# UNIVERSITY OF MUMBAI

**Bachelor of Engineering**
**in**

**Mechanical Engineering**

**Direct Second Year Admitted Students for the Academic Year 2020-21(Only)**

(As per AICTE guidelines with effect from the academic year 2019–2020)

**(REV- 2019 'C' Scheme) from Academic Year 2019 – 20**

**Under**
**FACULTY OF**
**SCIENCE & TECHNOLOGY**

**Program Structure for Second Year Engineering**

**UNIVERSITY OF MUMBAI**
**(With Effect from 2020-2021)**

**Semester III**

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| MEC301 | Engineering Mathematics-III | 3 | -- | 1 | 3 | -- | 1 | 4 |
| MEC302 | Strength of Materials | 3 | | -- | 3 | | -- | 3 |
| MEC303 | Production Processes | 4 | -- | -- | 4 | -- | -- | 4 |
| MEC304 | Materials and Metallurgy | 3 | -- | -- | 3 | -- | -- | 3 |
| MEC305 | Thermodynamics | 3 | -- | -- | 3 | -- | -- | 3 |
| MEL301 | Materials Testing | -- | 2 | -- | -- | 1 | -- | 1 |
| MEL302 | Machine Shop Practice | -- | 4 | -- | -- | 2 | -- | 2 |
| MESBL301 | CAD –Modeling | -- | 4 | -- | -- | 2 | -- | 2 |
| MEPBL301 | Mini Project – 1A | -- | 4[$] | -- | -- | 2 | -- | 2 |
| **Total** | | **16** | **14** | **1** | **16** | **07** | **1** | **24** |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | | | Term Work | Pract/ Oral | Total |
| | | Internal Assessment | | | End Sem. Exam | Exam. Duration (in Hrs) | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| MEC301 | Engineering Mathematics-III | 20 | 20 | 20 | 80 | 3 | 25 | -- | 125 |
| MEC302 | Strength of Materials | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| MEC303 | Production Processes | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| MEC304 | Materials and Metallurgy | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| MEC305 | Thermodynamics | 20 | 20 | 20 | 80 | 3 | -- | -- | 100 |
| MEL301 | Materials Testing | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| MEL302 | Machine Shop Practice | -- | -- | -- | -- | -- | 50 | -- | 50 |
| MESBL301 | CAD – Modeling | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| MEPBL301 | Mini Project – 1A | -- | -- | -- | -- | -- | 25 | 25 | 50 |
| **Total** | | **--** | **--** | **100** | **400** | **--** | **150** | **75** | **725** |

**$ indicates work load of Learner (Not Faculty), for Mini Project**
**SBL – Skill Based Laboratory**
**PBL – Project Based Learning**

| Course Code | Course Name | Credits |
|---|---|---|
| **MEC301** | **Engineering Mathematics-III** | **4** |

**Pre-requisite:** Engineering Mathematics-I, Engineering Mathematics-II,

**Objectives:** The course is aimed

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills
3. To familiarize with the concept of complex variables, C-R equations with applications.
4. To study the application of the knowledge of matrices and numerical methods in complex engineering problems.

**Outcomes:** On successful completion of course learner/student will be able to:

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variable theory.
5. Apply Matrix algebra to solve the engineering problems.
6. Solve Partial differential equations by applying numerical solution and analytical methods for one dimensional heat and wave equations

| Module | Detailed Contents | Hrs. |
|---|---|---|
| **01** | **Module: Laplace Transform**<br>1.1 Definition of Laplace transform, Condition of Existence of Laplace transform,<br>1.2 Laplace Transform (L) of Standard Functions like $e^{at}$, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n$ , $where\ n \geq 0$.<br>1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof).<br>1.4 Evaluation of integrals by using Laplace Transformation.<br>**Self-learning topics:** Heaviside's Unit Step function, Laplace Transform. of Periodic functions, Dirac Delta Function. | **07** |
| **02** | **Module: Inverse Laplace Transform**<br>2.1 Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivative<br>2.2 Partial fractions method & first shift property to find inverse Laplace transform.<br>2.3 Inverse Laplace transform using Convolution theorem (without proof)<br>**Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations. | **06** |
| **03** | **Module: Fourier Series:**<br>3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof)<br>3.2 Fourier series of periodic function with period 2π and 2*l*,<br>3.3 Fourier series of even and odd functions<br>3.4 Half range Sine and Cosine Series.<br>**Self-learning Topics:** Complex form of Fourier Series, orthogonal and orthonormal set of functions, Fourier Transform. | **07** |
| **04** | **Module: Complex Variables:**<br>4.1 Function *f*(z) of complex variable, limit, continuity and differentiability of *f*(z), Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without | **07** |

| | | |
|---|---|---|
| | proof),<br>4.2 Cauchy-Riemann equations in cartesian coordinates (without proof)<br>4.3 Milne-Thomson method to determine analytic function *f*(z) when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given.<br>4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories<br>**Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio, fixed points and standard transformations | |
| **05** | **Module: Matrices:**<br>5.1 Characteristic equation, Eigen values and Eigen vectors, Properties of Eigen values and Eigen vectors. (**No theorems/ proof**)<br>5.2 Cayley-Hamilton theorem (without proof): Application to find the inverse of the given square matrix and to determine the given higher degree polynomial matrix.<br>5.3 Functions of square matrix<br>5.4 Similarity of matrices, Diagonalization of matrices<br>**Self-learning Topics:** Verification of Cayley Hamilton theorem, Minimal polynomial and Derogatory matrix & Quadratic Forms (Congruent transformation & Orthogonal Reduction) | **06** |
| **06** | **Module: Numerical methods for PDE**<br>6.1 Introduction of Partial Differential equations, method of separation of variables, Vibrations of string, Analytical method for one dimensional heat and wave equations. (only problems)<br>6.2 Crank Nicholson method<br>6.3 Bender Schmidt method<br>**Self-learning Topics:** Analytical methods of solving two and three dimensional problems. | **06** |

**Term Work:**

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

| | | |
|---|---|---|
| 1. | Attendance (Theory and Tutorial) | 05 marks |
| 2. | Class Tutorials on entire syllabus | 10 marks |
| 3. | Mini project | 10 marks |

**Assessment:**

**Internal Assessment Test:**

Assessment consists of two class tests of 20 marks each. The first class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and second class test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

**End Semester Theory Examination:**

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.

5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

**References:**


1. Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication
2. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Eastern Limited,
3. Advanced Engineering Mathematics, R. K. Jain and S.R.K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics, H.K. Das, S. Chand Publication
5. Higher Engineering Mathematics B.V. Ramana, McGraw Hill Education
6. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education,
7. Text book of Matrices, Shanti Narayan and P K Mittal, S. Chand Publication
8. Laplace transforms, Murray R. Spiegel, Schaum's Outline Series


**Links for online NPTEL/SWAYAM courses:**

1. https://nptel.ac.in/courses/111/104/111104085/
2. https://nptel.ac.in/courses/111/106/111106139/

**********

| Course Code | Course Name | Credits |
|---|---|---|
| **MEC302** | **Strength of Materials** | **03** |

**Objectives:**

1. To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres subjected to various types of simple loads.
2. To calculate the elastic deformation occurring in various simple geometries for different types of Loading.
3. To study distribution of various stresses in the mechanical elements under different types of loads.

**Outcomes:** Learner will be able to…

1. Demonstrate fundamental knowledge about various types of loading and stresses induced.
2. Draw the SFD and BMD for different types of loads and support conditions.
3. Analyse the bending and shear stresses induced in beam.
4. Analyse the deflection in beams and stresses in shaft.
5. Analyse the stresses and deflection in beams and Estimate the strain energy in mechanical elements.
6. Analyse buckling phenomenon in columns.

| Module | Detailed Contents | Hrs |
|---|---|---|
| **1.** | Uni axial, biaxial and tri axial stresses. Principal stresses and Principal planes- Mohr's circle. | 3 |
| **2.** | Shear Force and Bending Moment in Beams:<br>Concept & Examples of SFD & BMD for uniformly varying loads, couple and their combinations. | 5 |
| **3.** | Deflection of Beams:<br>Deflection of a beam: Double integration method, Maxwell's reciprocal theorems for computation of slopes and deflection in beams for point and distributed loads. | 6 |
| **4.** | Thin Cylindrical and Spherical Shells:<br>Stresses and deformation in Thin Cylindrical and Spherical Shells subjected to internal pressure<br>Strain Energy: Strain energy stored in the member due to gradual, sudden and impact loads, Strain energy due to bending and torsion. | 4 |
| **5.** | Columns:<br>Buckling load, Types of end conditions for column, Euler's column theory and its limitations and Rankine formula. | 2 |

**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions**, **each carrying 20 marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**.

**References:**


1. Strength of Materials by Ryder, Macmillan
2. Mechanics of Materials by James M. Gere and Barry J. Goodno, Cengage Learning, 6thEd, 2009
3. Mechanics of Materials by Gere and Timoshenko, CBS 2nd Edition
4. Elements of Strength of Materials by Timoshenko and Youngs, Affiliated East -West Press
5. Mechanics of Materials byBeer, Jhonston, DEwolf and Mazurek, TMHPvt Ltd., New Delhi
6. Mechanics of Structures by S.B.Junnarkar, Charotar Publication
7. Mechanics of Materials by S.S.Ratan, Tata McGraw Hill Pvt. Ltd
8. Introduction to Solid Mechanics by Shames, PHI
9. Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
10. Strength of Materials by W.Nash, Schaum's Outline Series, McGraw Hill Publication, Special Indian Edition
11. Strength of Materials by R. Subramanian, Oxford University Press, Third Edition 2016


**Links for online NPTEL/SWAYAM courses:**

1. http://www.nptelvideos.in/2012/11/strength-of-materials-prof.html
2. https://swayam.gov.in/nd1_noc20_ce34

| Course Code | Course Name | Credits |
|---|---|---|
| **MEC303** | **Production Processes** | **04** |

**Objectives:**

1. To familiarize with the various production processes used on shop floors
2. To study appropriate production processes for a specific application.
3. To introduce to the learner various machine tools used for manufacturing
4. To familiarize with principle and working of non-traditional manufacturing
5. To introduce to them the Intelligent manufacturing in the context of Industry 4.0

**Outcomes**: Learnerwill be able to….

1. Demonstrate an understanding of casting process
2. Illustrate principles of forming processes.
3. Demonstrate applications of various types of welding processes.
4. Differentiate chip forming processes such as turning, milling, drilling, etc.
5. Illustrate the concept of producing polymer components and ceramic components.
6. Illustrate principles and working of non-traditional manufacturing
7. Understand the manufacturing technologies enabling Industry 4.0

| Module | Details | Hrs. |
|---|---|---|
| 1 | **Introduction to Production Processes and Metal Casting:**<br>Classification of Production Processes and applications areas<br>Machine moulding, Types of riser, types of gates, solidification<br>**Special casting processes**: CO2 and shell moulding, Investment casting, Die casting, Vacuum casting, Inspection | 4 |
| 2 | **Joining Processes:**<br>Classification of various joining processes; Applicability, advantages and limitations of Adhesive bonding, Mechanical Fastening; Welding and allied processes, Hybrid joining processes. Classification and Working of various welding methods: Chemical, Radiant, Solid State, Welding Joints, Welding Positions and their remedies. | 5 |
| 3 | **Forming processes:**<br>Introduction and classification of metalworking processes, hot and cold working processes. Defects in rolled and forged components,<br>Classification and analysis of wire and tube drawing processes.<br>**Sheet metal working processes:** Classification of Sheet metal operations | 3 |
| 4 | **Machine Tools and Machining Processes:**<br>Grinding Machines and selection of grinding wheel (Dressing and Truing), Broaching machines, Lapping/Honing machines (Super Finishing Operations) and planning Machines.<br>**Gear Manufacturing** Gear milling, standard cutters and limitations,<br>**Tool Engineering** Taylor's tool life equation | 3 |
| 5 | **Polymer Processing:** Polymer Moulding Techniques for thermoplastic and thermosetting plastics. Applications of Plastics in engineering field.<br>**Powder Metallurgy:** Introduction to PM, Powder making processes, Steps in PM. Compaction and Sintering processes. Secondary and finishing operations in PM<br>**Intelligent manufacturing in the context of Industry 4.0,**<br>Cyber-physical systems (CPS) | 5 |

| | | |
|---|---|---|
| | Internet of Things (IoT) enabled manufacturing<br>Cloud Manufacturing | |

**Assessment:**

**Internal Assessment for 20 marks:** Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

**End Semester Examination:** Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

**References:**


1. Welding technology by O P Khanna
2. Foundry technology by O P Khanna
3. Elements of workshop technology. Vol. 1 & II by S K HajraChoudhury
4. Manufacturing Science by Ghosh and Malik
5. Rapid Manufacturing –An Industrial revolution for the digital age by N.Hopkinson, R.J.M.Hauge, P M, Dickens, Wiley
6. Rapid Manufacturing by Pham D T and Dimov, Springer Verlag
7. Production Technology by WAJ Chapman Vol I, II, III
8. Production Technology by P C Sharma.
9. Production Technology by Raghuvanshi.
10. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, 2016, Apress.
11. Cyber-Physical Systems: From Theory to Practice by Danda B. Rawat, Joel Rodrigues, Ivan Stojmenovic, 2015, C.R.C. Press.
12. Optimization of Manufacturing Systems using Internet of Things by Yingfeng Zhang, Fei Tao, 2017, Academic Press (AP), Elsevier.


**Links for online NPTEL/SWAYAM courses:**

1. https://nptel.ac.in/courses/112/107/112107219/
2. https://nptel.ac.in/courses/112/107/112107215/
3. https://nptel.ac.in/courses/112/107/112107084/
4. https://nptel.ac.in/courses/112/107/112107144/
5. https://nptel.ac.in/courses/112/107/112107078/
6. https://nptel.ac.in/courses/112/107/112107239/
7. https://nptel.ac.in/courses/112/104/112104195/
8. https://nptel.ac.in/courses/112/107/112107219/
9. https://nptel.ac.in/courses/112/107/112107144/
10. https://nptel.ac.in/courses/112/107/112107213/
11. https://nptel.ac.in/courses/112/107/112107090/
12. https://nptel.ac.in/courses/113/106/113106087/
13. https://nptel.ac.in/courses/112/103/112103263/
14. https://nptel.ac.in/courses/112/107/112107239/
15. https://nptel.ac.in/courses/112/106/112106153/
16. https://nptel.ac.in/courses/112/107/112107250/
17. https://nptel.ac.in/courses/112/107/112107144/
18. https://nptel.ac.in/courses/112/107/112107239/
19. https://nptel.ac.in/courses/112/107/112107219/

| Course Code | Course Name | Credits |
|---|---|---|
| **MEC304** | **Materials and Metallurgy** | **03** |

**Objectives:**

1. To familiarize the structure -property correlation in materials
2. To acquaint with the processing dependency on the performance of the various materials
3. To study the role of alloying in the development of steels.
4. To familiarize with the advances in materials development

**Outcomes:** Learner will be able to ….

1. Identify the various classes of materials and comprehend their properties
2. Apply phase diagram concepts to engineering applications
3. Apply particular heat treatment for required property development
4. Identify the probable mode of failure in materials and suggest measures to prevent them
5. Choose or develop new materials for better performance
6. Decide an appropriate method to evaluate different components in service

| Module | Contents | Hrs. |
|---|---|---|
| 1 | Introduction to engineering materials – significance of structure property correlations in all classes of engineering materials<br>**Concepts of crystals**- Crystalline and Non-crystalline, Crystal systems, Crystallographic planes and directions,<br>**Crystal Defects:** Crystal Imperfections-definition, classification and significance of imperfections -point defects, line defects, Surface defects and volume defects.<br>Importance of dislocations in deformation and its mechanisms. Critical Resolved shear stress, Slip systems and deformability of FCC, BCC and HCP lattice systems.<br>**Cold Working and Recrystallization annealing:** Definition, effects and mechanism of cold work, Need for Recrystallization Annealing, the stages of recrystallization annealing and factors affecting it | 5 |
| 2 | **Mechanism of Crystallization**- Nucleation-Homogeneous and Heterogeneous Nucleation and Growth. Solidification of metals and -alloys– Cooling curves<br>**Classification of Alloys based on phases and phase diagram**-Binary alloy phase diagram – Isomorphous, Eutectics type I and II, Peritectic Microstructural changes of hypo and hyper-eutectoid steel- TTT and CCT diagram-Hardenability and its tests, Graphitization in cast irons. | 3 |
| 3 | **Heat treatment:** Overview – Objectives – Thorough treatments: austempering and martempering – microstructure changes<br>**Surface hardening processes:** Carbonitriding, induction and flame hardening, Laser and Electron beam hardening– principles and case depths<br>**Alloy steels -** Maraging steels and Ausformed steels | 3 |
| 4 | **Strengthening mechanisms in materials**<br>**Fracture of metals** – Ductile Fracture, Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Griffith's criteria and Orowan's modification<br>**Fatigue** – Endurance limit of ferrous and non-ferrous metals -Fatigue test, S-N curves, factors affecting fatigue, structural changes accompanying fatigue; | 4 |

| | | |
|---|---|---|
| | **Creep** – mechanism of creep – stages of creep and creep test, creep resistant materials | |
| 5 | Basic concepts of composites, Processing of composites, advantages over metallic materials, various types of composites<br>Introduction, Concepts, synthesis of nanomaterials, examples, and Nano composites,<br>Classification of Smart materials, Shape Memory Alloys | 2 |
| 6 | **Processing-** of ceramics and composites through Injection Moulding<br>**Non-destructive Testing of Materials-**ultrasonic testing, radiographic methods, magnetic particle testing | 3 |

**Assessment:**

**Internal Assessment for 20 marks:** Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

**End Semester Examination:** Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

**Textbooks:**


1. Callister's Materials Science and Engineering, 2nd edition by R.Balasubramanium Wiley India Pvt. Ltd


**References:**


1. Introduction to Materials Science for Engineers; 8th Edition by James F. Shackelford Pearson
2. Introduction to Physical Metallurgy,2nd edition by Sidney Avner, TataMcGrawHill
3. Mechanical Metallurgy, 3rd edition by GH Dieter,TataMcGraw Hill
4. Fundamentals of Materials Science and Engineering: An Integrated Approach, 5th Edition by William D. Callister, Jr., David G. Rethwisch, Wiley & Sons.
5. Materials Science and Engineering,5th edition by V.Raghavan, Prentice Hall India


**Links for online NPTEL/SWAYAM courses:**

1. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/
2. https://nptel.ac.in/courses/113/102/113102080/
3. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-mm09/
4. https://nptel.ac.in/content/syllabus_pdf/113104074.pdf
5. https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_09_m.pdf
6. https://nptel.ac.in/content/storage2/courses/112108150/pdf/PPTs/MTS_08_m.pdf
7. https://nptel.ac.in/courses/112/104/112104229/
8. https://nptel.ac.in/courses/118/104/118104008/
9. https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat_lec_6.pdfhttps://nptel.ac.in/courses/112/104/112104229/
10. https://nptel.ac.in/courses/118/104/118104008/
11. https://nptel.ac.in/content/storage2/courses/112104173/Mod_1_smart_mat_lec_6.pdf

| Course Code | Course Name | Credits |
|---|---|---|
| **MEC305** | **Thermodynamics** | **03** |

**Objectives:**

1. To familiarize the concepts of Energy in general and Heat and Work inparticular
2. To study the fundamentals of quantification and grade ofenergy
3. To study the effect of energy transfer on properties of substances in the form of charts anddiagrams
4. To familiarize the application of the concepts of thermodynamics in vapour power, gas power cycles, compressible fluid flow

**Outcomes:** Learners will be able to….

1. Demonstrate application of the laws of thermodynamics to a wide range ofsystems.
2. Compute heat and work interactions in thermodynamicsystems
3. Demonstrate the interrelations between thermodynamic functions to solve practicalproblems.
4. Compute thermodynamicinteractions using the steam table and Mollier chart
5. Compute efficiencies of heat engines, power cycles.
6. Apply the fundamentals of compressible fluid flow to the relevant systems

| Module | Detailed contents | Hrs. |
|---|---|---|
| 1 | Basic Concepts:<br>Thermodynamics system and types, Macroscopic and Microscopic approach, Thermodynamic properties of the system, state, path, process and cycle, Point and Path functions, Quasi-static process & Equilibrium,<br>Perpetual Motion Machine of the First Kind, Application of first law to non-flow systems (Ideal gas processes with numerical) and flow systems, throttling device. Significance of –VdP work, Relation between flow and non-flow work | **3** |
| 2 | Second Law of Thermodynamics:<br>Perpetual Motion Machine of the second kind, Carnot cycle, Carnot theorem.<br>Entropy:<br>Entropy is property of a system, Temperature-Entropy diagram, Increase of entropy principle, T ds relations, Entropy change During a process. | **3** |
| 3 | Availability:<br>High grade and low-grade energy, Available and Unavailable energy, Dead State, Useful work, Irreversibility, Availability of closed system& steady flow process, Helmholtz & Gibbs function<br>Thermodynamic Relations:<br>Maxwell relations, Clausis-Clapeyron Equation, Mayer relation, Joule-Thomson coefficient (Only Theory) | **3** |
| 4 | Properties of Pure Substance:<br>Vapour Power cycle:<br>Principal components of a simple steam power plant, Carnot cycle and its limitations as a vapour cycle, Rankine cycle with different turbine inlet conditions, Mean temperature of heat addition, Reheat Rankine Cycle, Revision on steam table and Mollier chart. | **4** |
| 5 | Gas Power cycles:<br>Comparison of Otto and Diesel cycle for same compression ratio, Brayton Cycle. Sterling Cycle, Ericsson Cycle, Lenoir cycle, and Atkinson cycle (Only theory). | **3** |
| 6 | Compressible Fluid flow:<br>Propagation of sound waves through compressible fluids, Sonic velocity and Mach number; Stagnation properties, Application of continuity, momentum and energy equations for steady-state conditions; Steady flow through the nozzle, Isentropic flow through ducts of | **4** |

| | | |
|---|---|---|
| | varying cross-sectional area, Effect of varying back pressure on nozzle performance, Critical pressure ratio | |

**Assessment:**

**Internal Assessment for 20 marks:** Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

**End Semester Examination:** Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

**References:**


1. Thermodynamics: An Engineering Approach by Yunus A. Cengel and Michael A. Boles, 9th edition, TMH
2. Basic Engineering Thermodynamics by Rayner Joel, 5thedition, Longman Publishers
3. Engineering Thermodynamics by P Chattopadhyay, 2ndedition, Oxford University PressIndia
4. Thermodynamics by P K Nag, 6th Edition,TMH
5. Thermodynamics by Onkar Singh, 4th Edition New AgeInternational
6. Thermodynamics by C P Arora,1stEditionTMH
7. Thermal Engineering By Ajoy Kumar, G. N. Sah, 2nd Edition, Narosa Publishing house
8. Engineering Thermodynamics Through Examples by Y V C Rao, Universities Press (India) Pvt Ltd
9. Fundamentals of Thermodynamics by Moran &Shapiro, Eighth Edition, Wiley
10. Fundamentals of Classical Thermodynamics by Van Wylen G.H. & Sonntag R.E., 9th Edition JohnWiley& Sons
11. Thermodynamics by W.C. Reynolds, McGraw-Hill &Co
12. Thermodynamics by J P Holman, 4th Edition McGraw-Hill & Co


**Links for online NPTEL/SWAYAM courses:**

1. https://nptel.ac.in/courses/112/105/112105266/
2. https://nptel.ac.in/courses/112/103/112103275/
3. https://nptel.ac.in/courses/112/105/112105220/
4. https://nptel.ac.in/courses/101/104/101104063/

| Course Code | Course Name | Credits |
|---|---|---|
| **MEL301** | **Materials Testing** | **01** |

**Objectives:**

1. To familiarize with the use of metallurgical microscope for study of metals
2. To study the microstructures of ferrous (steel and cast iron) metals
3. To acquaint with the material testing by performing experiment related to Hardness , Fatigue, Tension, Torsion, Impact and Flexural Test

**Outcomes:** Learner will be able to…

1. Prepare metallic samples for studying its microstructure following the appropriate procedure.
2. Identify effects of heat treatment on microstructure of medium carbon steel and hardenability of steel using Jominy end Quench test
3. Perform Fatigue Test and draw S-N curve
4. Perform Tension test to Analyze the stress - strain behaviour of materials
5. Measure torsional strength, hardness and impact resistanceof the material
6. Perform flexural test with central and three point loading conditions

**a)List of Experiments:** Total four experiments are required to be performed.

| Experiment Number | Detailed Contents | Laboratory Sessions (Hrs.) |
|---|---|---|
| 1 | Comparison of Microstructures and hardness before and after Annealing, Normalizing and Hardening in medium carbon steel | 2 |
| 2 | Study of tempering characteristics of hardened steel | 2 |
| 3 | Determination of hardenability of steel using Jominy end Quench Test (Using different hardness testers to measure the Hardness) | 2 |
| 4 | Fatigue test – to determine number of cycles to failure of a given material at a given stress | 2 |

**b) Assignments**: At least one problem on each of the following topics:
1. Simple stress strain
2. SFD and BMD
3. Stresses in beams
4. Torsion and deflection.
5. Thin cylinder and strain energy
6. Buckling of Columns

Note: Preferably, the assignments shall be based on live problems.**Project Based Learning may be incorporated by judiciously reducing number of assignments.**

**Assessment:**

**Term Work:** Including Part a and b both
Distribution of marks for Term Work shall be as follows:

Part a: 10 marks.
Part b:10 Marks
Attendance: 05 marks.

**End Semester Practical/Oral Examination:**
Pair of Internal and External Examiner should conduct practical examination followed by Oral

| Course Code | Course Name | Credits |
|---|---|---|
| **MEL302** | **Machine Shop Practice** | **02** |

**Objectives:**

1. To familiarize with basic machiningprocesses.
2. To familiarize various machining operations and machineprotocols

**Outcomes:** Learner will be able to…

1. Know the specifications, controls and safety measures related to machines and machining operations.
2. Use the machines for making various engineering jobs.
3. Perform various machining operations
4. Perform Tool Grinding
5. Perform welding operations

| Module | Details | Hrs |
|---|---|---|
| **1** | One composite job consisting minimum four parts employing operations performed of various machine tools. | **40** |
| **2** | Tool Grinding – To know basic tool Nomenclature | **04** |
| **3** | One Job on Welding – Application of Metal Arc Welding | **04** |

**Assessment**:

Term Work:

1. **Composite job** mentionedabove and the **Welding Job**
2. Complete Work-Shop Book giving details of drawing of the job and timesheet

The distribution of marks for Term work shall be as follows:

1. Job Work with completeworkshopbook ……. 40 marks
2. Attendance ……. 10marks

| Course Code | Course Name | Credits |
|---|---|---|
| **MESBL301** | **Skill Based Lab: CAD – Modeling** | **02** |

**Prerequisites:** Engineering Drawing

**Objectives:**

1. To impart the 3D modeling skills for development of 3D models of basic engineering components.
2. To introduce Product data exchange among CAD systems.
3. To familiarize with production drawings with important features like GD &T, surface finish, heat treatments etc.

**Outcomes:** Learner will be able to…

1. Illustrate basic understanding of types of CAD model creation.
2. Visualize and prepare 2D modeling of a given object using modeling software.
3. Build solid model of a given object using 3D modeling software.
4. Visualize and develop the surface model of a given object using modeling software.
5. Generate assembly models of given objects using assembly tools of a modeling software
6. Perform product data exchange among CAD systems.

| Sr. No. | Exercises | Hrs. |
|---|---|---|
| **1** | CAD Introduction<br>CAD models Creation, Types and uses of models from different perspectives. Parametric modeling. | **10** |
| **2** | 2D Modeling<br>Geometric modeling of an Engineering component, demonstrating skills in sketching commands of creation (line, arc, circle etc.) modification (Trim, move, rotate etc.) and viewing using (Pan, Zoom, Rotate etc.) | |
| **3** | Solid Modeling<br>3D Geometric modeling of an Engineering component, demonstrating modeling skills using commands like Extrude, Revolve, Sweep, Blend, Loft etc. | |
| **4** | Surface Modeling<br>Extrude, Sweep, Trim etc and Mesh of curves, free form surfaces etc. Feature manipulation using Copy, Edit, Pattern, Suppress, History operations etc. | |
| **5** | Assembly<br>Constraints, Exploded views, interference check. Drafting (Layouts, Standard & Sectional Views, Detailing & Plotting). | |
| **6** | Data Exchange<br>CAD data exchange formats Like IGES, PDES, PARASOLID, DXF and STL along with their comparison and applicability. | |

**Assessment:**

**Term work**

Using the above knowledge and skills acquired through six modules students should complete Minimum six assignments/Experiments from the given sets of assignments **(Two from each set)** using standard CAD modeler like PTC Creo/CATIA/ Solid work/UG /any other suitable software.

**Set 1: Beginner Level:**

3D modeling of basic Engineering components likes Nuts, Bolts, Keys, cotter, Screws, Springs etc.

**Set 2: Intermediate Level:**

3D modeling of basic Machine components like Clapper block, Single tool post, Lathe and Milling tail stock,Shaper tool head slide, jigs and fixtures Cotter, Knuckle joint, Couplings: simple, muff, flanged Protected flange coupling, Oldham's coupling, Universal coupling,element of engine system and Miscellaneous parts.

**Set 3: Advance Level:**

1) Generation of any Assembly model (minimum five child parts) along with Production drawing for any of the system by creating 3D modeling with assembly constraints, Interference check, Exploded view, GD&T, Bill of material.

2) Reverse Engineering of a physical model: disassembling of any physical model having not less than five parts, measure the required dimensions of each component, sketch the minimum views required for each component, convert these sketches into 3-D model and create an assembly drawing with actual dimensions

The distribution of marks for Term work shall be as follows:

1. Printouts/Plots : 20 marks
2. Attendance : 05 marks

**End Semester Practical/Oral examination:**

To be conducted by pair of Internal and External Examiner

1. Practical examination duration is two hours, based on Advance level of the Term work.
   Oral examination should also be conducted to check the knowledge of CAD Modeling Tools.
2. The distribution of marks for practical examination shall be as follows:
   a. Practical Exam ….15 marks
   b. Oral Exam ...…….10 marks
3. Evaluation of practical examination to be done based on the printout of students work
4. Students work along with evaluation report to be preserved till the next examination

**References:**


1. Machine Drawing by N.D. Bhatt.
2. A textbook of Machine Drawing by Laxminarayan and M.L.Mathur, Jain brothers Delhi
3. Machine Drawing by Kamat and Rao
4. Machine Drawing by M.B.Shah
5. A text book of Machine Drawing by R.B.Gupta, Satyaprakashan, Tech. Publication
6. Machine Drawing by K.I. Narayana, P. Kannaiah, K.Venkata Reddy
7. Machine Drawing by Sidheshwar and Kanheya
8. Autodesk Inventor 2011 for Engineers and Designers by ShamTickoo and SurinderRaina, Dreamtech Press

**NOTE –**

1: For Detailed Course Schemes, Course Objectives, Internal & External Assessment process, End Semester Examination, Recommended & reference Books please refer MU syllabus of Second year (C-Scheme / R-19) Mechanical Engineering.

2: Theory and Practical Examination will be strictly based on above compressed syllabus.