euler's equation, Problems on extremals of functional. Geodesics on a plane, Variational problems<br>**Self Study:** Hanging chain problem<br>**(RBT Levels: L1, L2 and L3)** |
| **Course outcomes:** After successfully completing the course, the students will be able :<br>➢ To solve ordinary differential equations using Laplace transform.<br>➢ Demonstrate the Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.<br>➢ To use Fourier transforms to analyze problems involving continuous-time signals and to apply Z-Transform techniques to solve difference equations<br>➢ To solve mathematical models represented by initial or boundary value problems involving partial differential equations<br>➢ Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis. |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% ( 18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

**Continuous Internal Evaluation:**

Three Unit Tests each of **20 Marks (duration 01 hour)**

First test at the end of 5$^{th}$ week of the semester

Second test at the end of the 10$^{th}$ week of the semester

Third test at the end of the 15$^{th}$ week of the semester

Two assignments each of **10 Marks**

First assignment at the end of 4$^{th}$ week of the semester

Second assignment at the end of 9$^{th}$ week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

At the end of the 13$^{th}$ week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks

There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Text Books:**


1. **B.S.Grewal**:"HigherEngineeringMathematics",Khanna publishers,44$^{th}$Ed.2018
2. **E.Kreyszig**:"AdvancedEngineeringMathematics",JohnWiley&Sons,10$^{th}$Ed.(Reprint),2016.


**Reference Books**


1. **V.Ramana**:"HigherEngineeringMathematics"McGraw-HillEducation,11$^{th}$Ed.
2. **SrimantaPal&SubodhC.Bhunia:**"EngineeringMathematics"OxfordUniversityPress,3$^{rd}$Reprint, 2016.
3. **N.P Bali and Manish Goyal**: "A textbook of Engineering Mathematics" Laxmi Publications, Latest edition.
4. **C. Ray Wylie, Louis C. Barrett:** "Advanced Engineering Mathematics" McGraw – Hill Book Co.Newyork, Latested.
5. **Gupta C.B, Sing S.R and Mukesh Kumar:** "Engineering Mathematic for Semester I and II", Mc- Graw Hill Education(India) Pvt. Ltd2015.
6. **H.K.DassandEr.RajnishVerma:**"HigherEngineeringMathematics"S.ChandPublication(2014).
7. **JamesStewart:"**Calculus"Cengagepublications,7$^{th}$edition,4$^{th}$Reprint2019.


**Web links and Video Lectures (e-Resources):**

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| • http://.ac.in/courses.php?disciplineID=111<br>• http://www.class-central.com/subject/math(MOOCs)<br>• http://academicearth.org/<br>• http://www.bookstreet.in.<br>• VTU e-ShikshanaProgram<br>• VTU EDUSATProgram |
| **Activity-Based Learning (Suggested Activities in Class)/ Practical Based learning**<br>• Quizzes<br>• Assignments<br>Seminars |

**Semester - 03**

| METAL CASTING FORMING & JOINING PROCESS (IPCC) | | | |
|---|---|---|---|
| Course Code | 21ME32 | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:2*:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory + 12 Lab slots | Total Marks | 100 |
| Credits | 04 | Exam Hours | 03 |

**** One additional hour may be considered for instructions, wherever required***

**Course objectives:**

- To acquaint with the basic knowledge on fundamentals of metal forming processes
- To study various metal forming processes.
- To provide adequate knowledge of quality test methods conducted on welded and cast components.
- To provide knowledge of various casting process in manufacturing.
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys.
- To provide detailed information about the moulding processes.
- To impart knowledge of various joining process used in manufacturing.

**Teaching-Learning Process (General Instructions)**

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

| **MODULE-1** | **8 HOURS** |
|---|---|
| **Introduction & basic materials used in foundry**: *Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy. Introduction to casting process & steps involved – (Brief Introduction)-Not for SEE*<br>**Patterns:** Definition, classification, materials used for pattern, various pattern allowances and their importance.<br>**Sand moulding**: Types of base sand, requirement of base sand. Binder, Additive's definition, need and types; preparation of sand moulds. Molding machines- Jolt type, squeeze type and Sand slinger.<br>**Study of important moulding process:** Green sand, core sand, dry sand, sweep mould, CO2mould, shell mould, investment mould, plaster mould, cement bonded mould.<br>**Cores**: Definition, need, types. Method of making cores,<br>Concept of gating (top, bottom, parting line, horn gate) and risers (open, blind) Functions and types. | |
| **Teaching-Learning Process** | Understanding, Remembering<br>Chalk & Talk Method / Power point presentation/ You tube videos |

| **MODULE-2** | **8HOURS** |
|---|---|
| **Melting furnaces**: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.<br>**Casting using metal moulds:** Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes. Casting defects, their causes and remedies. | |
| **Teaching-Learning Process** | . Understanding, Remembering<br>Chalk & Talk Method / Power point presentation/ You tube videos |

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|---|---|
| **MODULE-3** | **8 HOURS** |
| **METAL FORMING PROCESSES**<br>***Introduction of metal forming process:*** Mechanical behaviour of metals in elastic and plastic deformation, stress-strain relationships, Yield criteria, Application to tensile testing, train rate and temperature in metal working; Hot deformation, Cold working and annealing.<br>***Metal Working Processes:*** Fundamentals of metal working, Analysis of bulk forming processes like forging, rolling, extrusion, wire drawing by slab method,<br>***Other sheet metal processes:*** Sheet metal forming processes (Die and punch assembly, Blanking, piercing, bending etc., Compound and Progressive die), High Energy rate forming processes. | |
| **Teaching-Learning Process** | Understanding, Remembering<br>Chalk & Talk Method / Power point presentation/ You tube videos |
| **MODULE-4** | **8 HOURS** |
| **JOINING PROCESSES**<br>***Operating principle, basic equipment, merits and applications of***: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding. | |
| **Teaching-Learning Process** | Understanding, Remembering<br>Chalk & Talk Method / Power point presentation/ You tube videos |
| **MODULE 5** | **8 HOURS** |
| ***Weldability and thermal aspects***: Concept of weldability of materials; Thermal Effects in Welding (Distortion, shrinkage and residual stresses in welded structures); Welding defects and remedies.<br>***Allied processes***: Soldering, Brazing and adhesive bonding<br>**Advance welding processes:** Resistance welding processes, friction stir welding (FSW). | |
| **Teaching-Learning Process** | Understanding, Remembering<br>Chalk & Talk Method / Power point presentation/ You tube videos |

**PRACTICAL COMPONENT OF IPCC**

**Course objectives:**

- Impart fundamental understanding of various casting, welding and forming processes
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys
- Discuss design methodology and process parameters involve in obtaining defect free component

| Sl.NO | Experiments |
|---|---|
| 1 | Studying the effect of the clay and moisture content on sand mould properties |
| 2 | Preparation of sand specimens and conduction of the following tests: 1. Compression, Shear and Tensile tests on Universal Sand Testing Machine. |
| 3 | To determine permeability number of green sand, core sand and raw sand. |
| 4 | To determine AFS fineness no. and distribution coefficient of given sand sample. |
| 5 | Use of Arc welding tools and welding equipment Preparation of welded joints using Arc Welding equipment L-Joint, T-Joint, Butt joint, V-Joint, Lap joints on M.S. flats |

| | |
|---|---|
| 6 | To study the effect of heat affected zone on the microstructure of steel weldment using MMAW. |
| 7 | Preparing minimum three forged models involving upsetting, drawing and bending operations |
| 8 | Sheet metal punch/die design and layout optimization |
| | **Demo experiments for CIE** |
| 9 | To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing |
| 10 | Mould preparation of varieties of patterns, including demonstration |
| 11 | To generate plastic curve of a given metal strip at room temperature and at recrystallization temperature during rolling. Observe the changes in metal characteristic after rolling. |
| 12 | Demonstration of material flow and solidification simulation using Auto-Cast software |

**Course outcome (Course Skill Set)**

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

1. Select appropriate primary manufacturing process and related parameters for obtaining initial shape and size of components.
2. Design and develop adequate tooling linked with casting, welding and forming operations.
3. Appreciate the effect of process parameters on quality of manufactured components
4. Demonstrate various skills in preparation of molding sand for conducting tensile, shear and compression tests using Universal sand testing machine.
5. Demonstrate skills in preparation of forging models involving upsetting, drawing and bending operations.
6. Demonstrate skills in preparation of Welding models.

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

**CIE for the theory component of IPCC**

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5$^{th}$ week of the semester
- Second test at the end of the 10$^{th}$ week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4$^{th}$ week of the semester
- Second assignment at the end of 9$^{th}$ week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

**CIE for the practical component of IPCC**

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of

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the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.

- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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**SEE for IPCC**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

3. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
4. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
5. The students have to answer 5 full questions, selecting one full question from each module.

**The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).**

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

**Suggested Learning Resources:**

**Books**


1. Ghosh, A. and Mallik, A. K., (2017), Manufacturing Science, East-West Press.
2. Parmar R. S., (2007), Welding Processes and Technology, Khanna Publishers.
3. Little R. L. – 'Welding and Welding Technology' – Tata McGraw Hill Publishing Company Limited, New Delhi – 1989
4. Grong O. – 'Metallurgical Modelling of Welding' – The Institute of Materials – 1997 – 2nd Edition
5. Kou S. – 'Welding Metallurgy' – John Wiley Publications, New York – 2003 – 2nd Edition.
6. Serope Kalpakjian and Steven R. Schmid – 'Manufacturing Engineering and Technology' – Prentice Hall – 2013 – 7th Edition
7. Principles of foundry technology, 4th edition, P L Jain, Tata McGraw Hill, 2006.
8. Advanced Welding Processes technology and process control, John Norrish, Wood Head Publishing, 2006.


**Web links and Video Lectures (e-Resources):**

- (Link:http://www.springer.com/us/book/9781447151784http://nptel.ac.in/courses/112
- 105127/)
- http://www.astm.org/DIGITAL_LIBRARY/MNL/SOURCE_PAGES/MNL11.htm
- http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/COMPTECH/PAGES/CTR10654J.htm
- MOOCs: http://nptel.ac.in/courses/112105126/.

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Metal Casting: Design pattern/core for a given component drawing and develop a sand mould with optimum gating and riser system for ferrous and non-ferrous materials. Melting and casting, inspection for macroscopic casting defects.
- Welding: TIG and MIG welding processes – design weld joints – welding practice –weld quality inspection.
- Metal Forming: Press working operation – hydraulic and mechanical press -load calculation: blanking, bending and drawing operations – sheet metal layout design.

**Semester - 03**

| MATERIAL SCIENCE AND ENGINEERING (IPCC) | | | |
|---|---|---|---|
| Course Code | 21ME33 | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 3:0:2*:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 hours Theory + 12 Lab slots | Total Marks | 100 |
| Credits | 04 | Exam Hours | 03 |
| * One additional hour may be considered wherever required | | | |

**Course objectives:**

- Provide basic background to systematically approach for selection of materials for a wide range of products in engineering applications.
- Introduce the concept of crystal structure, atomic planes and directions.
- Introduce the concept of atomic packing, coordination, and symmetry elements.
- Introduce imperfections in solids.
- Introduce phase stabilities and phase diagrams.
- Teach mechanism of phase transformations.
- Introduce various heat treatment methods.

**Teaching-Learning Process (General Instructions)**

Teacher can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

**MODULE-1** **8 HOURS**

***Structure of Materials***

*Introduction:* Classification of materials, crystalline and non-crystalline solids, atomic bonding

*Geometrical Crystallography:* Symmetry elements: the operation of rotation, Proper and Improper rotation axes, Screw axes, Glide planes

*Crystal Structure:* Crystal Lattice, Unit Cell, Planes and directions in a lattice, Planar Atomic Density, packing of atoms and packing fraction, Classification and Coordination of voids, Bragg's Law

*Imperfections in Solids:* Types of imperfections, Point defects: vacancies, interstitials, line defects, 2-D and 3D-defects, Concept of free volume in amorphous solids.

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|---|---|
| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk.<br>4. Laboratory Demonstrations and Practical Experiments. |

**MODULE-2** **8 HOURS**

***Physical Metallurgy***

*Alloy Systems:* Classification of Solid solutions, Hume- Rothery Rules

*Phase Diagrams:* Gibbs Phase Rule, Solubility limit, phase equilibria and Phase Diagrams: Isomorphous systems, Invariant Binary Reactions, Lever Rule; important phase- diagrams , Iron-Carbon Diagram.

*Diffusion:* Diffusion-Fick's Laws, Role of imperfections in diffusion.

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|---|---|
| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk,<br>4. Laboratory Demonstrations and Practical Experiments. |

**MODULE-3** **8 HOURS**

*Nucleation and growth:* Introduction to homogeneous and heterogeneous nucleation, critical radius for nucleation. *Plastic Deformation:* Slip, Twinning; Recovery- Recrystallization-Grain Growth, Introduction to Strengthening mechanisms. Lever rule and phase diagram.

*Heat treatment: Annealing, Normalizing, hardening, Tempering, Nitriding, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology.* TTT diagram, microstructural effects brought about by these processes and their influence on mechanical properties.

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|---|---|
| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk,<br>4. Laboratory Demonstrations and Practical Experiments. |

**MODULE-4** **8 HOURS**

*Surface coating technologies: Introduction, coating materials, coating technologies, types of coating, advantages and disadvantages of surface coating.*

*Powder metallurgy: Introduction, Powder Production Techniques: Different Mechanical and Chemical methods, Characterization of powders (Particle Size & Shape Distribution), Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process, Sintering and Application of Powder Metallurgy.*

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|---|---|
| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk,<br>4. Laboratory Demonstrations and Practical Experiments. |

**MODULE 5** **8 HOURS**

**Materials Selection**

*The need for material selection in design, the evolution of Engineering materials.*

*The Design Process and Materials Data: Types of design, design tools and materials data, processes of obtaining materials data, materials databases*

*Engineering Materials and Their Properties: The classes of engineering materials and their structure, material properties: mechanical properties, functional properties.*

*Material Selection Charts: Selection criteria for materials, material property Charts, deriving property limits and material indices, materials indices which include shape.*

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| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk. |

**PRACTICAL COMPONENT OF IPCC**

| Sl.NO | Experiments |
|---|---|
| 1 | Specimen preparation for macro and micro structural examinations and study the macrostructure and microstructure of a sample metal/ alloys- |
| 2 | To study the crystal structure of a given Cast Iron, Mild steel, Aluminium and Copper/Brass specimens and study the crystal imperfections in a given Cast Iron, Mild steel and Aluminium specimens. |
| 3 | Study the heat treatment processes (Hardening and tempering) of steel/Aluminium specimens. |

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| 4 | To determine the hardness values of Mild Steel/ Aluminium by Rockwell hardness/Vickers Hardness. |
| 5 | To determine the hardness values of Copper/ Brass by Brinell's Hardness testing machine. |
| 6 | To study the creep behaviour of a given Cast Iron or Aluminium specimen. |
| 7 | To study of microstructure of welding Mild Steel components and Heat affected zone (HAZ) macro and micro examinations |
| 8 | To determine the tensile strength, modulus of elasticity, yield stress, % of elongation and % of reduction in area of Cast Iron, Mild Steel/Brass/ Aluminium and to observe the necking. |
| 9 | To conduct a wear test on Mild steel/ Cast Iron/Aluminium/ Copper to find the volumetric wear rate and coefficient of friction. |
| 10 | Study the chemical corrosion and its protection. ***Demonstration*** |
| 11 | Study the properties of various types of plastics. ***Demonstration*** |
| 12 | Computer Aided Selection of Materials: Application of GRANTA Edupack for material selection: Case studies based on material properties. ***Demonstration*** |

**Course outcomes (Course Skill Set):**

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

1. Understand the atomic arrangement in crystalline materials and describe the periodic arrangement of atoms in terms of unit cell parameters.
2. Understand the importance of phase diagrams and the phase transformations.
3. Know various heat treatment methods for controlling the microstructure..
4. Correlate between material properties with component design and identify various kinds of defects.
5. Apply the method of materials selection, material data and knowledge sources for computer-aided selection of materials.

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

**CIE for the theory component of IPCC**

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5$^{th}$ week of the semester
- Second test at the end of the 10$^{th}$ week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4$^{th}$ week of the semester
- Second assignment at the end of 9$^{th}$ week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

**CIE for the practical component of IPCC**

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the

laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.

- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

**SEE for IPCC**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be proportionally reduced to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

**The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).**

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

**Suggested Learning Resources:**

**Text Books:**


1. Ashby, M.F. (2010), *Materials Selection in Mechanical Design*, 4th Edition, Butterworth- Heinemann.
2. Azaroff, L.V., (2001) *Introduction to solids*, 1st Edition, McGraw Hill Book Company.
3. Avner, S.H., (2017), *Introduction to Physical Metallurgy*, 2nd Edition, McGraw Hill Education.
4. Powder Metallurgy Technology, Cambridge International Science Publishing,2002.


**Reference Books**


1. Jones, D.R.H., and Ashby,M.F., (2011), *Engineering Materials 1:* An Introduction to Properties, Application and Design, 4th Edition, Butterworth-Heinemann.
2. Jones, D.R.H., and Ashby,M.F., (2012), *Engineering Materials 2:* An Introduction to Microstructure and Processing, 4th Edition, Butterworth-Heinemann.
3. Callister Jr, W.D., Rethwisch, D.G., (2018), *Materials Science and Engineering: An Introduction*, 10th Edition, Hoboken, NJ: Wiley.
4. Abbaschian, R., Abbaschian, L., Reed-Hill, R. E., (2009), *Physical Metallurgy Principles*, 4th Edition, Cengate Learning.
5. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi,2008.


**Web links and Video Lectures (e-Resources):**

1. Bhattacharya,B., *Materials Selection and Design*, NPTEL Course Material, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, http://nptel.ac.in/courses/112104122/
2. Prasad, R., Introduction to Materials Science and Engineering, NPTEL Course Material, Department of Materials

Science and Engineering, Indian Institute of Technology Delhi, http://nptel.ac.in/courses/113102080/

3. Subramaniam, A., Structure of Materials, NPTEL Course Material, Department of Material Science and Engineering, Indian Institute of Technology Kanpur,https://nptel.ac.in/courses/113104014/
4. Schuh, C., 3.40J Physical Metallurgy. Fall 2009. Massachusetts Institute of Technology: MIT Open Course Ware, https://ocw.mit.edu. License: Creative Commons BY-NC-SA.
5. Ghosh, R.N., Principles of Physical Metallurgy, IIT Kharagpur, http://nptel.ac.in/syllabus/113105024/

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- **Course seminar**
- **Industrial tour**

**III Semester**

| THERMODYNAMICS | | | |
|---|---|---|---|
| Course Code | **21ME34** | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 2:2:0 | SEE Marks | 50 |
| Total Hours of Pedagogy | 40 | Total Marks | 100 |
| Credits | 03 | Exam Hours | 03 |

**Course objectives:**

- State the governing laws of Thermodynamics.
- Explain the concepts and principles of pure substances and entropy.
- Describe air standard, gas and vapour power cycles used in prime movers.

**Teaching-Learning Process (General Instructions)**

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

**Module-1**

***Introduction and Review of fundamental concepts:*** *Thermodynamic definition and scope, Microscopic and Macroscopic approaches, Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium,* (Only for Self study)

**Zeroth law of thermodynamics.** Temperature; scales, thermometry, Importance of temperature measuring instruments. Design of Thermometers.

**Work and Heat**: Thermodynamic definition of work; examples, sign convention, Displacement work, Heat; definition, units and sign convention, Expressions for displacement work and heat in various processes through p-v diagrams. Shaft work, Electrical work.

**First Law of Thermodynamics:** Statement of the first law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, Steady Flow Energy Equation (SFEE) and engineering applications.

| | |
|---|---|
| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk are used for Problem Solving./White board |

**Module-2**

**Second Law of Thermodynamics and Entropy:** Limitations of first law of thermodynamics. Devices converting heat to work; (a) In a thermodynamic cycle, (b) In a mechanical cycle. Thermal reservoir, direct heat engine; schematic representation and efficiency. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Carnot cycle, Clausius inequality, Statement-proof, Entropy-definition, a property, change of entropy, entropy as a quantitative test for irreversibility, entropy as a coordinate.

**Available energy and Exergy:** Available energy, Maximum work in a reversible process; useful work; Dead state; availability; Second law efficiency.

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Dept. Of Mechanical Engineering
Alva's Institute of Engg. & Technology
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| | |
|---|---|
| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk are used for Problem Solving. |

**Module-3**

***Introduction and Review of Ideal and Real gases:*** *Ideal gas mixtures, Daltons law of partial pressures, Amagats law of additive volumes, Evaluation of properties of ideal gases. Real gases: introduction, Van-Der Waal's equation, Van-Der Waal's constants in terms of critical properties.* (Only for self study)

**Compressibility factor, compressibility chart and applications.**

**Thermodynamic relations:** Maxwell's equations, TdS equation. Ratio of Heat capacities and Energy equation, Joule-Kelvin effect, Clausius-Clapeyron equation.

**Combustion thermodynamics:** Theoretical (Stoichiometric) air for combustion of fuels, excess air, actual combustion. Exhaust gas analysis. A/F ratio, energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion, adiabatic flame temperature, combustion efficiency.

| | |
|---|---|
| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk are used for Problem Solving. |

**Module-4**

**Pure Substances**: P-T and P-V diagrams, triple point and critical points, sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat), Dryness fraction (quality) representation of various processes on T-S & H-S diagrams.

**Vapour Power Cycles:** Carnot vapour power cycle, simple Rankine cycle, actual vapour power cycles, ideal and practical regenerative Rankine cycles, open and closed feed water heaters, Reheat Rankine cycle and characteristics of an Ideal working fluid in vapour power cycles.

| | |
|---|---|
| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk are used for Problem Solving. |

**Module-5**

**Gas power cycles**

Ericson Cycle, Stirling Cycle, Air standard cycles-Otto cycle, Diesel cycle and Dual cycle, computation of thermal efficiency and mean effective pressure, comparison of Otto, Diesel & Dual cycles.

**Gas turbine Cycles:** Introduction and classification of gas turbine, gas turbine (Brayton) cycle; description and thermal analysis and methods to improve thermal efficiency of gas turbines, Jet Propulsion.

| | |
|---|---|
| **Teaching-Learning Process** | 1. Power-point Presentation,<br>2. Video demonstration or Simulations,<br>3. Chalk and Talk are used for Problem Solving.<br>4. Arrange Industrial visit to a power plant. |

**Course Outcomes (Course Skill Set)**

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

1. Describe the fundamental concepts and principles of engineering thermodynamics.
2. Apply the governing laws of thermodynamics for different engineering applications.
3. Analyse the various thermodynamic processes, cycles and results.
4. Interpret and relate the impact of thermal engineering practices to real life problems.

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

**Continuous Internal Evaluation:**

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

1. First assignment at the end of 4th week of the semester
2. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

1. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

**CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.**

**Semester End Examination:**

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.**Marks scored shall be proportionally reduced to 50 marks**
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module

**Suggested Learning Resources:**

**Text Books Books**

- Basic and Applied Thermodynamics, P K Nag, 2nd Ed., Tata McGraw Hill Publications, 2017.
- A textbook of Engineering Thermodynamics, R K Rajput, Fifth edition, Laxmi Publications, 2019.
- Fundamentals of Thermodynamics by Claus Borgnakke and Richard E Sonntag, 8th edition, Wiley India Edition, 2020
- Thermodynamics, An Engineering Approach, by Yunus A Cenegal, Michael A Boles, and Mehmet Kanoglu, 9th Edition, Tata McGraw Hill publications, 2019

**Reference Books**

- Engineering Thermodynamics, J B Jones and G A Hawkins, John Wiley and sons, 1986.
- An Introduction to Thermodynamics, Y V C Rao, Wiley Eastern, 2003
- Applications of Thermodynamics, Dr V Kadambi and Dr T R Seetharam, Wiley Publications, 2018.

**Web links and Video Lectures (e-Resources):**

- https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8
- https://www.youtube.com/watch?v=jkdMtmXo664&list=PL3zvA_WajfGAwLuULH-L0AG9fKDgplYne
- https://www.youtube.com/watch?v=1lk7XLOxtzs&list=PLkn3QlSf55zy2Nlqr5F09oO2qclwNNfrZ&index=3
- https://www.youtube.com/watch?v=Dy2UeVCSRYs&list=PL2_EyjPqHc10CTN7cHiM5xB2qD7BHUry7

**Activity Based Learning (Suggested Activities in Class)/ Practical Based learning**

- Organise Industrial visits to Thermal power plants and submission of report
- Case study report and power point presentation on steam power plant.
- List of thermal energy devices at homes, hostels and college premises and applicable laws

| **Semester 03** | | | |
|---|---|---|---|
| **MACHINE DRAWING AND GD & T** | | | |
| Course Code | 21MEL35 | CIE Marks | 50 |
| Teaching Hours/Week (L:T:P: S) | 0:0:2*:0 | SEE Marks | 50 |
| Credits | 01 | Exam Hours | 03 |
| **** One additional hour may be considered wherever required*** | | | |

**Course objectives:**

- To acquire the knowledge of limits, tolerance and fits and indicate them on machine drawings.
- To make drawings using orthographic projections and sectional views
- To impart knowledge of thread forms, fasteners, keys, joints, couplings and clutches.
- To understand and interpret drawings of machine components leading to preparation of assembly drawings manually and using CAD packages.

**Module 1 (only for CIE)** — **01 Sessions**

Review of basic concepts of Engineering Visualization

**Geometrical Dimensioning and Tolerances (GD&T)**: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.

**Module 2 (only for CIE)** — **02 Sessions**

**Sections of Simple and hollow solids:** True shape of sections.

**Module 3 (only for CIE)** — **03 Sessions**

**Thread Forms**: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread, Helicoil thread inserts

**Fasteners**: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly), simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, countersunk head screw, grub screw, Allen screw

**Rivets**

**Keys:** Parallel key, Taper key, Feather key, Gib-head key and Woodruff key.

**Module 4** — **03 Sessions**

**Assembly of Joints, couplings and clutches (with GD&T)using 2D environment**

**Joints**: Like Cotter joint (socket and spigot), knuckle joint (pin joint).

**Couplings**: Like flanged coupling, universal coupling

**Clutches**: Like Single Plate clutch, cone clutch

**Module 5** — **05 Sessions**

**Assembly of Machine Components (with GD&T) using 3D environment**

*(Part drawings shall be given)*

1. **Bearings**
2. **Valves**
3. **Safety Valves**
4. **I.C. Engine components**
5. **Lifting devices**
6. **Machine tool components**
7. **Pumps**

**Course outcomes (Course Skill Set):**

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

CO1: Interpret the Machining and surface finish symbols on the component drawings.

CO2: Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.

CO3: Illustrate various machine components through drawings

CO4: Create assembly drawings as per the conventions.

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks) and that for SEE minimum passing mark is 35% of the maximum marks (18 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% ( 18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

**Continuous Internal Evaluation (CIE):**

CIE marks for the practical course is **50 Marks**.

- CIE shall be evaluated for max marks 100. Marks obtained shall be accounted for CIE final marks, reducing itby 50%.
- CIE component should comprise of
  - Continuous evaluation of Drawing work of students as and when the Modules are covered.
  - At least one closed book **Test** covering all the modules on the basis of below detailed weightage.
  - ***Weightage for Test and Continuous evaluation shall be suitably decided by respective course coordinators.***

| **Module** | **Max. Marks weightage** | **Evaluation Weightage in marks** | |
|---|---|---|---|
| | | **Computer display & printout** | **Preparatory sketching** |
| Module 1 | 10 | 05 | 05 |
| Module 2 | 15 | 10 | 05 |
| Module 3 | 25 | 20 | 05 |
| Module 4 | 25 | 20 | 05 |
| Module 5 | 25 | 25 | 00 |
| **Total** | **100** | **80** | **20** |

**Semester End Evaluation (SEE):**

SEE marks for the practical course is 50 Marks.

- The duration of SEE is 03 hours. **Questions shall be set worth of 3 hours**
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.
- SEE shall be conducted and evaluated for maximum marks 100. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.
- Question paper shall be set jointly by both examiners and made available for each batch as per schedule. **Questions are to be set preferably from Text Books.**
- Evaluation shall be carried jointly by both the examiners.
- Scheme of Evaluation: *To be defined by the examiners jointly and the same shall be submitted to the university along with question paper.* .
- One full question shall be set from Modules 3 and 4 as per the below tabled weightage details. ***However, the student may be awarded full marks, if he/she completes solution on computer display without sketch.***

| Module | Max. Marks Weightage | Evaluation Weightage in marks | |
|---|---|---|---|
| | | Computer display & printout | Preparatory sketching |
| Module 4 | 40 | 30 | 10 |
| Module 5 | 60 | 50 | 10 |
| **Total** | **100** | **80** | **20** |

**Suggested Learning Resources:**

**Books:**

- K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
- N D Bhatt , "Machine Drawing", Charotar Publishing House Pvt. Ltd.,50th Edition, ISBN-13: 978-9385039232, 2014

**Reference Books:**

- Sadhu Singh, P. L. Sah, "Fundamentals of Machine Drawing", PHI Learning Pvt. Ltd, 2nd Edition, ISBN: 9788120346796, 2012
- Ajeet Singh, "MACHINE DRAWING", Tata McGraw-Hill Education, , ISBN: 9781259084607, 2012