# DEPARTMENT OF MECHANICAL ENGINEERING

REGULATION 2018 –3RD AND 4TH SEM SYLLABUS – Approved By BOS, 09.04.18

| CURRICULUM - 3rd SEMESTER | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Sl No** | **Paper Code** | **Theory** | **Contact Hours /Week** | | | | **Credit Points** |
| | | | **L** | **T** | **P** | **Total** | |
| **A. THEORY** | | | | | | | |
| 1 | ME 301 | Engineering Thermodynamics | 3 | 0 | 0 | 3 | 3 |
| 2 | ME 302 | Strength of Material | 3 | 0 | 0 | 3 | 3 |
| 3 | ME 303 | Fluid Mechanics-I | 3 | 0 | 0 | 3 | 3 |
| 4 | ME 304 | Materials Engineering | 3 | 0 | 0 | 3 | 3 |
| 5 | M 301 | Mathematics -III | 3 | 1 | 0 | 4 | 4 |
| 6 | PH(ME)301 | Physics - II | 3 | 0 | 0 | 3 | 3 |
| **Total of Theory** | | | | | | **19** | **19** |
| **B. PRACTICAL** | | | | | | | |
| 7 | ME 391 | Material Testing Lab | 0 | 0 | 3 | 3 | 1.5 |
| 8 | ME 392 | Machine Drawing | 0 | 0 | 3 | 3 | 1.5 |
| 9 | PH(ME)391 | Physics – II Lab | 0 | 0 | 2 | 2 | 1 |
| **Total of Practical** | | | | | | **8** | **4** |
| **C.SESSIONAL** | | | | | | | |
| 10 | MC 381 | Environmental Science | 2 | 0 | 0 | 2 | 2 UNITS |
| | | | | | | **29** | **23** |
| **D. PROJECT*** | | | | | | | |
| **11** | **Project Code** | **Project Name** | **Credit Hours /Week** | | | | **Credit Points** |
| | ME 351 | Eng. Thermodynamics Project | 1 | | | | 0.5 |
| | ME 352 | Strength of Material Project | 1 | | | | 0.5 |
| | ME 353 | Fluid Mechanics-I Project | 1 | | | | 0.5 |
| | ME 354 | Materials Engineering Project | 1 | | | | 0.5 |
| | M 351 | Mathematics –III Project | 1 | | | | 0.5 |
| | PH(ME) 351 | Physics – II Project | 1 | | | | 0.5 |
| **Total of Theory, Practical, Sessional & Project** | | | **33** | | | | **23+2** |

*** Student need to select any four projects (Total Credit: 0.5+0.5+0.5+0.5=2)**

# BTech ME- 3rd Semester - Detailed Syllabus

**Course Name: Engineering Thermodynamics**
**Course Code: ME 301**
**Credit: 3**
**Contact Hours/Week (L:T:P) : 3:0:0**
**Total Lectures: 33L**
**Full Marks = 100 (Internal Assessment-30; End Semester Exam-70)**
**Prerequisite: Physics (10+2 level)**

**Objectives:**

- To learn about work and heat interactions, and balance of energy between system and its surroundings
- To learn about application of I law to various energy conversion devices
- To evaluate the changes in properties of substances in various processes
- To understand the difference between high grade and low grade energies and II law limitations on energy conversion

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

1. Learn about the interrelationship of heat and work to draw an energy balance between a system and its surroundings.
2. Understand the second law limitation of energy conversion and differentiate realistic and unrealistic thermodynamic systems.
3. Carry out Entropy and Exergy analysis of thermal systems to evaluate sustainability of practical equipments in industries.
4. Evaluate the performance of energy conversion devices using utility thermodynamic cycles.

**Course Articulation Matrix:**

| CO | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ME301.1** | 2 | 2 | 2 | - | - | - | 1 | - | - | 1 | - | 1 | - | - | - |
| **ME301.2** | 3 | 2 | 2 | 1 | - | - | 2 | 1 | - | 1 | - | 2 | - | - | - |
| **ME301.3** | 3 | 3 | 3 | 1 | - | - | 3 | - | - | 1 | - | 2 | - | 1 | - |
| **ME301.4** | 2 | 1 | 2 | - | - | - | - | - | - | 1 | - | 2 | - | - | 1 |

**Course Contents:**

| Module | Syllabus | Contact Hrs |
|---|---|---|
| 1 - Fundamentals | System & Control volume; Property, State & Process; Exact & Inexact differentials; Work-Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement | 4 |
| | work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work. | |
| **2 - Temperature** | Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems- First Law for Cyclic & Non-cyclic processes; Concept of total energy E ; Demonstration that E is a property; Various modes of energy, Internal energy and Enthalpy. | 4 |
| **3 – Pure substance** | Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Compressibility charts- Properties of two phase systems - Const. temperature and Const. pressure heating of water; Definitions of saturated states; P-v-T surface; Use of steam tables and R134a tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier's chart. | 7 |
| **4 – First Law for Flow Processes** | Derivation of general energy equation for a control volume; Steady state steady flow processes including throttling; Examples of steady flow devices; Unsteady processes; examples of steady and unsteady I law applications for system and control volume. | 5 |
| **5 – Second law of Thermo dynamics** | Definitions of direct and reverse heat engines; Definitions of thermal efficiency and COP; Kelvin-Planck and Clausius statements; Definition of reversible process; Internal and external irreversibility; Carnot cycle; Absolute temperature scale | 5 |

| | | |
|---|---|---|
| **6 – Entropy and its application** | Clausius inequality; Definition of entropy S ; Demonstration that entropy S is a property; Evaluation of S for solids, liquids, ideal gases and ideal gas mixtures undergoing various processes; Determination of entropy from steam tables- Principle of increase of entropy; Illustration of processes in Ts coordinates; Definition of Isentropic efficiency for compressors, turbines and nozzles. Irreversibility and Availability, Availability function for systems and Control volumes undergoing different processes, Lost work. | 7 |
| | Second law analysis for a control volume. Exergy balance equation and Exergy analysis. | |
| **7 – Thermodynamic cycles** | Basic Rankine cycle; Basic Brayton cycle; Basic vapor compression cycle and comparison with Carnot cycle. | 4 |
| **Total Hours (36 lectures)** | | |

**Project Topics:**

**Text Books:**

1. Yunus A. Cengel , Michael A. Boles , 2014, 8th Edition, Thermodynamics**:** An Engineering Approach, McGraw-Hill Education.

2. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley and Sons.

3. Nag, P.K, 1995, Engineering Thermodynamics, Tata McGraw-Hill Publishing Co. Ltd.

4. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall of India

5. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley and Sons.

**Course Name: Strength of Materials**
**Course Code: ME 302**
**Credit: 3**
**Contact Hours/Week (L:T:P): 3:0:0**
**Total Lectures: 33L**
**Full Marks = 100 (Internal Assessment-30; End Semester Exam-70)**
**Prerequisite:** Engineering Mechanics

**Objectives:**

- To understand the nature of stresses developed in simple geometries such as bars, cantilevers, beams, shafts, cylinders and spheres for various types of simple loads
- To calculate the elastic deformation occurring in various simple geometries for different types of loading

**Course Contents:**

| Module | Syllabus | Contact Hrs |
|---|---|---|
| **1 - Deformation in solids** | Hooke's law, stress and strain- tension, compression and shear stresses, elastic constants and their relations- volumetric, linear and shear strains- principal stresses and principal planes- Mohr's circle. | **7** |
| **2 – Failure Theories** | Static failure theories: Ductile and brittle failure mechanisms, Tresca, Von-mises, Maximum normal stress, Mohr-Coulomb and Modified Mohr-Coulomb Theory | **4** |
| **3 – Beams** | Beams and types of transverse loading on beams- shear force and bend moment diagrams- Types of beam supports, simply supported and over-hanging beams, cantilevers. Theory of bending of beams, bending stress distribution and neutral axis, shear stress distribution, point and distributed loads. | **7** |
| **4 – Moment of inertia** | Moment of inertia about an axis and polar moment of inertia, deflection of a beam using double integration method, computation of slopes and deflection in beams, Maxwell's reciprocal theorems. | **6** |
| **5 – Torsion** | Torsional stresses and deformation in circular and hollow shafts, stepped shafts, deflection of shafts fixed at both ends, stresses and deflection of helical springs. | **7** |
| **6 – Pressure Vessels** | Axial and hoop stresses in cylinders subjected to internal pressure, deformation of thick and thin cylinders, deformation in spherical shells subjected to internal pressure | **6** |
| **Total Hours (36 lectures)** | | |

**Course Outcomes:** After completing this course the students will be able to,

1. Recognize various types loads applied on machine components of simple geometry and understand the nature of internal stresses that will develop within the components
2. Evaluate the strains and deformation in materials that will result due to the elastic stresses developed within the materials for simple types of loading.
3. Quantify mechanical integrity and failure in materials

**Text Books:**

1. Egor P. Popov, Engineering Mechanics of Solids, Prentice Hall of India, New Delhi, 2001.

2. R. Subramanian, Strength of Materials, Oxford University Press, 2007.

3. Ferdinand P. Been, Russel Johnson Jr and John J. Dewole, Mechanics of Materials, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi 2005.

**Course Name: Fluid Mechanics-I**
**Course Code: ME 303**
**Credit: 3**
**Contact Hours/Week (L:T:P): 3:0:0**
**Total Lectures: 37L**
**Full Marks = 100 (Internal Assessment-30; End Semester Exam-70)**
**Prerequisite:** Physics and Mechanics (10+2 level)

**Course Objectives:** To introduce and explain fundamentals of Fluid Mechanics which is useful in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics, Heat Transfer, Power Plant etc.

**Course Outcomes:**

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

1. Get knowledge about fluid flow properties and analyze hydrostatic forces on flat or curved surfaces.

2. Explore the detailed analysis of kinematics and dynamics of fluid for laminar and turbulent flow and exploit the conservation equations for the flow regimes of practical interest.

3. Learn about boundary layer theory for a variety of constraints and understand the basics of a turbulent flow.

4. Explain the basics of compressible flow and apply for dimensional analysis for practical

prototyping.

**Course Articulation Matrix:**

| CO Codes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ME303.1** | 2 | 2 | 1 | 1 | - | - | - | - | - | - | - | - |
| **ME303.2** | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | 1 |
| **ME303.3** | 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | 1 |
| **ME303.4** | 2 | 2 | 1 | 1 | - | - | - | - | - | - | - | 1 |
| **Avrg.** | **2.5** | **2.25** | **1.25** | **1.5** | | | | | | | | **0.75** |

**Course Contents:**

| Module No. | Syllabus | Contact Hrs. |
|---|---|---|
| 1- **Introduction:** | Introduction to Fluid Mechanics - Fluid, Fluid types, Newton's law of viscosity, surface tension | 02 |
| **2- Analysis of Fluid Motion** | **Fluid statics:** Forces on submerged surfaces; forces or vertical, horizontal, inclined and curved surfaces, Center of pressure. Stability of floating bodies. | 03 |
| | **Fluid kinematics:** fluid flow and classifications. Continuity equation in 1D & 3D. Potential flow & Stream function; types of flow lines. | 03 |
| | **Dynamics of fluid:** equations of motion; Euler's equation; Navier-Stokes equation; Bernoulli's equation; Applications of Bernoulli's equation. | 03 |
| **3- Viscous and Turbulent Flow** | Flow through circular pipes, Flow between parallel plates, momentum and energy correction factors, Reynold's experiment, characteristics of turbulent flow, velocity distribution in turbulent flow through pipes in terms of average velocity. | 05 |

| | | |
|---|---|---|
| **4- Flow through pipes** | Fluid friction in pipes, head loss due to friction. Darcy–Weisbach equation of friction loss; hydraulic grade line and total energy line. Variation of friction factor with wall roughness – Moody's chart. Minor losses in pipes. | 04 |
| **4- Flow Measurement** | Orifices, notches and weirs: Basic principle for flow through orifices, rectangular and V-notches, rectangular and trapezoidal weir. | 03 |
| **5- Boundary layer flow** | Definition; Boundary layer separation – basic concept. Drag force on a flat plate due to boundary layer, Turbulent layer on a flat plate, displacement thickness, momentum thickness and energy thickness. | 04 |
| **6- Submerged bodies** | Flow of fluid and forces around submerged bodies; basic concepts of drag and lift. | 03 |
| **7- Dimensional Analysis** | Dimensions and dimensional homogeneity, Importance and use of dimensional analysis. Buckingham's Pi theorem with applications. Geometric, Kinematic and Dynamic similarity, Non Dimensional Numbers, Model studies | 03 |
| **8- Compressible Flow** | Thermodynamic relations, Basic equations of compressible flow, velocity of pressure wave in a fluid, Mach number, Stagnation properties, area velocity relationship, flow of compressible fluid through orifices and nozzles fitted to a large tank. | 04 |

**Books Recommended**

1. Introduction to Fluid Mechanics & Fluid Machines – Som & Biswas, TMH
2. Fluid Mechanics & Machinery – R.K.Bansal, Luxmi Publications.
3. A textbook on Fluid Mechanics and Hydraulic Machines – Sukumar Pati, TMH
4. Fluid Mechanics & Turbo Machines – M.M.Das, PHI, 2010.
5. Introduction to Fluid Mechanics – Fox & Macdonald, Wiley.
6. Fluid Mechanics – Fundamentals & Applications – Cengel & Cimbala, TMH.
7. Mechanics of Fluid – Bernard Massey, Taylor & Francis.

**Course Name: Materials Engineering**
**Course Code: ME 304**
**Credit: 3**
**Contact Hours/Week (L:T:P): 3:0:0**
**Total Lectures: 36L**
**Full Marks = 100 (Internal Assessment-30; End Semester Exam-70)**

**Prerequisite:** Engineering Physics and Engineering Chemistry

**Course Objectives:**

1. Understanding of the correlation between the internal structure of materials, their mechanical properties and various methods to quantify their mechanical integrity and failure criteria.
2. To provide a detailed interpretation of equilibrium phase diagrams
3. Learning about different phases and heat treatment methods to tailor the properties of Fe-C alloys.

**Course Contents:**

| **Module** | **Syllabus** | **Contact Hrs** |
|---|---|---|
| **1 – Crystal Structure** | Unit cells, Metallic crystal structures, Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress. | **6** |
| **2 – Mechanical Property measurement** | Tensile, compression and torsion tests; Young's modulus, relations between true and engineering stress-strain curves, generalized Hooke's law, yielding and yield strength, ductility, resilience, toughness and elastic recovery; Hardness: Rockwell, Brinell ,Vickers and their relation to strength. | **7** |
| **3 – Metals & Alloys** | Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; Iron - Iron-carbide phase diagram, and microstructure analysis of ferrous materials, cast iron, steel. | **6** |

| | | |
|---|---|---|
| **4 – Heat treatment** | Heat treatment of Steel: Annealing, tempering, normalising and spheroidising, isothermal transformation diagrams for Fe-C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering, martempering, case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening | **7** |
| **5 – Alloying of** | Properties of stainless steel and tool steels, maraging steels- cast irons; - copper and copper alloys; brass, bronze and cupro-nickel; | **5** |
| **steel** | Aluminium and Al -Cu - Mg alloys- Nickel based superalloys and Titanium alloys | |
| **6- Ceramics and Advanced Materials** | Structure, properties and application of ceramics, Composite Types, Types and properties of main composition, Smart Materials, Ferroelastic and Piezoelectric materials, Nanomaterials, Biomaterials, Shape memory alloys | **5** |
| **Total Hours (36 lectures)** | | |

**Course Outcomes:**

On successful completion of the learning sessions of the course, the learner will be able to:

1. Identify crystal structures for various materials and understand the defects in such structures
2. Analyze the effect of heat treatment of mechanical properties of a material
3. Understand how to tailor material properties of ferrous and non-ferrous alloys
4. Learn about advanced materials useful in modern industrial application.

**Text Books:**


1. W. D. Callister, 2006, Materials Science and Engineering-An Introduction, 6th Edition, Wiley India.
2. Kenneth G. Budinski and Michael K. Budinski, Engineering Materials, Prentice Hall of India Private Limited, 4th Indian Reprint, 2002.
3. V. Raghavan, Material Science and Engineering, Prentice Hall of India Private Limited, 1999.
4. U. C. Jindal, Engineering Materials and Metallurgy, Pearson, 2011.

**Course Name: Mathematics - III Course Code: M 301**

**Contacts: 3L: 1T: 0P;**
**Credit: 4**
**Total Contact Hours: 44**
**Full Marks = 100 (Internal Assessment-30; End Semester Exam-70)**

**Prerequisite:** The students to whom this course will be offered must have the concept of (10+2) standard calculus, basic probability and differential equations.

**Course Objectives:**

The objective of this course is to disseminate the prospective engineers with advanced techniques for solving ordinary differential equations and basic techniques for solving partial differential equations. It also aims to equip the students with concepts and tools of calculus of complex variables, Fourier series and Fourier transform, and probability distribution as an intermediate to the advanced level of applications that they would find useful in their disciplines.

**Course Outcomes (COs):**

On successful completion of the learning sessions of the course, the learner will be able to:

**Course Contents:**

| CODES | BLOOM'S TAXONOMY | DESCRIPTIONS |
|---|---|---|
| **M 301.1** | Remembering | Recall the underlying principle and properties of Fourier series, Fourier transform, probability distribution of a random variable, calculus of complex variable, partial differential equation and ordinary differential equation. |
| **M 301.2** | Understanding | Exemplify the variables, functions, probability distribution and differential equations and find their distinctive measures using the underlying concept of Fourier series, Fourier transform, probability distribution of a random variable, calculus of complex variable, partial differential equation and ordinary differential equation. |

| | | |
|---|---|---|
| **M 301.3** | Applying | Apply Cauchy's integral theorem and the residue theorem to find the value of complex integration, and compute the probability of real world uncertain phenomena by indentifying probability distribution that fits the phenomena. |
| **M 301.4** | Applying | Solve partial differential equation using method of separation of variables and ordinary differential equation using techniques of series solution and special function (Legendre's and Bessel's). |
| **M 301.5** | Analyzing | Find the Fourier series and Fourier transform of functions by |
| | | organizing understandings of underlying principles and also evaluate the integral using Parseval's identity. |

**Project Domains:**

1. Study of physical processes through PDE and ODE.
2. Application of calculus of complex variable in real world engineering problems.
3. Study of uncertainty in real world phenomena using probability distribution.
4. Application of Fourier series and Fourier transform in engineering problems.

**Text Books:**


1. Herman, R. L. *An Introduction to Fourier Analysis*, Chapman and Hall/CRC, 2016.
2. Grafakos, L. *Classical Fourier Analysis*, Springer, India, Private Ltd.
3. Das, N.G. *Probability and Statistics*; The McGraw Hill Companies.
4. Gupta, S. C. and Kapoor, V. K. *Fundamentals of Mathematical Statistics*, Sultan Chand & Sons.
5. Mathews, J. H. and Howell, R. W. *Complex Analysis for Mathematics & Engineering,* Jones & Bartlett Pub, 2006.
6. Chowdhury, B. *Elements of Complex Analysis*, New Age International, 1993.
7. Raisinghania, M .D. *Advanced Ordinary & Partial Differential. Equation*; S. Chand Publication.
8. Ross, S. L. *Differential Equations*, John Willey & Sons.
9. Grewal, B. S. *Higher Engineering Mathematics*, Khanna Pub.
10. Kreyszig, E. *Advanced Engineering Mathematics*, John Wiley & Sons, 2006.

**CO-PO Mapping:**

| PO / CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **M 301.1** | 3 | 1 | 1 | - | - | - | - | - | - | - | - | 1 |
| **M 301.2** | 3 | 2 | 1 | - | - | - | - | - | - | - | - | 1 |
| **M 301.3** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 |
| **M 301.4** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 1 |
| **M 301.5** | 3 | 3 | 2 | 3 | - | - | - | - | - | - | - | 1 |

**Course Name: Physics - II**
**Course Code: PH(ME)301**
**Contacts: 3L: 0T: 0P**
**Credit: 4**
**Total contact hours: 33L**
**Full Marks = 100 (Internal Assessment-30; End Semester Exam-70)**
**Prerequisite: Physics I**

**Course Contents :**

**Module 1: Electric and Magnetic properties of materials (7L)**

**Module 1.01: Insulating materials:**

Dielectric Material: Concept of Polarization, the relation between **D, E** and **P**, Polarizability, Electronic (derivation of polarizability), Ionic, Orientation & Space charge polarization (no derivation), internal field, Claussius Mossotti equation, ferroelctric and piezoelectrics (Qualitative study). 3L

**Module 1.02: Magnetic materials and storage devices:**

Magnetic Field & Magnetization M, relation between **B, H, M**. Bohr magneton, susceptibility, Diamagnetism- & Paramagnetism - Curie law (qualitative discussion), Ferromagnetism– Curie Temperature, Weiss molecular field theory (qualitative) & Curie-Weiss law, concept of $\theta_p$ , Hysteresis, Hard ferromagnets, Comparison and applications of permanent magnets (storage devices) and Soft ferromagnets (Permalloys, Ferrites etc.) **4L**

**Module 2: Ultrasound and infrasound (4L)**

**Ultrasound-**Introduction, definition and properties –Production of ultrasonics by Piezo-electric crystal and magnetostriction method; Detection of ultrasonics; Engineering applications of Ultrasonics (Non-destructive testing, cavitations, measurement of gauge),

**Infrasound** – Introduction and definition, production, application: 4L

**Module 3: Quantum Mechanics-II (7L)**

Formulation of quantum mechanics and Basic postulates- superposition principle, orthogonality of wave function, expectation value; operator correspondence, Commutator. Measurements in Quantum Mechanics-Eigen value, Eigen function, Schrödinger's equation as energy eigen value equation. 4L

Application of Schrödinger equation – Particle in an infinite square well potential (1-D and 3-D potential well; Discussion on degenerate levels), 1D finite barrier problem and concept of quantum tunnelling (solve only $E<V_0$). 3L

**Module 4: Statistical Mechanics (4L)**

Concept of energy levels and energy states. Microstates, Macrostates and thermodynamic probability, MB, BE, FD, statistics (Qualitative discussions)- physical significance, conception of bosons, fermions, classical limits of quantum statistics, Fermi distribution at zero & non-zero temperature, Concept of Fermi level. 4L

**Module 5: Solid state physics (8L)**

**5.1 :** Introduction to Band theory (mention qualitatively improvement over free electron theory)- Kronig-Penny model (qualitative treatment)-Energy-band (E-k) diagram, formation of allowed and forbidden energy bands, Concept of effective mass – electrons and holes, crystal momentum. 3L

**5.2 : Defects**: Point defects; line defects; Dislocations, Types of dislocations, Planar defects, stacking faults, twins, grain boundaries, defect propagation (qualitative). 3L

**5.3 : Vibration in solids:** Lattice vibrations – Mono and diatomic lattice, concept of phonon, specific heat of solids-Dulong-Pettit law, Einstein, Debye theory (qualitative discussion). 2L

**Module 6: Physics of Nanomaterials (3L)**

Reduction of dimensionality, properties of nanomaterials, Quantum wells (two dimensional), Quantum wires (one dimensional), Quantum dots (zero dimensional); Quantum size effect and Quantum confinement. Carbon allotropes. Application of nanomaterials (CNT, grapheme, electronic, environment, medical). 3L

**Course Name: Materials Testing Laboratory**
**Course Code: ME 391**
**Contacts: 0L: 0T: 3P**
**Credit: 1.5**
Full Marks = **100** (**Internal Evaluation - 40; End Semester Exam Evaluation - 60**.)

**Prerequisite:** Engineering Chemistry.

**Course Objectives:**
To measure the mechanical properties of a material to understand the deformation behavior of materials and observe the microstructure of a material sample under heat treatment.

**Course Outcomes:**

1. To measure the mechanical properties of a material
2. To understand the deformation behavior of materials
3. To observe the microstructure of a material sample under heat treatment.

**Course Contents:** Atleast 6 experiments need to be conducted.

1. Uniaxial tension test on mild steel rod
2. Torsion test on mild steel rod
3. Impact test on a metallic specimen
4. Brinnell and Rockwell hardness tests on metallic specimen
5. Bending deflection test on beams
6. Strain measurement using Rosette strain gauge
7. Microscopic examination of heat-treated and untreated metallic samples

Course Name: **Machine Drawing I**
Course Code: **ME 392**
Credit : **2**
Contact Hours/Week (L:T:P): **0:0:3**
Full Marks = **100** (**Internal Evaluation - 40; End Semester Exam Evaluation - 60**.)

**Prerequisite:** Basic knowledge of Machine elements, engineering drawing/drafting

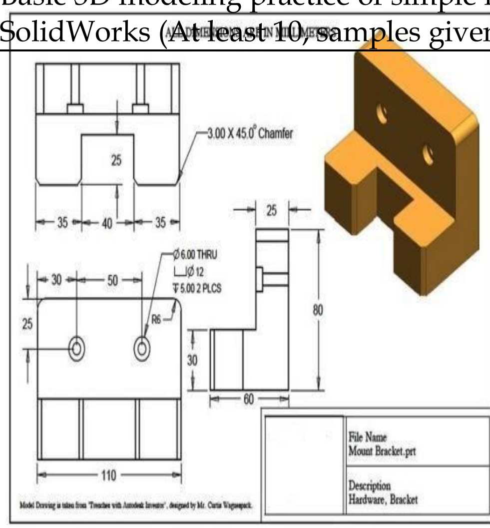
**Course Objective:** The objective of this lab is to practically demonstrate the failure criteria of different mechanical elements or bodies.
**Course Outcome:** Upon successful completion of this course, the student will be able to

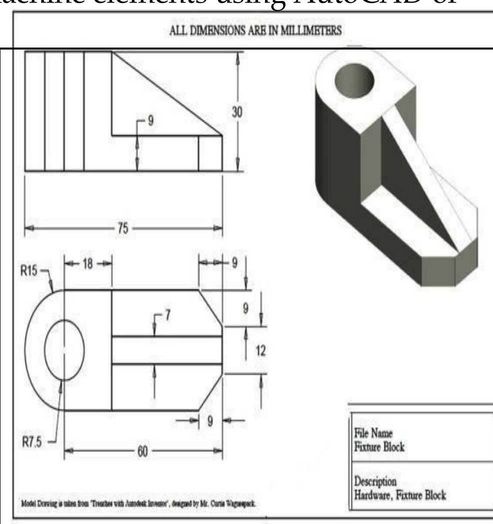
1. Gain knowledge about the isometric views of a given three dimensional object/part.
2. Understand and draw the orthogonal projection of a solid body and assemble drawing using part drawings.
3. Learn and practice 3D modeling of machine parts using AutoCAD/Solidworks/Catia.

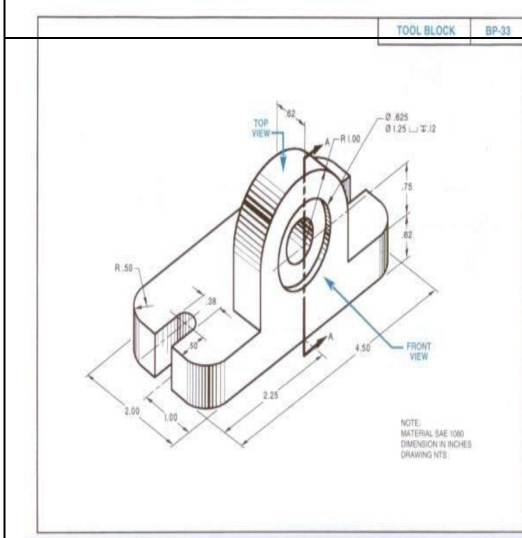
4. Draft the shape and structure of different types of screws, keys and Couplings.

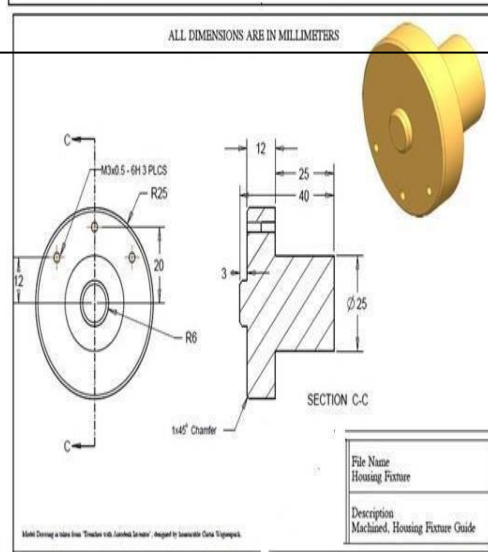
**Course Content:**

<table>
<tr><th>Experiment No.</th><th>Description</th></tr>
<tr><td>1</td><td>Schematic product symbols for standard components in welding and pipe joints</td></tr>
<tr><td>2</td><td>Orthographic projections of machine elements, different sectional views- full, auxiliary sections, Isometric projection of components (Manual and CAD)</td></tr>
<tr><td>3</td><td>Assembly and detailed drawings of a mechanical assembly (Manual Drafting)<br>a) Plummer block<br>b) Tool head of a shaping machine<br>c) Tailstock of a lathe<br>d) Welded pipe joints indicating work parts before welding</td></tr>
<tr><td>4</td><td>Basic 3D modeling practice of simple machine elements using AutoCAD or SolidWorks (At least 10 samples given)



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</table>

**Recommended Books:**

1. Text Book on Engineering Drawing, Narayana/ Kannaia H, Scitech
2. Mechanical Engineering Drawing and Design, S. Pal and M. Bhattacharyya
3. Machine Drawing by N.D. Bhatt
4. Machine Drawing by P.S. Gill
5. Engineering Drawing and Graphics + AutoCAD by K. Venugopal, New Age International Pub.
6. Engineering Drawing with an Introduction to AutoCAD by D.A. Jolhe, Tata-McGraw-Hill Co.
7. Introduction to Solid Modeling Using SolidWorks 2008, Joseph C. Musto and William E. Howard
8. SOLIDWORKS 2016 Basic Tools, Paul Tran

**Course Name:** Physics – II Lab
**Course Code:** PH(ME)391
**Contacts:** 0L: 0T: 2P
**Credit: 1**
Full Marks = **100** (**Internal Evaluation - 40; End Semester Exam Evaluation - 60**.)
**Prerequisite:** Physics – II Theory
**Objectives:** To enable students carry out several experiments on applied physics and apply the knowledge in innovative solution in mechanical engineering.

**Course Outcome:** At the end of the course students' should have the

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| **CO1: ability to define, understand and explain**<br>➢ instruments used in spectroscopy<br>➢ Oscilloscope (digital)<br>➢ Solenoidal field, Magnetization, demagnetization<br>➢ Cathitometer |
| **CO2: ability to apply the knowledge of**<br>➢ Hysteresis in magnetic storage<br>➢ Photovoltaic action in solar cell<br>➢ Band theory |
| **CO3: Ability to analyze**<br>➢ Role of magnetic field in changing resistance of a sample |
| **CO4: Ability to conduct experiments using**<br>➢ Intrinsic semiconductor<br>➢ Temperature sensor<br>➢ Photovoltaic cell, Light emitting diodes, Light dependent resistor<br>➢ Various types of magnetic materials<br>➢ Curie temperature of the given ferroelectric material |
| **CO5: Ability to communicate effectively, write reports and make effective presentation using available technology**<br>➢ on presentation of laboratory experiment reports<br>➢ on presentation of innovative experiments |
| **CO6: Ability to engage in independent self-study to perform**<br>➢ Performing mini project with the lab |

**Contents :**

*At least 7 experiments to be performed during the semester

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**Experiments on Module 1: Electric and Magnetic properties of materials (9L)**
1. Study of dipolar magnetic field behavior.
2. Study of hysteresis curve of a ferromagnetic material using CRO.
3. Use of paramagnetic resonance and determination of Lande-g factor using ESR setup.
4. Measurement of Curie temperature of the given sample.
5. Determination of dielectric constant of given sample (frequency dependent)/Measurement of losses in a dielectric using LCR circuits.

**Experiments on Module 2: Ultrasound and infrasound (4L)**
6. Determination of velocity of ultrasonic wave using piezoelectric crystal.

**Experiments on Module 3: Quantum Mechanics-II (7L)**
7. Determination of Stefan's radiation constant.
8. To study current-voltage characteristics, load response, areal characteristics and spectral response of photo voltaic solar cells & measurement of maximum workable power.
9. Measurement of specific charge of electron using CRT.

**Experiments on Module 5: Solid state physics (8L)**
10. Study of lattice dynamics.
11. Determination of band gap of a semiconductor.
12. Determination of Hall co-efficient of a semiconductor and measurement of Magnetoresistance of a given semiconductor

**In addition to regular 7 experiments it is **recommended** that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment.

**Probable experiments beyond the syllabus:**
1. Determination of thermal conductivity of a bad conductor by Lees and Chorlton's method.
2. Determination of thermal conductivity of a good conductor by Searle's mothod.
3. Study of I-V characteristics of a LED.
4. Study of I-V characteristics of a LDR
5. Study of transducer property: Determination of the thermo-electric power at a certain temperature of the given thermocouple.