Subject Code:PCPE-101
Subject Name: Strength of Material

Programme: B.Tech. (PE**)**	**L:** 3 **T:** 0 **P:** 0
Semester: 3	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 50**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#.	**Course Outcomes (Cos)**
1	Execute the fundamental concepts of stress, strain and elastic behaviour of materials to analyse structural members subjected to tension, compression and torsion.
2	Analyze the bending stress on different types of sections.
3	Formulate appropriate theoretical basis for the analysis of combined axial and bending stresses.
4	Understand the behaviour of column and struts under axial loading.
5	Demonstrate the use of critical thinking and problem solving techniques as applied to structural systems.
6	To predict the deflection in beams of varying sections and different materials.

Detailed Contents

Part A

Simple Stresses and Strains: Concept of stress and strain; St. Venant's principle, stress and strain diagram, Hooke's law, Young's modulus, Poisson ratio, stress at a point, stress and strains in bars subjected to axial loading. Modulus of elasticity, stress produced in compound bars subject to axial loading. Temperature stress and strain calculations due to applications of axial loads and variation of temperature in single and compound bars. Compound stress and strains, the two dimensional system; stress at a point on a plane, principal stresses and principal planes; Mohr's circle of stress; ellipse of stress and their applications. Generalized Hook's Law, principal stresses related to principal strains.**[8 Hours]**

Bending Moment and Shear Force Diagrams: S.F and B.M definitions. BM and SF diagrams for cantilevers, simply supported beams with or without overhangs and calculation of maximum BM and SF and the point of contra flexure under the following loads: Concentrated loads, Uniformity distributed loads over the whole span or part of span, Combination of concentrated loads (two or three) and uniformly distributed loads, Uniformity varying loads & Application of moments Relation between rate of loading, shear force and bending moment**[8 Hours]**

Theory of Bending: Stresses in beams due to bending, assumptions in the simple bending theory, derivation of formula: its application to beams of rectangular, circular channel, I and T-sections; combined direct and bending stresses in aforementioned section, composite / flitched beams.**[4 Hours]**

Part B

Torsion: Derivation of torsion equation and its assumptions. Applications of the equation to the hollow and solid circular shafts, torsional rigidity, combined torsion and bending of circular shafts principal stress and maximum shear stresses under combined loading of bending and torsion.**[4 Hours]**

Thin Cylinders & Spheres: Derivation of formulae and calculation of hoop stress, longitudinal stress in a cylinder, effects of joints, change in diameter, length and internal volume; principal stresses in sphere and change in diameter and internal volume**[3 Hours]**

Columns and Struts: Columns and failure of columns: Euler's formulas; Rankine-Gordon's formula, Johnson's empirical formula for axially loaded columns and their applications.**[3 Hours]**

Slope and Deflection: Relationship between moment, slope and deflection, Moment area method of integration; Macaulay's method: Use of all these methods to calculate slope and deflection for the Cantilevers, Simply supported beams with or without overhang, & under concentrated loads, uniformly distributed loads or combination of concentrated and uniformly distributed loads**[6 Hours]**

Text Books

1. EP Popov Mechanics of Materials-SI Version 2nd Edition Prentice Hall Indi
2. D.H Shames Introduction to Solid Mechanics Prentice Hall Inc.
3. D.S. Bedi Strength of Materials S Chand Publishers
4. R. S. Lehri and A.S. Lehri Strength of Materials S.K Kataria and Sons.
5. Sadhu Singh Strength of Materials Khanna Publishers
6. R. S. Khurmi Strength of Materials S. Chand& Co.

Subject Code: PCPE-102
Subject Name: Machine Drawing

Programme: B.Tech. (PE**)**	**L:** 2 **T:** 0 **P:** 4
Semester: 3	**Teaching Hours:** 72
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 60	**Duration of End Semester Exam(ESE):** 4hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#.	**Course Outcomes**
1	Read, draw and interpret the machine drawings and related parameters.
2	Understand and monitor the manufacturing of components at shop floor level as per the information in the given drawing.
3	Understand the concept of limits, fits and tolerances in various mating parts.
4	Visualize and generate different views of couplings and joints.
5	Visualize and generate different views of a component with detailed internal information in the assembly and disassembly.
6	Draw the various components on the computer aided drafting software's.

Note:

1. Drawing Sheet Size Should be A2
2. Drawing Practice is to be done as per IS code SP 46: 2003.
3. First angle projection to be used.
4. Drawings should contain Bill of Materials and should illustrate surface finish**.**

Detailed Contents

Part A

Introduction: Requirements of machine drawing, Sectioning and conventional representation, Dimensioning, concept of limits, fits & tolerances and their representation, Machining Symbols, introduction and Familiarization of Code SP 46:2003.**[10 hours]**

Fasteners: Various types of screw threads, types of nuts and bolts, screwed fasteners, welding joints and riveted joints. **[10 hours]**

Part B

Drawing of pipe joints, clutches, keys and couplings: Couplings: Solid or Rigid Coupling, Protected Type Flange coupling, Pin type flexible coupling, muff coupling, universal coupling, cone friction clutch, Single Plate friction clutch. Knuckle and cotter joints, keys, spline shafts. Pipe and Pipe Fittings: Flanged joints, Spigot and socket joint, Union joint, Hydraulic and expansion joint. **[16 hours]**

Assembly & Disassembly: Piston, connecting rod, Swivel Bearing, Plummer Block, Foot Step Bearing, Screw Jack, Drill Press Vice, Tail Stock. **[28 hours]**

Computer Aided Drawing

1. 2-D drawing of various views of Screw Thread on AutoCAD/Solid works/Pro E
2. 3-D drawing of various views of shaft joints and pipe joints on Solid works/Pro E**[8 hours]**

Text Books:

1. N. D. Bhatt "Machine Drawing", Charotar Publishers India.
2. P.S. Gill "Machine Drawing", S. K. Kataria & Sons.
3. Pohit, G., "Machine Drawing with AutoCAD", Pearson Education Asia
4. French, T. E. and Vierck, C. J., "Graphic Science and Design", McGraw Hill
5. Dhawan, R.K., "Machine Drawing", S. Chand & Company Limited

Reference Books:

1. Narayana, K.L., Kannaiah P. and Reddy, K.V., "Machine Drawing", New Age International Publishers
2. N. Sidheshwar, Shastry , Kanhaiah, "Machine Drawing", Tata McGraw Hill
3. Sadhu Singh, P. L. Shah "Fundamentals of Machine Drawing", PHI Learning Pvt. Ltd

Subject Code: PCPE-103
Subject Name: Thermal Engineering

Programme: B.Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 3	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 50%**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator & Psychometric Charts and Steam Tables

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	An ability to identify, track and solve various combustion problems.
2	An ability to recognize and understand the working of devices involved in thermal plants
3	An ability to evaluate theoretically the performance of various components involved in steam power plants and reciprocating compression machines.
4	An ability to design some components working on non-conventional power sources
5	An ability design machines based on heat transfer phenomenon.
6	An ability to understand and interpret the working of various engines and generators.

Detailed Contents **Part A**

Thermodynamics: Zeroth, first and second law of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Properties of Steam and its formation at constant pressure: wet, dry, saturated and super-heated steam; Sensible heat (enthalpy), latent heat and total heat (enthalpy) of steam. Entropy and internal energy of steam.**[7 hours]**

I.C Engines, Gas Turbines & Boilers: Classifications of I.C. engines, working of two and four stroke petrol and diesel engines. Measurement of BHP, IHP, mechanical and thermal efficiency, Specific fuel consumption. Elementary idea of combustion phenomenon in S.I. and C.I. engines. Description of simple carburetor, fuel pump and injector, Magneto and battery ignition system. Testing of I.C. Engines. Description of open cycle Gas turbines, comparison of I.C. Engines and gas turbines, Steam turbine comparison of I.C. Engines, Gas Turbine and Steam Turbine with their applications. Applications of Boilers, Fire tube and water tube boilers, Description of Lancashire, Cochran, Locomotive, Babcock Wilcox Boiler, Boiler mountings and accessories. . **[8 hours]**

Non-Conventional Power Generation: Introduction, advantages of non-conventional energy sources, Wind power plants – multiple blade type, savonius type and darrieus type, Wind electric generation power plant – horizontal and vertical axis wind machines. Tidal power plant – classification and operation, single basin and double basin, solar power plants – flat plate collector, concentrating collector, solar pond, geothermal power plants. Biogas plants **[7 hours]**

Part B

Thermodynamics: Zeroth, first and second law of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Properties of Steam and its formation at constant pressure: wet, dry, saturated and super-heated steam; Sensible heat (enthalpy), latent heat and total heat (enthalpy) of steam. Entropy and internal energy of steam.**[6 hours]**

I.C Engines, Gas Turbines & Boilers: Classifications of I.C. engines, working of two and four stroke petrol and diesel engines. Measurement of BHP, IHP, mechanical and thermal efficiency, Specific fuel consumption. Elementary idea of combustion phenomenon in S.I. and C.I. engines. Description of simple carburetor, fuel pump and injector, Magneto and battery ignition system. Testing of I.C. Engines. Description of open cycle Gas turbines, comparison of I.C. Engines and gas turbines, Steam turbine comparison of I.C. Engines, Gas Turbine and Steam Turbine with their applications. Applications of Boilers, Fire tube and water tube boilers, Description of Lancashire, Cochran, Locomotive, Babcock Wilcox Boiler, Boiler mountings and accessories. **[8 hours]**

Text Books:

1. V.P. Vasandani and D.S. Kumar "Thermal Engineering", Treatise on Heat Engineering Metropolitan
2. John R. Howell & Richrd O Buckius "Fundamentals of Engineering Thermodynamics" McGraw Hill
3. C.P. Arora "Refrigeration & Air Condition", Tata McGraw Hill
4. Domkundwar "Thermal Engineering", Dhanpat Rai & Co.
5. R. K. Rajput "Thermal Engineering", S. Chand & Co.

Reference Books:

1. J. S. Rajadurai , "Thermodynamics and Thermal Engineering" New Age Int.(P) Ltd. Publishers,.
2. G. Rogers and Y. Mayhew, "Engineering Thermodynamics", Pearson Education Canada,

Subject Code: HSMPE-101
Subject Name: Operation Management

Programme: B.Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 3	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 10**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	An ability to apply knowledge of mathematics, science, and engineering
2	An ability to design and conduct experiments, as well as to analyze and interpret data.
3	An ability to design a system, process to meet desired needs within realistic constraints.
4	An ability to function on multidisciplinary teams.
5	An Ability to design and maintain the systems
6	An ability to plan, control and execute the different duties in an organization

Detailed Contents

Part A

Introduction : Overview of Production System, Objectives of Operation Management, Scope of Operations Management, Operations Management Frame work, Relationship of operations with other Functional areas, Manufacturing Vs Service sector, Operations Decision making, productivity, Introduction to MIS, Steps in designing MIS **[3 hours]**

Product Design And Development: Steps involved in product design and development, considerations of technical, ergonomic, aesthetic, economic and time factors. Use of concurrent engineering in product design and development. Discussion of case studies. Feasibility and locational analysis. **[5 hours]**

Forecasting: Role of market survey and market research in preplanning, long medium and short range forecasting, objective and techniques of forecasting, smoothening and revision of forecast, Patterns of a time series Forecasting techniques Forecasting a time series with trend and seasonal component. **[5 hours]**

Production Planning: Production planning objective and functions, Bill of material, operation analysis and process planning, long range planning, aggregate planning; Objective, Strategies, graphical and mathematical techniques of aggregate planning, master production scheduling, MRP and MRPII Systems, Scheduling **[6hours]**

Production Control: Production control functions; Routing, scheduling, dispatching, expediting and follow up. Techniques of production control in job shop production, batch production and mass production systems **[4 hours]**

Part B

Capacity Planning: Measures of capacity, Factors affecting capacity, Capacity planning, Systematic approach to capacity planning, Long-term and short-term capacity decisions, Tools for capacity planning, Capacity Requirement planning-Business process outsourcing. **[5 hours]**

Material Management: Objectives, scope and functions of material management, planning, procurement, storing, ending and inventory control. Purpose of inventory, inventory cost, inventory control systems, Selective inventory control systems, Determination of EOQ, Lead time and reorder point. Methods of physical stock control **[5 hours]**

Quality Control: Meaning of quality and quality control, quality of design, quality of conformance and quality of performance, functions of quality control. Introduction to statistical quality control-control charts and sampling plans**[4 hours]**

Maintenance Systems: Type of maintenance, objective of maintenance, planned maintenance strategies, preventive maintenance, condition monitoring and total productive maintenance **[3 hours]**

Text Books:

1. Charry, "Production and Operation Management", Tata-McGraw Hill
2. J.G. Monks, " Production/Operation Management", Tata-McGraw Hill
3. R.N. Nauhria & Rajnish Prakash, "Management of Systems", Wheeler Publishing, Delhi
4. E. L. Grant and R.S. Leaven Worth, "Statistical Quality Control", McGraw Hill

Reference Books:

1. Buffa and Sarin "Modern Production/Operations Management", John Wiley & Sons.
2. Russell & Taylor "Operations Management", PHI.

Subject Code: BSPE-101
Subject Name: Material Science

Programme: B.Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 3	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:20**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Apply knowledge of Crystal growth, Crystal structure, re-crystallization in various manufacturing processes.
2	Understand the reasons of deformations in crystals.
3	Acknowledge the various applications of different types of materials.
4	Determine the crystal structure of simple crystals.
5	Recognize the crystal defects during manufacturing and their respective remedies.
6	Apply knowledge about the various material properties for different engineering applications.

Detail Content:

Part A

Crystal Structure: Unit cells, Metallic crystal structures, Ceramics. Imperfection in solids: Point, line, interfacial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.**[4 Hours]**

Alloys: Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, ferrite and cementite, cast iron.**[6 Hours]**

Alloying of steel: Properties of stainless steel and tool steels, maraging steels- cast irons; grey, white, malleable and spheroidal cast irons- copper and copper alloys; brass, bronze and cupro-nickel; Aluminum and Al-Cu – Mg alloys- Nickel based super alloys and Titanium alloys**[5 Hours]**

Electrical Properties: Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionic ceramics and in polymers. Dielectric behavior. Ferroelectricity. Piezoelectricity.**[5 Hours]**

Part B

Magnetic Properties: Diamagnetism and paramagnetism. Ferromagnetism. Anti-Ferromagnetism and Ferrimagnetism. Influence of temperature on magnetic behavior. Domains and Hysteresis,**[4 Hours]**

Optical Properties: Optical properties of metals. Optical properties of nonmetals. Application of optical phenomena.**[3Hours]**

Thermal Property: Heat capacity. Thermal expansion. Thermal conductivity. Thermal stresses**[4 Hours]**

Applications and Processing of Ceramics, Polymers & Composites: Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behavior of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced composites. Fiber reinforced composites. Structural composites**[5 Hours]**

Text Books:

1. W. D. Callister, "Materials Science and Engineering-An Introduction", Wiley India.
2. Kenneth G. Budinski & Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited,
3. V. Raghavan, "Material Science and Engineering', Prentice Hall of India Pvt. Ltd.
4. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, India

Recommended Books:

1. Allen, S. M., and E. L. Thomas. "The Structure of Materials" . J. Wiley & Sons New York.
2. Rohrer, G. "Structure and Bonding in Crystalline Materials". Cambridge University Press, New York.
3. Nye, J. F. "Physical Properties of Crystals: Their Representation by Tensors and Matrices", Oxford University Press, New York.
4. Bransden, B. H., and C. J. Joachain. "Physics of Atoms and Molecules", Prentice Hall New Jersey.

Subject Code: ESPE-101
Subject Name: Industrial Engineering

Programme: B.Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 3	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:20**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	An ability to apply knowledge of mathematics, science, and engineering
2	An ability to design and conduct analyze and interpret data.
3	An ability to plan and design layouts of an organization with an eye on enhancements..
4	An ability to function on multidisciplinary teams.
5	An ability evaluate the economic aspects of an organization.
6	An ability to design and implement the work and jobs in an organization.

Detailed Contents **Part A**

Introduction: Definition and scope of industrial engineering, role of an Industrial engineer in industry, functions of industrial engineer, qualities of an industrial engineer **[3 Hours]**

Plant Layout & Material Handling: Introduction and different types of layouts, Site Selection, Types of Buildings, development of plant layout, types of material handling equipment, relationship of material handling with plant layouts. **[4 Hours]**

Work Study-Method Study: Introduction to work study, objectives and procedure for methods analysis, recording techniques, micro motion and macro motion Study; Principles of motion economy, normal work areas and workplace design. **[5 Hours]**

Work Study-Work Measurement: Objectives, work measurement techniques – time study, work sampling, predetermined motion time standards (PMTS), Determination of time standards, Observed Time, Basic Time, Normal Time, Rating Factors, allowances, Standard Time. **[5 Hours]**

Part B

Work Design: Concepts of job enlargements, job enrichment and job rotation, effective job design considering technological and behavioral factors, Scientific Management, Re Engineering, Gillworth Contribution towards work system design. **[5 Hours]**

Ergonomics: Introduction to ergonomics consideration in designing Man Machine systems with special reference to design of displays and controls. Anthropometry, Introduction to Human Metabolism, Application of Ergonomics. **[6 Hours]**

Engineering Economics: Introduction to Economics, Flow of Economics, Law of supply and demand, concept of Engineering Economics, Elements of Costs, Depreciation, Maintenance and Replacement Problems **[6 Hours]**

Advancement in Industrial Engineering: Introduction to Agile Manufacturing, Supply Chain Management, Value Engineering, TPM, JIT, JOT, Enterprise Resource Planning, 5S, SMED, Kaizen, Root Couse Analysis, Why-Why Analysis & Green Manufacturing [**5 Hours]**

Text Books:

1. Martand Telsang "Industrial Engineering and Production Management", S. Chand
2. Hicks, "Industrial Engg. And Management ", Tata McGraw Hill.
3. Suresh Dalela and Saurabh, "Work Study and Ergonomics", Standard Publishers.
4. R. Bernes, "Motion and Time Study", John Wiley and sons.
5. D. J. Oborne, "Ergonomics at work", John Wiley and sons.
6. Dwivedi, D.N., Managerial Economics, Vikas Publishing House Pvt. Ltd.
7. Chan S. Park "Contemporary Engineering Economics" Prentice Hall of India

Reference Books:

1. Donald G. Newman and Jerome P. Lavelle "Engineering Economics and Analysis" Engg. Press
2. Principles of Economics: P.N. Chopra (Kalyani Publishers).
3. O.P. Khana "Industrial Engineering and Management", Dhanpat Rai Publications
4. Salvatore, D. and Srivastav, R., Managerial Economics: Principles and Worldwide Applications, Oxford University Press.
5. Work study by ILO

Subject Code: LPCPE-101
Subject Name: Strength of Material Lab

Programme: B.Tech. (PE)	**L:** 0 **T:** 0 **P:** 2
Semester: 3	**Teaching Hours:** 24
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 20	**Duration of End Semester Exam(ESE):** 1.5 hr
Total Marks: 50	**Elective Status:** Compulsory

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Perform tensile and compression test.
2	Knowledge of bending test on beam.
3	Perform torsion test and determine modulus of rigidity.
4	Understand study and compute various hardness test.
5	Perform shear test and determine ultimate shear strength.
6	Perform impact test and determine impact strength.

Sr. No.	Experiment
1	To perform tensile test in ductile and brittle materials and to draw stress-strain curve and to determine various mechanical properties.
2	To perform compression test on C.I. and to determine ultimate compressive strength.
3	To perform shear test on different materials and determine ultimate shear strength.
4	To perform any one hardness test (Rockwell, Brinell & Vicker's test) and determine hardness of materials.
5	To perform impact test to determine impact strength.
6	To perform torsion test and to determine various mechanical properties.
7	Study of performance of Fatigue & Creep tests.
8	To perform bending test on beam (wooden or any other material) and to determine the Young's modulus and Modulus of rupture.
9	To perform Torsion test and close coiled helical spring in tension and compression and to determine modulus of rigidity/stiffness.
10	Determination of Bucking loads of long columns with different end conditions.
11	One Minor Project based on the syllabi of Strength of Material Subject

Reference Material
Manuals available in Lab.

Subject Code: LPCPE-102
Subject Name: Thermal EngineeringLab

Programme: B.Tech. (PE)	**L:** 0 **T:** 0 **P:** 2
Semester: 3	**Teaching Hours:24**
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 20	**Duration of End Semester Exam(ESE):** 1.5 hr
Total Marks: 50	**Elective Status:** Compulsory

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	An ability to identify, track various combustion problems in I.C. engines.
2	An ability to recognize and understand the working of devices operating on the principles of Heat Transfer.
3	An ability to evaluate practically the performance of various components involved in steam power plants and reciprocating compression machines.
4	An ability to design some components working on non-conventional power sources
5	An ability determine the C.O.P. of various machines like refrigerator, air conditioner etc.
6	An ability to understand and interpret the working of various industrial boilers

Sr. No.	Experiment
1	Determination of coefficient of heat transfer for free/forced convection from the surface of a cylinder/plate when kept along the direction of flow.
2	Determination heat transfer coefficient of radiation and hence find the Stefan Boltzman's constant using two plates/two cylinders of same size by making one of the plates/cylinders as a black body.
3	Trial of single Cylinder, four stroke diesel engine to calculate BHP, IHP, and air fuel ratio thermal efficiency.
4	Morse test on multi cylinder petrol engine.
5	To find C.O.P of domestic refrigerator.
6	To find COP of an Air conditioner.
7	To find COP of water cooler.
8	Study of various types of boilers Models.
9	One Minor Project based on the syllabi of Thermal Engineering Subject

R**eference Material**
Manuals available in Lab.

Subject Code: PCPE-104
Subject Name: Design of Machine Elements

Programme: B.Tech. (PE**)**	**L:** 4 **T:** 0 **P:** 0
Semester: 4	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 70**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 4hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator & Design Data Hand Book

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	To understand the design flow chart for existing and new conceptual design.
2	Deal with the machine design problems in technical way using design principles and procedures.
3	Understand different stresses and strains (loading conditions), and also effect of these stresses and strains on different machine members.
4	To deal with problems of designing various types of joints and other important machine elements in a technical way.
5	Will be able to analyze the design and recommend/apply appropriate adjustments in the existing design.
6	To manage Design of machine components like: springs, flywheel, clutches and brakes etc. according to various necessities in the business/Industry.

Detailed Contents

Part A

Introduction: - Scope and meaning of machine design. Sources of design data. Design considerations from economics, manufacturing, assembly, aesthetics and ergonomics aspects. Design Process, Selection of Materials, Limits and Fits **[04 Hours]**

Fasteners:-Screwed Joints: - Design of Bolted joints, Bolted Joints under eccentric Loading. Welded Joints: -Design of Fillet Welded Joints, Butt Joints, Un-symmetric Welded sections, eccentrically loaded welded joints. Riveted Joints: - Design of Lap Joints, Butt Joints, Diamond Riveting, Eccentrically loaded riveted joints. Design of Cotter and Knuckle Joints: - Socket and Spigot, Gib and Cotter, Knuckle joint **[06 Hours]**

Shafts: - Design of shafts under different types of loading conditions. **[04 Hours]**

Transmission Drives – Design of Belt drives (Flat, V) and Spur gear drive **[04 Hours]**

Part B

Keys & Couplings: - Design of rectangular and square keys, muff coupling, split muff coupling, flange coupling, bushed-pin type flexible coupling. **[05 Hours]**

Pressure vessels: - Classification of vessels, Types of stresses, stresses in thin, thick and compound cylinders/shells. **[05 Hours]**

Levers: - Design of straight levers, Bell -Crank levers, foot levers, hand levers. **[04 Hours]**

Brakes and Clutches: - Design of friction plate and cone clutches, band brake band and block brakes. **[04 Hours]**

Text Books:

1. J.E. Shigley "Mechanical Engineering Design", McGraw-Hill Education (India) Pvt Ltd Sadhu Singh "Machine Design", Khanna Publishers
2. R. S. Khurmi & J. K. Gupta "A text book of machine design", S Chand & Co.
3. D. K. Aggarwal & P. C .Sharma "Machine Design" by S.K Kataria and Sons

Design Data Books

1. Design Data Book, PSG College of Engineering and Technology, Coimbatore,
2. Design Data Handbook for Mechanical Engineers, Mahadevan, K. and Reddy Balveera, K., CBS Publishers and Distributors Pvt. Ltd.

Reference Books:

1. James G. Skakoon "The Elements of Mechanical Design", ASME Press New York
2. David G. Ullman" The Mechaqnical Design Proess" Mc-Graw Hill Publications
3. Krishnamurthi, "Design and Manufacturing", S.K. Kataria and Sons

Subject Code: PCPE-105
Subject Name: Fluid Mechanics & Machinery

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 4	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 50**%
External Marks: 60	**Duration of End Semester Exam(ESE): 3**hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	An ability to solve problems relating to kinematic and dynamics of fluid flow.
2	An ability to analyze the fluid dynamic conditions and in assessing the equations involved on the basis of dimensional homogeneity.
3	An ability to evaluate theoretically the performance of various components involved in pumps and turbines.
4	An ability to check the homogeneity of various equations involved in fluid mechanics.
5	An ability to solve various problems arising in fluid working machinery.

Detailed Contents

Part A

Fluids & Their Properties: Concept of fluid; Ideal & Real fluids; significance of fluid Mechanics; continuity concept of fluid; density, specific weight, viscosity & its dependence on temperature; vapor pressure & cavitations; compressibility & bulk modulus, Newtonian & non Newtonian fluids.**[5 hours]**

Fluid statics, kinematics & dynamics: Concept of pressure, Pascal's Law, Buoyancy & floatation, stability of floating & submerged bodies. Concept of Metacentre. Classification of fluid flows; streamline, path line & streakline; continuity equation in Cartesian coordinates. Euler's equation; Bernoulli's Equation & steady flow energy equation, Impulse momentum equation. **[8 hours]**

Dimensional Analysis: Need of dimensional analysis; Fundamental & derived units & dimensions; dimensional homogeneity; Rayleigh's & Buckingham's Pi method for dimensional Analysis. Model studies, Dimensionless numbers & their significance. **[5 hours]**

Part B

Laminar & Turbulent flows & their measurements: Flow in circular cross section pipes; Turbulent &flow losses in pipes; Darcy Equation. -Manometers; pitot tubes; venture meter & Orifice meter; rotameter. **[6 hours]**

Fluid machinery concepts: Impulse momentum principle; Jet impingement on stationary & moving flat plates and on stationary or moving vanes with jet striking at center & tangentially at one end of vane, calculations for force exerted, work done & efficiency of jet. **[5 hours]**

Turbines and Pumps: Components parts & operation of Pelton, Franics & Kaplan Turbines Draft Tube- Its function &types. Component parts & operation of centrifugal & reciprocating pumps: Suction, delivery & manometric heads of centrifugal pumps; priming & priming devices. Multistage pumps, series & parallel arrangements. Pressure variation due to piston acceleration & acceleration effects &air vessel. (No Numerical). **[7 hours]**

Text Books:

1. D.S. Kumar “Fluid Mechanics & fluid power Engineering”, Metropolitan Publishers
2. Fluid Mechanics by R. K. Bansal, (Laxmi Publications)
3. Fluid Mechanics by Potter & Wiggert (Cengage Learning) 4
4. Fluid Mechanics by A.K Mohanty (PHI Learning Pvt. Ltd.) 5.
5. Fluid Mechanics and Hydraulic Machines by R. K. Rajput (Khanna Publishers)
6. Fluid Mechanics and Machinery by C.S.P. Ojha (Oxford University

Reference Books:

1. S.K. Som, G. Biswas and S. Chakraborty, “Introduction to Fluid Mechanics and Fluid Machines”, Tata McGraw Hill Publications, 3rd edition, 2011.
2. C.S.P. Ojha, R. Berndtsson and P.N. Chandramouli, “Fluid Mechanics and Machinery”, Oxford University Press,1st Edition, 2010.

Subject Code: PCPE-106
Subject Name: Manufacturing Processes

Programme: B.Tech. (PE**)**	**L:** 3 **T:** 0 **P:** 0
Semester: 4	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:10**%
External Marks: 60	**Duration of End Semester Exam(ESE): 3**hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	An ability to identify various equipment's required the casting and welding processes.
2	An ability to test the products made by casting and welding processes
3	An ability to apply the knowledge for practical use & application of manufacturing processes
4	An ability to understand the various process parameters involved in different Manufacturing Processes
5	Implement appropriate machining processes effectively and economically.
6	Design newer combinations of different processes of machining, machining parameters, tool material &shape to enhance the tool life.

Detailed Contents

Part A

Casting & Welding: Introduction to metal casting, types of patterns, their materials and allowances. Moulding materials, moulding sand compositions properties, sand testing; types of moulds, moulding Machines. Cores: core sands, types of cores, core baking. Elements of Gating systems and Risers and their design. Cupola and its operation, charge calculations, types of furnaces. Casting processes, and types of castings Casting defects, Introduction and classification of welding processes, welding positions, joint design and filler metals. Types of welding, Principle of different welding processes, Flame cutting. Welding equipment, Welding Defects, Brazing and soldering. **[8 Hours]**

Lathe Machine and its operations: Lathe & its accessories, Lathe specifications, Lathe cutting tools, speed, feed, depth of cut & machining time, various operations on Lathe (turning, facing, copy turning, boring, counter boring, parting off, chamfering, threading, chamfering etc.), Turret & Capstan Lathe, Tool holding devices. Detailed calculations and numerical related to material removal rate, surface finish and tool wear for turning operations**[6 Hours]**

Milling Machines: Milling machines (Horizontal, Vertical & Universal milling machine), specifications, accessories, standard and Special attachments, milling operations; Indexing, Type of indexing (Direct, Simple, Compound, Differential, Angular); milling cutters, size, shape & material of milling cutters; numerical related to cutting speed, feed, depth of cut & machining time.**[5 Hours]**

Part B

Shapers, Planer and Drilling Machines : Types of Shaper, Various types of presses, feeding mechanisms, Planners and its operations, specifications, Types of drilling machines, specifications, operations Multi-spindle drilling head, Drills and Reamers; Type of boring machines Boring tools,**[7 Hours]**

Gear Manufacturing: Methods used in production of spur, bevel and worm gears (Powder metallurgy, Moulding, Forming, Rolling, Gear-hobbing and shaping), Gear finishing.**[4 Hours]**

Grinding and Broaching Machines: Type, specifications. Composition of Grinding wheel, Standard marking of Grinding wheel, Shapes of Grinding wheels; Types of Grinding Machines , Dressing and Truing of Grinding wheels; machining time; Centreless grinding, Honing, Lapping, Super finishing. Types of Broaching machines, Broaching tools, Materials for Broach, Cutting action, Chip disposal, applications of broaching, advantages and limitations.**[6 Hours]**

Text Books:

1. Heine, R.W. C.R. Loperand P.C. Rosenthal "Principles of Metal Casting", McGrawHill, N York
2. R.S. Parmar "Welding Technology", Khanna Publishers
3. B.S Raghuwanshi "Workshop Technology"Vol.1 & Vol.2 Dhanpat Rai& Co.
4. Myron L. Begeman "Manufacturing Processes", John Wiley & Sons
5. Production Technology by H.M.T Tata McGraw-Hill Education.

Reference Books:

1. Rao, P. N. "Manufacturing Technology", McGraw Hill (2008).
2. O.P Khanna "Foundry Technology", DhanpatRai & Co.
3. Little "Welding and Welding Technology", McGraw-Hill Education (India).
4. S. Kalpakjian "Manufacturing Processes", Pearson India Ltd.

Subject Code: PCPE-107

Subject Name: Kinematics & Dynamics of Machine

Programme: B.Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 4	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 50**%
External Marks: 60	**Duration of End Semester Exam(ESE): 3**hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Understand the working of various primitive components of a machine.
2	Develop mathematical skills for the computation of industry related problems.
3	Determine the various physical parameters of power transmission devices, friction devices and different governing devices.
4	Compute the essential parameters like fluctuation of speed and energy in a flywheel of a vehicle, slotting machine etc.
5	Understand the function of belt drives, cams, flywheels and governors and solve related problems
6	Understand the capacity and use of gears in machines and the concept of gyroscopic couple and its impact in ships, planes, two wheeler and four wheeler.

Detail Content

Part A

Classification of mechanisms-Basic kinematic concepts and definitions-Degree of freedom, mobility Grashof's law, Kinematic inversions of four bar chain and slider crank chains-Limit positions Mechanical advantage-Transmission angle-Description of some common mechanisms-Quick return mechanism, straight line generators-Universal Joint-Rocker mechanisms **[3 Hours]**

Displacement, Velocity and Acceleration: Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations kinematic analysis of simple mechanisms- slider crank mechanism dynamics-Coincident points Coriolis component of acceleration- introduction to linkage synthesis- three position graphical synthesis for motion and path generation **[6 Hours]**

Classification of Cams and Followers-Terminology and definitions-Displacement diagrams- Uniform velocity, parabolic, simple harmonic and cycloidal motions- derivatives of follower motions- specified contour cams- circular and tangent cams- pressure angle and undercutting, sizing of cams, graphical and analytical disc cam profile synthesis for roller and flat face followers **[5 Hours]**

Gears: Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting- helical, bevel, worm, rack & pinion gears, epicyclical and regular gear train kinematics**[5 Hours]**

Part B

Surface Contacts- sliding and rolling friction- friction drives- bearings and lubrication- friction clutches- belt and rope drives- friction in brakes **[5 Hours]**

Flywheels: Turning moment and crank effort diagrams for reciprocating machines Fluctuation of speed, coefficient of fluctuation of speed and energy, Determination of flywheel effect. Governorsand types of governors. **[3 Hours]**

Brakes, Dynamometers and Clutches: Types of brakes, principle, function of brakes, types of dynamometer, Function of Clutches. Disc and Cone clutches. **[5 Hours]**

Gyroscope- Introduction, axis of spin, axis of precession, gyroscopic couple, Gyroscope effect on stabilization of ships and planes, stability of automobile (two and four wheeled) taking a turn. **[4 Hours]**

Text Books:

1. Thomas Bevan, "Theory of Machines", CBS Publishers & Distributors
2. Ballaney, P. L. "Theory of Machines", Khanna Publishers
3. Shigley "Theory of Machines" , McGraw Hill
4. Khurmi R. S. "Theory of Machines", S.Chand and Sons

Reference Books:

1. Cleghorn W. L. , Mechanisms of Machines, Oxford University Press
2. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill
3. Ghosh A. and Mallick A.K., Theory of Mechanisms and Machines, Affiliated East-West Pvt. Ltd, New Delhi,
4. Ratan S. S. "Theory of Machines", McGraw Hill

Subject Code: PCPE-108

Subject Name: Physical Metallurgy and Heat Treatment

Programme: B.Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 4	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 10**%
External Marks: 60	**Duration of End Semester Exam(ESE): 3**hr
Total Marks: 100	**Elective Status:** Compulsory

Additional Material Allowed in ESE: Scientific Calculator

On completion of the course, the student will have the ability to

CO#	Course Outcomes(CO)
1	Explain crystallography, deformations and re-crystallization in various crystal structures and their effect on the properties of metals.
2	Use various techniques to check microstructure and mechanical properties of materials.
3	Implement various heat treatment processes to enhance the properties of materials.
4	Build new alloys with different structures and properties by altering composition of various alloying elements.
5	Analyze the various transformations in equilibrium phase diagrams.
6	Figure out at which temperatures various transformations in phase diagrams become stable.

Detailed Contents

Part A

Atomic Bonding & Crystal Structure: Atomic structure of metals, crystal structure, crystal lattice of SC, BCC, FCC, HCP, crystallographic notation of atomic planes, polymorphism and allotropy.**[3 Hours]**

Experimental tools & techniques: Metallography (Optical TEM, SEM), X Ray Diffraction, Mechanical Properties, strain hardening, cold working.**[4 Hours]**

Solidification of metals: Nucleation and Growth, Homogeneous Nucleation, Heterogeneous Nucleation, Growth of solid, Smooth or Stable interface growth, Temperature inversion in pure metals-Dendritic growth in pure metals, Constitutional Supercooling, Segregation, Porosity, Freezing of Ingots**[5 Hours]**

Equilibrium diagrams: General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Isomorphous systems, Lever rule, Coring, Eutectic system, Eutectoid, Peritectic, Peritectoid, Monotectic and Syntectic reactions, Study of Fe-Fe3C, Cu-Zn, Al-Si Binary diagrams.**[6 Hours]**

Part B

Phase Transformations: Equilibrium diagrams of a system whose components are subject to allotropic change. Iron carbon equilibrium diagram, phase transformation in the iron carbon diagram: (i) Formation of Austenite (ii) Transformation of austenite into pearlite (iii) Martensite transformation in steel, time temperature transformation curves, Cooling curves.**[7 Hours]**

Heat treatment of steel: Principles and applications of heat treatment processes viz annealing, normalizing, hardening, tempering,; harden ability & its measurement, surface hardening processes (nitriding, carburizing, case hardening etc), Defects in heat treatment and their remedies.**[7 Hours]**

Alloying of steels: Effects produced by alloying elements on the structures and properties of steel. Distribution of alloying elements (Si, Mn, Ni, Cr, Mo, Ti, Al, P, Mg, S) in steel.**[4 Hours]**

Text Books:

1. William Callister, “Materials Science and Engineering” , John Wiley & Sons
2. V Raghavan, “Materials Science and Engineering”, PHI learning
3. Er. Harvinder Singh Dhaliwal, “A Textbook of Engineering materials and Metallurgy”, Laxmi Publications.
4. Donald Askeland, “The Science and Engineering of Materials”, Cengage learning
5. Srinivasan R, “Engineering Materials and Metallurgy”, Tata McGraw-hill Education India.
6. O.P. Khanna, “Material Science and Metallurgy”, Dhanpat rai Publications.

Subject Code: LPCPE-103
Subject Name: Fluid Mechanics & Machinery Lab

Programme: B.Tech. (PE)	**L:** 0 **T:** 0 **P:** 2
Semester: 4	**Teaching Hours:24**
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 20	**Duration of End Semester Exam(ESE):** 1.5 hr
Total Marks: 50	**Elective Status:** Compulsory

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	An ability to analyze the working of various fluid flow measurement devices.
2	An ability to determine the various losses in the fluid flow under different working conditions.
3	An ability to evaluate practically the performance of various components involved in pumps and turbines.
4	An ability to check the proper working of various turbines and pumps.
5	An ability to measure/determine the changes in the fluid properties due to change in certain conditions.
6	An ability to explain the phenomenon of fluid flow in various types of flows.

SNo.	Experiment
1	To study flow through a variable area duct & verify Bernoulli's energy equation.
2	To determine coefficient of discharge for venturimeter.
3	To determine coefficient of discharge for orifice.
4	To determine the head loss in a pipe line due to sudden expansion/sudden contraction/ bend.
5	To determine friction coefficients for pipes of different materials.
6	To draw Characteristics of Francis Turbine.
7	To study constructional features and characteristics of reciprocating or centrifugal pump.
8	To draw the characteristics of Pelton turbine.
9	One Minor Project based on the syllabi of Fluid Mechanics & MachinerySubject

R**eference Material**
Manuals available in Lab.

Subject Code: LPCPE-104

Subject Name: Kinematics and Dynamics of Machine Lab

Programme: B.Tech. (PE)	**L:** 0 **T:** 0 **P:** 2
Semester: 4	**Teaching Hours:24**
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 20	**Duration of End Semester Exam(ESE):** 1.5 hr
Total Marks: 50	**Elective Status:** Compulsory

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	Understand the working of different types of link motions and mechanisms.
2	Understand the working and application of gears and gear trains.
3	Understand the working and application of brakes and clutches.
4	Compute the essential parameters of quick return mechanisms and their application.
5	Understand the function and application of cams, flywheels and belts.
6	Understand the capacity and use of dynamometers.

S No.	Experiment
1	Study of working principles and construction of the different types of link motions and mechanisms.
2	Study of different types of gears and gear trains.
3	Study of different types of brakes and clutches.
4	Study of various types of quick return mechanisms and determination of quick return effects.
5	To study various types of cams and followers and the working, construction of a cylindrical cam for doing operation.
6	To study the flywheel and draw turning moment and crank effort diagram for a four stroke, single cylinder petrol and diesel engines.
7	Study various types of belts and calculate the length of belt and power transmitted by the flat and V belts.
8	Study of various types of dynamometers and calculate the forces on a multi cylinder petrol engine.
9	One Minor Project based on the syllabi of Kinematics and Dynamics of MachineSubject

R**eference Material**

Manuals available in Lab.

Subject Code: LPCPE-1065

Subject Name: Manufacturing Processes Lab & Physical Metallurgy & Heat Treatment Lab

Programme: B.Tech. (PE)	**L:** 0 **T:** 0 **P:** 4
Semester: 4	**Teaching Hours: 48**
Theory/Practical: Practical	**Credits:** 1
Internal Marks: 30	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 20	**Duration of End Semester Exam(ESE):** 1.5 hr
Total Marks: 50	**Elective Status:** Compulsory

On Completion of the course, the student will have the ability to:

CO#	Course Outcomes(CO)
1	To apply this knowledge for practical use and application of manufacturing processes in the industries.
2	To understand the various process parameters involved in different machining processes.
3	To understand the essential components of casting and welding processes.
4	Understand the crystal structures and microstructure of materials.
5	Know about the effect of quenching medium and effect of annealing time on mechanical properties of steel.
6	Recognize the various phases of Fe-C diagram and effect of cooling rate in formation of Austenite, bainite, martensite and pearlite.

S No.	Experiment
1	To study of MIG/TIG and PMIG/PTIG welding equipment and making a weld joint by this process.
2	To study the resistance welding processes and prepares a spot-welded joint.
3	To determination of permeability of a moulding sand sample and to test tensile, compressive, transverse strength and hardness a moulding sand in dry/wet conditions.
4	To determine clay content and moisture content in a moulding sand sample and measurement of grain fineness number and find shatter index of different sand samples and to compare and discuss the results.
5	To study of recommended cutting speeds/feed/depth of cut for different H.S.S tool-MS work material combinations.
6	To study different indexing methods and calculate indexing movements by (Simple, Compound, Differential and Angular) indexing method.
7	One Minor Project based on the syllabi of Manufacturing Processes LabSubject
8	Preparation of model and study of atomic structures of metals.
9	Practice of specimen preparation (cutting, mounting, polishing, etching)) and study of microstructure of mild steel and aluminum specimen.
10	Hardening of steel specimen and study the effect of quenching medium on hardness of steel.
11	Annealing the steel specimen and study the effect of annealing time and temperatures on hardness of steel.
12	Study of Iron-Carbon diagram and its various phases.
13	Study of T-T-T diagram and formation of austenite, bainite, martensite and pearlite.
14	One Minor Project based on the syllabi of Physical Metallurgy & Heat TreatmentSubject

R**eference Material**

Manuals available in Lab.