SUBJECT CODE: PCPE-101
SUBJECT NAME: STRENGTH OF MATERIALS

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	**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	predict the deflection in beams of varying sections and different materials.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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**
Unit 2	**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**
Unit 3	**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**
		Part B	
Unit 4	**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**
Unit 5	**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**
Unit 6	**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**
Unit 7	**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	**6**

		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	

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.

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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:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 60	**Duration of End Semester Exam(ESE):** 4hr
Total Marks: 100	**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	demonstrate and monitor the manufacturing of components at shop floor level as per the information in the given drawing.
3	explain 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:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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**
Unit 2	**Fasteners**	Various types of screw threads, types of nuts and bolts, screwed fasteners, welding joints and riveted joints.	**10**
		Part B	
Unit 3	**Drawing of pipe joints, clutches, keys and couplings**	keys, spline shafts, Knuckle and cotter joints, Couplings: Solid or Rigid Coupling, Protected Type Flange coupling, Pin type flexible coupling, muff coupling, universal coupling, cone friction clutch, Single Plate friction clutch, Pipe and Pipe Fittings: Flanged joints, Spigot and socket joint, Union joint and Hydraulic joint.	**16**

Unit 4	**Assembly & Disassembly**	Plummer Block, Foot Step Bearing, Swivel Bearing, connecting rod, Screw Jack, Tail Stock, Drill Press Vice	**28**
Unit 5	**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**

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

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

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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**
Unit 2	**Heat Transfer**	Modes of Heat Transfer, Steady and unsteady heat transfer, Fourier law of conduction and thermal conductivity, Conduction of heat through a slab, a hollow cylinder and a hollow sphere, Natural and forced convection, dimensionless parameters in free and forced convection, convective heat transfer coefficient, Combined conduction and convective heat transfer, Critical thickness of insulation, Fin and its application, Types of fins, Analysis of heat transfer through a rectangular fin, Introduction to radiation, total emissive power, monochromatic	**8**

		emissive power, emissivity, Absorptivity, reflectivity and transmissivity, Black body, Opaque Body, White body and Gray body, Stefan Boltzmann's Law, Kirchhoff's law, Plank's law, Wien's displacement law, Intensity of radiation and Lambert's cosine law. Heat Exchangers: Introduction, classification of heat exchanger, Heat exchanger analysis – Logarithmic mean temperature difference (LMTD) for parallel flow and counter flow.	
Unit 3	**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.	**7**
		Part B	
Unit 4	**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.	**6**
Unit 5	**Refrigeration and Air Conditioning**	Description of simple Vapour compression and Vapor absorption cycles, relative merits and demerits, Properties of refrigerants, Types & Applications of Air Conditioning, Elementary idea of ozone friendly refrigerants, Concept of Psychrometry, Definitions of psychometric terms Psychrometric charts and their usage.	**8**

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,

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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	**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 mathematics, science, and engineering
2	design and conduct experiments, as well as to analyze and interpret data.

3	design a system, process to meet desired needs within realistic constraints.
4	function on multidisciplinary teams.
5	design and maintain the systems
6	plan, control and execute the different duties in an organization

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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**
Unit 2	**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**
Unit 3	**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**
Unit 4	**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	**6**
Unit 5	**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**
		Part B	
Unit 6	**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**
Unit 7	**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**
Unit 8	**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**
Unit 9	**Maintenance Systems**	Type of maintenance, objective of maintenance, planned maintenance strategies, preventive maintenance, condition monitoring and total productive maintenance.	**3**

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.

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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	**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 Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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**
Unit 2	**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**
Unit 3	**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**
Unit 4	**Electrical Properties**	Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionic ceramics and in polymers. Dielectric behavior. Ferroelectricity. Piezoelectricity	**5**
		Part B	
Unit 5	**Magnetic Properties**	Diamagnetism and paramagnetism. Ferromagnetism. Anti-Ferromagnetism and Ferrimagnetism. Influence of temperature on magnetic behavior. Domains and Hysteresis	**4**
Unit 6	**Optical Properties**	Optical properties of metals. Optical properties of nonmetals. Application of optical phenomena	**3**
Unit 7	**Thermal Property**	Heat capacity. Thermal expansion. Thermal conductivity. Thermal stresses	**4**
Unit 8	**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**

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.

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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	**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:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Definition and scope of industrial engineering, role of an Industrial engineer in industry, functions of industrial engineer, qualities of an industrial engineer	**3**
Unit 2	**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**
Unit 3	**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**
Unit 4	**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**
		Part B	
Unit 5	**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**
Unit 6	**Ergonomics**	Introduction to ergonomics consideration in designing Man Machine systems with special reference to design of displays and controls.	**6**

		Anthropometry, Introduction to Human Metabolism, Application of Ergonomics.	
Unit 7	**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**
Unit 8	**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**

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

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SUBJECT CODE: LPCPE-101
SUBJECT NAME: STRENGTH OF MATERIAL LABORATORY

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	**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 syllabus Laboratory of Strength of Material Subject

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

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SUBJECT CODE: LPCPE-102
SUBJECT NAME: THERMAL ENGINEERING LABORATORY

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	**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 syllabus Laboratory of Thermal Engineering Subject

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

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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	**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	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	deal with problems of designing various types of joints and other important machine elements in a technical way.
5	analyze the design and recommend/apply appropriate adjustments in the existing design.
6	manage Design of machine components like: springs, flywheel, clutches and brakes etc. according to various necessities in the business/Industry.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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.	**4**
Unit 2	**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	**6**
Unit 3	**Shafts**	Design of shafts under different types of loading conditions.	**4**
Unit 4	**Transmission Drives**	Design of Belt drives (Flat, V) and Spur gear drive	**4**
		Part B	
Unit 5	**Keys & Couplings**	Design of rectangular and square keys, muff coupling, split muff coupling, flange coupling, bushed-pin type flexible coupling.	**5**
Unit 6	**Pressure vessels**	Classification of vessels, Types of stresses, stresses in thin, thick and compound cylinders/shells.	**5**
Unit 7	**Levers**	Design of straight levers, Bell -Crank levers, foot levers, hand levers.	**4**
Unit 8	**Brakes and Clutches**	Design of friction plate and cone clutches, band brake band and block brakes	**4**

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

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SUBJECT CODE: PCPE-105
SUBJECT NAME: FLUID MECHANICS AND 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	**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	solve problems relating to kinematic and dynamics of fluid flow.
2	analyze the fluid dynamic conditions and in assessing the equations involved on the basis of dimensional homogeneity.
3	evaluate theoretically the performance of various components involved in pumps and turbines.
4	check the homogeneity of various equations involved in fluid mechanics.
5	understand the concept of fluid machinery concepts.
6	solve various problems arising in fluid working machinery.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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**
Unit 2	**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**
Unit 3	**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**
		Part B	
Unit 4	**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**
Unit 5	**Fluid machinery concepts**	Impulse momentum principle; Jet impingement on stationary & moving flat plates and on stationary or moving vanes with jet striking at center	**5**

		& tangentially at one end of vane, calculations for force exerted, work done & efficiency of jet.	
Unit 6	**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**

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.

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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	**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	identify various equipment's required the casting and welding processes.
2	test the products made by casting and welding processes.
3	apply the knowledge for practical use & application of manufacturing processes.
4	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:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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**

Unit 2	**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**
Unit 3	**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**
Part B			
Unit 4	**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**
Unit 5	**Gear Manufacturing**	Methods used in production of spur, bevel and worm gears (Powder metallurgy, Moulding, Forming, Rolling, Gear-hobbing and shaping), Gear finishing	**4**
Unit 6	**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**

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.

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SUBJECT CODE: PCPE-107

SUBJECT NAME: KINEMATICS AND DYNAMICS OF MACHINES

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):** 3hr
Total Marks: 100	**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 Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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**
Unit 2	**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**
Unit 3	**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**
Unit 4	**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**
		Part B	
Unit 5	**Surface Contacts**	sliding and rolling friction- friction drives- bearings and lubrication-friction clutches- belt and rope drives- friction in brakes	**5**
Unit 6	**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**
Unit 7	**Brakes, Dynamometers and Clutches**	Types of brakes, principle, function of brakes, types of dynamometer, Function of Clutches. Disc and Cone clutches	**5**
Unit 8	**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**

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

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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):** 3hr
Total Marks: 100	**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:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**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**
Unit 2	**Experimental tools & techniques**	Metallography (Optical TEM, SEM), X Ray Diffraction, Mechanical Properties, strain hardening, cold working	**4**
Unit 3	**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**
Unit 4	**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**
		Part B	
Unit 5	**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**
Unit 6	**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**
Unit 7	**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**

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.

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SUBJECT CODE: LPCPE-103

SUBJECT NAME: FLUID MECHANICS AND MACHINERY LABORATORY

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	**Status:** Compulsory

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

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

S. No.	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 syllabus Laboratory of Fluid Mechanics & Machinery Subject

R**eference Material**

Manuals available in Laboratory.

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SUBJECT CODE: LPCPE-104

SUBJECT NAME: KINEMATICS AND DYNAMICS OF MACHINES LABORATORY

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	**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 syllabus Laboratory of Kinematics and Dynamics of Machine Subject

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

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SUBJECT CODE: LPCPE-105
SUBJECT NAME: MANUFACTURING PROCESSES AND PHYSICAL METALLURGY & HEAT TREATMENT LABORATORY

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	**Status:** Compulsory

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

CO#	Course Outcomes(CO)
1	apply this knowledge for practical use and application of manufacturing processes in the industries.
2	understand the various process parameters involved in different machining processes.
3	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 syllabus Laboratory of Manufacturing Processes Laboratory Subject
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 syllabus Laboratory of Physical Metallurgy & Heat Treatment Subject

R**eference Material**

Manuals available in Laboratory.

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SUBJECT CODE: MCPE-101

SUBJECT NAME: ENVIRONMENTAL SCIENCE

Programme: B.Tech. (PE**)**	**L:** 2 **T:** 0 **P:** 0
Semester: 4	**Teaching Hours:** 26
Theory/Practical: Theory	**Credits:** 0
Internal Marks: 40+10	**Percentage of Numerical/Design/Programming Problems:** 0%
External Marks: Nil	**Duration of End Semester Exam(ESE):**
Total Marks: 50	**Status:** Mandatory

Additional Material Allowed in ESE: Nil

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

CO#	Course Outcomes(CO)
1	measure environmental variables and interpret results.
2	evaluate local, regional and global environmental topics related to resource use and management.
3	propose solutions to environmental problems related to resource use and management.
4	interpret the results of scientific studies of environmental problems.
5	describe threats to global biodiversity, their implications and potential solutions.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Natural Resources**	Renewable and non-renewable resources: Natural resources and associated problems: Forest resources: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people.	**2**
Unit 2	**Water resources**	Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems, Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers- pesticides problems, water logging, salinity, case studies, Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies, Land Resources: Land as a resource, land degradation, man induces landslides, soil erosion, and desertification.	**4**
Unit 3	**Eco Systems**	Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers, decomposers, Energy flow in the ecosystems, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystems: Forest ecosystem, Grass land ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	**4**
		Part B	
Unit 4	**Biodiversity and it's Conservation**	Introduction-Definition: genetics, species and ecosystem diversity, Biogeographically classification of India, Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local level, India as a mega diversity nation, Hot-spots of biodiversity, Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts, Endangered and endemic spaces of India, Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.	**5**

Unit 5	**Environmental Pollution**	Definition, causes, effects and control measures of: Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards.	**2**
Unit 6	**Solid waste Management**	Causes, effects and control measures of urban and industrial wastes, Role of an individual in prevention of pollution, Pollution case studies.	**2**
Unit 7	**Social issues and the Environment**	Form unsustainable to sustainable development, Water conservation, rain water harvesting, water shed management, Resettlement and rehabilitation of people; its problems and concerns, case studies, Environmental ethics: issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies, Environment protection Act, Air (prevention and control of pollution) Act, Water (prevention and control of pollution) Act, Wildlife protection act, Forest conservation act.	**4**
Unit 8	**Human population and the environment**	Population growth and variation among nations, Population explosion-family welfare program, Environment and human health, Human rights, Value education, HIV / AIDS, Women and child welfare	**3**

Text Books:

1. Textbook of Environmental studies, Erach Bharucha, UGC
2. Fundamental concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd
3. Environment Biology by Agarwal, K. C., Nidi Publ. Ltd. Bikaner.
4. Principle of Environment Science by Cunninghan, W.P.
5. Essentials of Environment Science by Joseph.
6. Perspectives in Environmental Studies by Kaushik, A.
7. Elements of Environment Science & Engineering by Meenakshi.
8. Elements of Environment Engineering by Duggal.

Reference Books

E-Books and online learning material

: https://www.ugc.ac.in/oldpdf/modelcurriculum/env.pdf

Online Courses and Video Lectures

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SUBJECT CODE: PCPE-109
SUBJECT NAME: INDUSTRIAL AUTOMATION & ROBOTICS

Programme: B .Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 5	**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	**Status** Professional Core

Additional Material Allowed in ESE: Scientific Calculator

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

CO#	**Course Outcomes COS**
1	Contribution of automation to the industry.
2	To differentiate between components of hydraulic and pneumatic systems.
3	Use of Hydraulics & Pneumatics circuits to meet functionality requirements of products.
4	Understand about various types of electrical and electronic controls for industrial applications.
5	To understand the basics of robots thoroughly this will help them to program
6	About applications of robots in industries

Detailed Contents

Part A			
S. No.	**Title**	**Content details (Part A)**	**Credit Hrs.**
Unit 1	**Introduction**	Concept and scope of automation, Advantages and disadvantages of automation Socio economic consideration, Low cost automation.	3
Unit 2	**Fluid Power Control**	Fluid power control elements and standard graphical symbols. Construction and performance of fluid power generators, Hydraulic and pneumatic cylinders - construction, design and mounting, Hydraulic and pneumatic valves for pressure, flow and direction control, Servo valves and simple servo systems with mechanical feedback, governing differential equation and its solution for step position input, Basic hydraulic and pneumatic circuits.	8
Unit 3	**Pneumatic Logic Circuits**	Design of pneumatic logic circuits for a given time displacement diagram or sequence of operations.	3
Unit 4	**Electrical and Electronic Controls**	Introduction to electrical and electronic controls such as electromagnetic controllers - transducers and sensors, microprocessors, programmable logic controllers (PLC), Selection & industrial applications, Integration of mechanical systems with electrical, electronic and computer systems.	**6**
		Part B	
Unit 5	**Fluidics**	Boolean algebra, Truth tables, Conda's effect, Fluidic elements their construction working and performance characteristics, Elementary fluidic circuits.	**3**
Unit 6	**Transfer Devices and Feeders**	Transfer Devices and Feeders, their Classification, Construction details and application of transfer devices and feeders (Vibratory bowl feeder, reciprocating tube feeder and centrifugal hopper feeder).	**4**
Unit 7	**Robotics**	Introduction, classification based on geometry, devices, control and path movement, End effectors - types and applications, Sensors - types and applications, Concept of Robotic/Machine vision, Teach pendent, Mechanical grippers & their types.	**6**
Unit 8	**Industrial Applications**	Industrial Applications of Robots for material transfer, Machine loading /unloading, welding, assembly and spray-painting operations.	**3**

Text Books

1. A. K. Gupta, "Industrial Automation and Robotics", Laxmi Publication (P) Limited.
2. Anthony Esposito, "Fluid Power with applications" Pearson prentice Hall.
3. SR Majumdar, "Pneumatic Control", Tata McGraw Hill.
4. SR Deb," Robotics and Flexible Automation", Tata McGraw Hill 5.

Additional Books:

1. Harry Colestock, "Industrial robotics: selection, design, and maintenance.
2. Robert technology Fundamentals by J.G. keramas, Delmar publisher.

SUBJECT CODE: PCPE-110
SUBJECT NAME: INSPECTION & QUALITY CONTROL

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 5th	**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	**Status** Professional Core

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Demonstrate and apply the concept of Inspection in an industrial organization.
2	Develop in-depth knowledge of quality and management.
3	Apply various quality controls tools in the industries to enhance the quality.
4	Develop analytical skills for investigating and analyzing quality management issues in the industry and suggest implementable solutions to those.
5	Explain the concept of process capability.
6	Develop in-depth knowledge on various aspects of quality management systems

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Inspection**	Introduction to Inspection, Objectives of Inspection, Inspection Planning, Measurement Errors, Types of Inspection Difference between Inspection & Quality Control.	**4**
Unit 2	**Quality**	Introduction to quality, Quality definitions, Total quality control, Quality characteristics, Quality traits, Quality management principles or quality principles, Quality function, Organizing for quality, Quality policy, Quality system, Quality planning, Quality of design, Quality circle-a way to quality improvement, Total quality management (TQM).	**6**
Unit 3	**Quality Costs**	Cost of quality, Hidden costs of quality, Computing cost of poor quality, Examples of quality costs with respect to functions, Value of quality, Quality cost models, how cost reduction is done through quality improvement?	**5**
	Part B		
Unit 4	**Quality Assurance**	Introduction to quality assurance, advantage of quality assurance, principles used in quality assurance, quality assurance product life cycle, types of quality assurance, various aspects quality assurance, how quality assurance can be evaluated?	**5**
Unit 5	**Quality Control**	Total Quality Control, Objectives of Quality Control, Principles of Quality Control, Quality Control Tools, Statistical Quality Control, Control Charts, Construction of Control Charts for Variables (X bar, R, σ - Chart) and Attributes (p, np, C, U Charts), Acceptance Sampling by Attributes, AOQ & OC Curves, Types of Sampling Plans, Process Capability.	**10**
Unit 6	**Quality Management System (QMS)**	Introduction to QMS/ certification system, Important definitions, Benefits of a QMS, An over-view of ISO series, ISO 9001:2000 requirement (main & sub clauses), Steps to registration, Documentation requirements, A work about other common standards, principles in ISO 9000	**6**

Text Books:

1. Kenedy, E.V. & Andrews Donald, "Inspection and Gauging", Industrial Press Inc., 1977.
2. Juran, J.M. & Gryan, F.M, "Quality Planning and Analysis", Tata McGraw Hill, 1995.
3. Grant, E.L. & Richards, S.L., "Statistical Quality Control", McGraw Hill, 1998.

Additional Books:

1. Mahajan. M, "Statistical Quality Control", Dhanpat Rai & Co., 2008.
2. Khanna, O.P, "Industrial Engineering and Management", Dhanpat Rai & Publication, 2007.

SUBJECT CODE: PCPE-111
SUBJECT NAME: METAL FORMING

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 5th	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 60%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status** Professional Core

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Demonstrate and correlate the theory of metal forming with the actual processes in the industry.
2	Develop in-depth knowledge of lubrication and its mechanisms.
3	Understand the state of stress in various metal forming processes.
4	Develop analytical skills for investigating and analyzing metal deformation in various forming processes.
5	Explain and utilize different analytical methods such as finite element analysis, upper bound method.
6	Develop better models of manufacturing using metal forming techniques..

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Classification of metal forming processes, hot and cold working processes and their advantages and disadvantages. Variables in metal forming process: Work material, tooling, friction and lubrication at tool work piece interface, mechanics of deformation, effects of deformation on mechanical and metallurgical properties, Tresca's and Von Mises yield criteria.	**8**
Unit 2	**Rolling**	Rolling of flat slabs and strips, stress evaluation of roll pressure for homogenous deformation with constant yield stress, assumptions and their justifications, evaluation of load, torque and mill power for cold rolling process, stress evaluation for rolling with high friction. Friction hill, effect of elastic deformation, minimum thickness of strip in rolling, empirical equation for measurement of rolling loads for hot and cold rolling, rolling defects, causes and remedies.	**8**
Unit 3	**Forging**	Determination of forging pressure for thin strip for low and high friction conditions, pressure distribution for sticking and sliding friction regions, forging of flat circular discs.	**6**
		Part B	
Unit 4	**Drawing and extrusion**	Drawing and extrusion processes for rods, wires and tubes, evaluation of drawing stress and force for wire drawing and extrusion under homogenous deformation without and with strain hardening conditions through conical dies, effect of friction, maximum reduction per pass under frictionless condition, effects of back pull and die geometry, optimum die angle, drawing stress for tube drawing with a conical die with and without internal support, wire drawing and extrusion defects, causes & remedies.	**8**
Unit 5	**Metal forming lubrication**	Friction at die-work piece interface, lubrication mechanisms, boundary lubrication, mixed lubrication, hydrodynamic lubrication, lubricants for wire drawing, rolling, extrusion, forging and sheet metal working. Metal forming machines, classification and characteristics of metal forming machines, metal forming hammers and presses.	**6**

Text Books:

1. Row, "Principles Industrial metal working processes", Prentice Hall of India
2. Surinder Kumar, "Metal working", DhanpatRai and Sons
3. Avitzur, "Metal Forming",Marcel Dekker
4. William F. Hosford, Robert M. Caddell, " Metal Forming: Mechanics and Metallurgy", Cambridge university press
5. R. H. Wagoner, J.-L. Chenot, " Metal Forming Analysis", Cambridge university press

SUBJECT CODE: PCPE-112
SUBJECT NAME: ENGINEERING METROLOGY

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 5	**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	**Status** Professional Core

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Understand the concept of tolerances and gauge design.
2	Use the various types of measuring instruments according to the specific requirements along with the knowledge of their working principles.
3	Measure and testing of different types of gears.
4	Familiarize with the working of optical measuring instruments
5	Utilize transducers for various measurements.
6	Measure pressure, torque and force using different techniques.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Concept Of Measurement**	General concept, measurement systems, Units and standards, measuring instruments: sensitivity, stability, range, accuracy and precision, static and dynamic response, repeatability, systematic and random errors, correction, calibration	**3**
Unit 2	**Limits, Fits And Tolerances**	Concepts of interchangeability, need for standards system of limits, fits and tolerances. BIS:919:1963 standard system, selection of limits and fits, exercise on limits, fits and tolerances, design principles for limit gauges, Taylor's principles, types of limit gauges, tolerances on limit gauges.	**4**
Unit 3	**Measuring And Gauging Instruments**	Mechanical linear and angle measuring instruments, verneir calipers, micrometers, dial gauges, bevel protectors, sine bars, spirit level, optical instruments autocollimator, tool room microscope. Comparators, principle, types of comparators, mechanical, optical, pneumatic, electrical comparators.	**6**
Unit 4	**Geometrical Metrology And Surface Finish**	Concepts of form errors, straightness, flatness, roundness errors and their measurements, concept of micro and macro errors, measurement of surface roughness, stylus method using, mechanical, electrical magnification methods, Interference method – using optical flat and interferometers.	**5**
		Part B	
Unit 5	**Screw Threads And Gear Metrology**	Elements of screw threads metrology, measurement of major, minor and effective diameters of external and internal screw threads, measurement of pitch and screw thread angle, Elements of gear metrology, measurement of gear tooth thickness, gear profile, pitch and run out for involute gears, gear rolling test.	**6**
Unit 6	**Transducers**	Transducers, types, governing principles of transducers, Examples. Displacement measurement, detailed study of various types of displacement transducers, Velocity transducers	**5**
Unit 7	**Force, Torque and Pressure Measurement**	Mechanical, pneumatic, and hydraulic load cells, torque measuring devices, dynamometers, types of strain gauges, factors affecting strain measurement, Electrical strain gauges, gauge material, use of strain gauges for the measurement of the force and torque, Pressure measurement, types of pressure transducer, differential pressure measuring devices.	**4**
Unit 8	**Advances in Metrology**	Basic concept of CMM and its types, Advantages and application of CMM, CMM probes, types of probes – contact probes and non-contact probes, Machine Vision – Introduction to machine vision, functions, applications and advantages of machine vision,	**3**

Text Books:

1. R.K.Jain, "Engineering Metrology ", S. Chand and Company
2. I.C.Gupta, "Engineering metrology", Dhanpatrai & sons Delhi
3. D.S.Kumar, "Mechanical Measurement & Control", Metropolitan Publishers
4. R.K. Rajput, "Engineering Metrology and Instrumentation",S.K. Kataria & Sons.

Additional Books:

1. Doeblin, "Mechanical Measurement",Mcgraw Hill.
2. Gharam T. smith, "Industrial Metrology", Springer

SUBJECT CODE: PCPE-113
SUBJECT NAME: MACHINING SCIENCE

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 5th	**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	**Status:** Professional Core

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Demonstrate and apply the concepts of machining.
2	Develop in-depth knowledge of tool geometry and tool life.
3	Apply various metal cutting theory in the industries to enhance the quality and reduce the cost of manufacturing..
4	Develop analytical skills for investigating and analyzing tool wear and tool failure.
5	Explain and utilize the concept of machinability.
6	Develop an economical model of machining.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction To Machining Processes**	Definition And Classification Of Machining Processes, Introduction To Single Point, Multipoint And Abrasive Cutting Tools. Introduction To Different Machining Processes Parameters In Turning, Drilling, Boring, Milling, Shaping, Planning And Grinding Operations.	**6**
Unit 2	**Tool Geometry**	Importance Of Tool Geometry, Geometry Of Single Point Cutting tool, Milling Cutters, Drilling Tools And Broaching Tools.	**4**
Unit 3	**Mechanics Of Metal Cutting**	Chip Formation Process, Type Of Chips, Orthogonal Cutting, Oblique Cutting, Merchant Theory, Calculations Of Shear Angle, Shear Stress, Shear Strain, Strain Rate, Kinetic Coefficient Of Friction, Velocity Relations, Calculation Of Various Forces, Lee And Shaffer Theory.	**5**
		Part B	
Unit 4	**Tool Wear And Tool Life**	Introduction, Types Of Tool Wear, Wear Mechanism, Tool Life, Variables Affecting The Tool Life, Determination Of Tool Life Exponents, Machinability, Simple Numerical Problems.	**5**
Unit 5	**Thermal Aspects Of Machining**	Introduction, Equations Of Heat Flow, Temperature In Orthogonal Cutting, Experimental Determination Of Cutting Temperatures, Cutting, Fluids, Their Selection And Application.	**6**
Unit 6	**Measurement Of Cutting Forces**	Introduction, Need, And Basic Methods of Measuring Cutting Forces, Introduction To Dynamometers, Working Principles And Construction Of Lathe Dynamometer, Drilling Dynamometer And Milling Dynamometers.	**6**
Unit 7	**Economics Of Machining**:	Machining Cost, Optimum Cutting Speed, Restrictions On Cutting Conditions, And Comparison Of The Criteria.	**4**

Text Books:

1. G.K. Lal, "Introduction to Machining Science, "New Age International Ltd,
2. B.L.Juneja ,G.S. Sekhon, "Fundamentals of Metal Cutting and Machine Tools", New Age International Ltd
3. Bhattacharya, "Metal cutting Principles",CBS Publishers
4. R.K. Rajput, "Production Technology", S Chand and company
5. P.C.Sharma, "Production Engineering" S Chand and company

Additional Books:

1. Fundamentals of Metal Machining & Machine Tools by Winston A. Knight, Geoffery Boothroyd

SUBJECT CODE: LPCPE-106

SUBJECT NAME: INDUSTRIAL AUTOMATION & ROBOTICS LABORATORY

Programme: B. Tech. (PE)	**L: 0 T:** 0 **P:** 2
Semester: 5th	**Teaching Hours:** 24
Theory/Practical: Theory	**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	**Status:** Professional Core

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

CO#.	Course Outcomes COS
1	Undertake kinematics analysis of robot manipulators.
2	Describe different mechanical configurations of robot manipulators.
3	To differentiate between components of hydraulic and pneumatic systems.
4	Have an understanding of the functionality and limitations of robot actuators.
5	To differentiate between components of hydraulic and pneumatic control systems
6	Use of Hydraulics & Pneumatics circuits to meet functionality requirements of products.

Detailed Contents:

S. No.	Experiment
1	Design and assembly of hydraulic / pneumatic circuit.
2	Study of power steering mechanism using cut piece model.
3	Study of reciprocating movement of double acting cylinder using pneumatic direction control valves.
4	Use of direction control valve and pressure control valves clamping devices for jig and fixture.
5	Study of robotic arm and its configuration.
6	Study the robotic end effectors.
7	Study of different types of hydraulic and pneumatic valves.
8	One Minor Project based on the syllabi of Strength of Material Subject

Reference Material:

Manuals available in Laboratory.

SUBJECT CODE: LPCPE-107

SUBJECT NAME: METAL FORMING & MACHINING SCIENCE LABORATORY

Programme: B. Tech. (PE)	**L:** 0 **T:** 0 **P:** 2
Semester: 5th	**Teaching Hours: 2**4
Theory/Practical: Theory	**Credits:** 1
Internal Marks30	**Percentage of Numerical/Design/Programming Problems:** NIL
External Marks: 20	**Duration of End Semester Exam(ESE): 1.5** hr
Total Marks: 50	**Status:** Professional Core

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

CO#.	Course Outcomes COS
1	Measure the torque, and thrust in various machining operations.
2	Use the tool work thermocouple for determining tool chip interface temperature.
3	Determine tool wear and tool life of a machining tool.
4	Determine the coefficient of friction in various metal forming processes.
5	Estimate the load required for plastic deformation of material.
6	Develop an experimental setup to calculate the effect of various parameters in various machining and metal forming processes.

Detailed Contents:

S. No.	Content details (Part A)
1	Prepare a HSS single point cutting tool of given tool signature and by using lathe tool dynamometer measure the cutting forces in all directions in order to calculate the following: a. Shear plane angle b. Coefficient of friction c. Power consumption
2	By using the drill dynamometers measure the torque, and thrust in Drilling operation.
3	By using the tool work thermocouple, measure the tool chip interface temperature.
4	To determine Taylor Tool life exponents by Facing test.
5	To study the effect of cutting variables on surface finish in any cutting (Turning, Drilling, Milling, Shaping, grinding etc) operation.
6	To determine the effect of percentage of reduction and geometry die on the drawing and extruding load.
7	To study of the effect of clearance and shear angle on the blanking and piercing operations.
8	Experimental determination of coefficient of friction for metal forming.
9	To determine roll load in the sheet rolling process.
10	Study of the drop forging operation (flowability, forging load etc by plasticine model.
11	One Minor Project based on the syllabi of Strength of Material Subject

Reference Material:

Manuals are available in laboratory

SUBJECT CODE: LPCPE-108
SUBJECT NAME: ENGINEERING METROLOGY LABORATORY

Programme: B. Tech. (PE)	**L: 0 T:** 0 **P:** 2
Semester: 5	**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	**Status:** Professional Core

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

CO#.	Course Outcomes COS
1	Use tool makers microscope and profile projector
2	Use the various types of measuring instruments according to the specific requirements along with the knowledge of their working principles.
3	Measure and testing of different types of gears.
4	Familiarize with the working of optical measuring instruments
5	Utilize the slip gauges and comparators
6	Calibrate a gauge and measure pressure and force using different techniques.

Sr. No.	Experiment
1	Measure the taper angle in the given workpiece by using sine bar & slip gauges.
2	Measure the surface roughness of the given workpiece on surface roughness measuring instrument.
3	Measure the various gear tooth profile parameters.
4	To measure various elements of screw thread by (a)Tool Makers Microscope & (b) Profile Projector
5	To check the flatness of surface plate by Auto-collimator.
6	To check the diameter of a rod by compactors and slip gauges.
7	Find out the strain in a given workpiece under given loading by using strain gauges. Calibration of pressure gauge
8	One Minor Project based on the syllabi of Strength of Material Subject

Reference Material:
Manuals are available in laboratory

SUBJECT CODE: PCPE-114
SUBJECT NAME: INDUSTRIAL TRIBOLOGY

Program: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 6th	**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):** 3hrs.
Total Marks: 100	**Status:** Professional Core.

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Understand the various theoretical concepts of tribology and co-relate the same with actual processes in industry.
2	Enable to understand the laws of various types of friction and measurement of the same practically.
3	Enhance the knowledge of different laws of wear and measurement of the same practically in various environmental conditions.
4	Understand the prevention and control of wear and friction by using different mechanisms of lubrication.
5	Suggest better lubricants depending upon the physical and environmental conditions.
6	Enable to design the tribological components (bearings) with respect to the required conditions.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Tribological considerations: Nature of surfaces and their contact, Physical &mechanical properties of surface layer, Geometrical properties of surfaces, Methods of studying surfaces, Study of contract of smoothly and rough surfaces.	**5**
Unit 2	**Friction**	Role of friction, Laws of static friction, Causes of friction, Adhesion theory, Laws of rolling friction, Friction measurements, Mechanism of friction, Friction of metals and non-metals, Adhesion of junctions due to friction, Principles of rolling motion, Slip-Reynolds and Heathcote, Rolling in plastic range, Track width and rolling friction.	**9**
Unit 3	**Wear**	Definitions of wear, Mechanism of wear, Types of wear, Analysis of adhesive wear and abrasive wear, Stages of fretting wear, Friction affecting wear, Wear measurement, Wear of metals and non-metals.	**9**
		Part B	
Unit 4	**Lubrication and lubricants**	Introduction, Principle of lubrication, Function of lubricants, Lubrication mechanism, Types of lubricants and their industrial uses, Properties of lubricants, Lubricant additives, Chemical characteristic values of lubricants, Solid lubricants and their categories.	**5**
Unit 5	**Special Topics**	Selection of bearing and lubricant, Bearing maintenance, Diagnostic maintenance of tribological components, Lubrication systems, Filters and filtration.	**8**

Text Books:

1. A.D. Sarkar, “Wear of Metals”, Pergamon Press.
2. Sushil Kumar Srivastava, “Tribology in Industries”, S.Chand & Co. Ltd.
3. R.D. Arnell, P.B. Davies, J.Halling and T.L. Whomes, “Tribology: Principles and Design Applications”, Springer-Verlag.
4. Raymond G. Bayer, “Mechanical Wear Prediction and Prevention”,Marcel Dekkar, Inc.
5. Basu, Sengupta and Ahuja, “Fundamentals of Tribology”, PHI Learning.

Additional Books

1. Kenneth C.Ludema and Oyelayo O. Ajayi, “Friction, Wear, Lubrication: ATextbbok in Tribology”, CRC Press.
2. ASM Handbook (vol.18), “Friction, Lubrication and Wear Technology”, ASM International.
3. Raymano O. Gunther, “Lubrication”, Bailey Bros & Swinfan Ltd.

SUBJECT CODE: PCPE-115
SUBJECT NAME: MACHINE TOOL DESIGN

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 6th	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 30%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Core

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Understand the various requirements of the machines.
2	Access the various feed drives and spindle drives design on the basis of varying load conditions.
3	Enhance the knowledge regarding the manufacturing aspects of the machining.
4	Get equipped with the knowledge of machine tool dynamics.
5	Evaluate the purpose and principal of tool geometry, construction and design.
6	Access machine tools control system which will further help in recognizing the different operational conditions on the machine.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	Data Calculation	Turning: Cutting force, Cutting Speed and Feed Rate. Drilling: Cutting forces, Cutting Speed and Feed Rate. Milling: Chip Section, Cutting force, Milling with Cutter Heads. Grinding: Grinding Forces, Cutting Speed, Feed Rate, and Depth Setting. Planning, Shaping and Broaching.	**3**
Unit 2	General Requirements of the Machine Tool	Accuracy of Shape, Dimensional accuracy and surface finish of the components produced. High Productivity. High Technical and Economic Efficiency.	**5**
Unit 3	Design Principles	Stiffness and Rigidity of the Separate Constructional Elements and their Combined behavior Under Load, Static Rigidity, Dynamic Rigidity, Natural frequencies, Damping, Mode of Vibration.	**5**
Unit 4	Standardization of Spindle Speeds and Feed Rates	Layout of Speed Change Gears. Saw Diagrams for Arithmetic Progression, Geometric Progression, Harmonic Progression and Logarithmic Progression of spindle speeds for Mechanical Stepped Drives for Machine Tools. Establishment of Gear Ratios, Layout of the Intermediate Reduction Gears, Calculation of Transmission Ratios, Pulley Diameter, Gear Wheel Diameters and Number of Teeth. Ray Diagram. Speed Diagram	**5**
		Part B	
Unit 5	Electrical, Mechanical and Hydraulic Drives for the Operational Movements	Electric Drive and Control Equipment. Mechanical and Hydraulic Drives. Drives for Producing Rotational Movements, Stepped Drives, Step less Drives. Drives for Producing Rectilinear Movements. Backlash Eliminator in the Feed Drive Nut.	**5**
Unit 6	Automatic Control	Principles and Constructional Elements. Automatic Driving of the Cutting Movements, Feed Movements, and Return Movements. Automatic control of movements for Starting, Stopping and Reversing. Automatic Clamping and Unclamping the work piece. Automatic Selection of Required Speeds, Automatic Setting of Tools. Automatic Measurement of Machined Shape and Surfaces. Transport of Components from One Machine to the Next. Applications (Examples of Automatic Machines). Control for Moving Slides into Defined, Fixed Positions. Control of Feed Movements in Producing Profiles or Surface by Continuous Path Control	**3**
Unit 7	Design of Constructional Elements	Machine Tool Structures, Structural Elements Design for Centre Lathe, Drilling Machine, Knee Type Milling Machine, Planning Machine, Boring Machine, and Grinding Machines.	**4**
Unit 8	Design of Slide Ways:	Design of Slide ways for Tables, Saddles and Cross-slides. Antifriction Bearings for slide ways. Hydrostatically Lubricated Slide ways.	**3**
Unit 9	Design of Spindles and Spindle Bearings:	Design of Spindles for Strength and Stiffness. Design of Spindles for Balancing. General Layout and Design of the Driving Elements and the Spindle Bearings. Selection and General Layout of Ball and Roller Bearings for Supporting Spindles. Design of Secondary Drives for Machine Tools, Design of Cutting Drives, Feed Drives and Setting Drives.	**3**

Text Books:

1. Sen and Bhattacharya, “Machine Tools Design”, CBS Publisher.
2. N.K. Mehta, “Machine Tool Design”, Tata McGraw Hill.
3. N. Acherkan, “ Machine Tool Design, Four Volumes” ,Mir Publishers.
4. P. H. Joshi, “ Machine Tools *Handbook:* Design *and* Operation”, McGraw Hill Professional.
5. S.K. Basu and D.K. Pal, “Design of machine tools”, Oxford and IBH.

Additional Boks

1. Pandey, P.C. and Singh, C.K., Production Engineering Sciences, Standard Publishers, New Delhi (2003).
2. Kundra T, Rao P.M., Tiwari N. K., “Numerical Control and Computer Aided Manufacturing”, Tata McGraw Hill
3. 3. Martin S. J., “NC Machine Tools”, ELBS publication

Subject Code: PCPE-116
Subject Name: Operation Research

Programme: B.Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 95%**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status: Professional Core**

Additional Material Allowed in ESE: Scientific Calculator, Random Number Table, Normal Table

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

CO#.	Course Outcomes COS
1	Student will be able to define an organization problem including specifying the objectives and parts of the system that must be analyzed before the problem is solved. Student will be able to industrial and business problems by using Linear Programming Models
2	Student will be able to apply the knowledge of Transportation and Travelling Salesman Problems in practical life to reduce the costs
3	Student will be able to collect assign jobs and work in industrial and service organizations
4	Student will be able to develop a mathematical model of the solving the queuing problems in industries, toll plazas, offices and malls.
5	Student will be able to prepare different strategies of industries or business organizations based upon the market competition.
6	Student will be able to develop and analyze the projects.

Detailed Contents

Sr. No	Title	Content Detail	Credit Hours
		Part A	
Unit 1	**Introduction**	Introduction, characteristics, objectives and necessity of operation research (OR), scope of OR in industry and management. Role of computers in OR, limitations of OR.	**3**
Unit 2	**Linear Programming**	Introduction to linear programming, formulation of linear programming problems, graphical solution, simplex algorithm, computational procedure in simplex, duality and its concept, application of L.P. model to product mix and production scheduling problems, limitations of linear programming.	**5**
Unit 3	**Transportation Model**:	Definition of transportation model, formulation and solution methods, and degeneracy in transportation problems.	**5**
Unit 4	**Assignment Model**	Definition of assignment model, comparison with transportation model, formulation and solution methods, the travelling salesman problem	**3**
		Part B	
Unit 5	**Queuing Models:**	Application of queuing models, characteristics of queuing models, single channel queuing theory, solution to single channel with poison arrivals and exponential service infinite population model, Industrial applications of queuing theory.	**4**
Unit 6	**Simulation**	Concept and use of simulation, advantages and limitations of the simulation technique, generation of random numbers, Monte-Carlo simulation, and computer-aided simulation: applications in maintenance and inventory management	**3**
Unit 7	**PERT & CPM**	Work breakdown structure, network logic, critical path, CPM and PERT, slack and floats. Recourses Leveling & Time cost trade off.	**5**
Unit 8	**Game Theory**	Concept of game, Two-person zero-sum game, Pure and Mixed Strategy Games, Saddle Point, Odds Method, Dominance Method	**4**
Unit 9	**Decision Making:**	Decision-making environments, Decision-making under certainty, uncertainty and risk situations, Uses of Decision tree	**4**

Text Books:

1. Gupta, P.K. and Hira, D. S. "Operations Research", S. Chand and Company 2014
2. Miller, W.D. & Starr, M. K. "Executive Decisions and Operations Research", Prentice Hall Inc, Eglewood Cliffs, N.J, 1969
3. Gupta, R. K. "Operations Research", Krishna publishers 2019
4. Mahajan, M. "Operation Research" by Dhanpat Rai & Co. Publisher 2014
5. Wayne L Winston "Operations Research: Applications and Algorithms" Publisher: Indian University, 4 th edition, 2004
6. Taha, H. A. (2016) "Operations Research: An Introduction" 10th edition, Prentice Hall
7. Panner Seevam, R. Operation Research PHI 2008
8. F.S. Hillier. G.J. Lieberman: "Introduction to Operations Research- Concepts and Cases", 9th Edition, Tata McGraw Hill. 2010
9. Ravindran, A., Phillips, D. T. & Solberg, J. J. "Operations Research- Principles and Practice", John Wiley & Sons, 2005.
10. Sharma J. K. "Operations Research" Macmillan India Ltd. 2006

Additional Books:

1. Anand Sharma "Operations Research" Himalaya Publications 2014

2. Durga Prasad M. V. “Operations Research” Cengage Learning 2012
3. Vohra N. D. “Quantitative Techniques in Management”, Tata McGraw-Hill 2006
4. Gross, D., John F. Shortle, James M. Thompson and Harris, C. “Fundamentals of Queuing Theory”, 4th Edition, Wiley India, 2008.
5. Trivedi K.S., “Probability and Statistics with Reliability, Queuing and Computer Science Applications”, Prentice-Hall of India, New Delhi, 2011.
6. P. R. Thie and G. E. Keough “An Introduction to Linear Programming and Game Theory”, Wiley, New Jersey, 3rd edition, 2008.

SUBJECT CODE: PCPE-117
SUBJECT NAME: NON TRADITIONAL MACHINING

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 6th	**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	**Status:** Professional Core

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Detailed study about advanced machining processes and their applications..
2	Describe principles of nontraditional machining processes and differences of same with conventional machining processes.
3	Apply material removal mechanisms in various non-conventional machining processes.
4	Develop in-depth knowledge on applications of non-traditional process in industry.
5	Explain the concept of material removal rates in processes like Ultrasonic machining and Abrasive Flow Machining, Abrasive Water Jet Machining, Electrochemical Machining.
6	Develop in-depth knowledge on various aspects of Thermal metal removal processes.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	Introduction	Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Nontraditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.	**5**
Unit 2	Ultrasonic Machining (USM)	Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.	**5**
Unit 3	Abrasive & Water Jet Machining (AJM & WJM)	Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD).Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM. Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.	**6**
Unit 4	Electrochemical Machining (ECM)	Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.	**6**
		Part B	
Unit 5	Chemical Machining (CHM)	Elements of the process: Resists (maskants), Etchants. Types of chemical machining process chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.	**5**
Unit 6	Electrical Discharge Machining (EDM)	Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM. Introduction to Wire EDM(WEDM) and Dry EDM(DEDM)	**6**
Unit 7	Plasma Arc Machining (PAM)	Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.	**5**
Unit 8	Laser Beam	Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM	**5**

	Machining (LBM)	parameters and characteristics, Applications, Advantages & limitations.	
Unit 9	Electron Beam Machining (EBM)	Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.	**5**

Text Books:

1. P.C. Panday and H.S. Shan, "Modern Machining Processes ",Tata McGraw Hill.
2. G. Boothroyd and W.A. Knight, "Fundamentals of Machining and Machine Tools",Mareel Dekker Inc.
3. G.F. Benedict, "Non traditional Manufacturing Processes", Marcel Dekker Inc.
4. Amitabha Bhattacharyya "New Technology", , The Institute of Engineers (India), 2000

Additional Books:

1. J. Weller, "Nontraditional Machining Processes", Society of Manufacturing Engineers, Publications.
2. Carl Sommer, " *Non-Traditional Machining* Handbook", Advance Publishing, Incorporated.
3. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001

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SUBJECT CODE: LPCPE-109

SUBJECT NAME: INDUSTRIAL TRIBOLOGY AND MACHINE TOOL DESIGN LAB.

Program: B. Tech. (PE)	**L: 0 T:** 0 **P:** 2
Semester: 6th	**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	**Status:** Professional Core

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

CO#.	Course Outcomes COS
1	Enable to use Pin on Disk apparatus to know the tribological properties of various materials under different environmental conditions.
2	Enable to use Air-Jet Erosion tester apparatus to know the tribological properties of various materials under different environmental conditions.
3	Enable to use Slurry Erosion tester apparatus to know the tribological properties of various materials under different environmental conditions
4	Familiarize with construction of kinematic diagrams using tracing paper method/ CAD software.
5	Enhance the ability to draw Gearing Diagrams of various machines.
6	Familiarize with speed chart, ray diagram and gearing diagram to determine the number of teeth on gears.

Sr. No.	Experiment
1	To study and perform the test on wear, coefficient of friction, friction force, weight loss on different materials(MS, Cu, Brass and CI) on Pin on disk setup under following conditions by varying load and velocity: a. Dry under normal temperature b. Dry under high temperature.
2	To study and perform the test on wear, coefficient of friction, friction force, weight loss on different materials(MS, Cu, Brass and CI) on Pin on disk setup under following conditions by varying load and velocity: a. Lubricated under normal temperature. b. Lubricated under high temperature.
3	To study and perform the test on erosive wear of different materials (MS, Cu, Brass and CI) by varying the following parameters: a. Impingement angle b. Velocity of erodent flow
4	To study and perform the test on slurry erosive wear of different materials (MS, Cu, Brass and CI) by varying the following parameters: a. Impingement angle b. Concentration of slurry
5	Construction of kinematics diagrams of the following machines (using tracing paper method / CAD software): a. Lathe Machine b. Drilling Machine c. Milling Machine
6	Construction of Gearing diagrams of the following machines: a. Lathe Machine b. Drilling Machine c. Milling Machine
7	Determination of number of teeth on gears using speed chart, ray diagram and gearing diagram.
8	One Minor Project based on the syllabi of Industrial Tribology Subject
9	One Minor Project based on the syllabi of Machine Tool Design Subject

Reference Material: Lab Manual

SUBJECT CODE: LPCPE-110

SUBJECT NAME: Non Traditional Machining Laboratory

Programme: B. Tech. (PE)	**L: 0 T:** 0 **P:** 2
Semester: 5	**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	**Status:** Professional Core

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Students will be able to perform experimental study on Ultrasonic Machine
2	Students will be able to perform experimental study on Abrasive Jet Machine
3	Students will be able to perform experimental study on Electro Discharge Machine
4	Students will be able to perform experimental study on Electro Chemical Machine
5	Students will be able to know the process parameters of different non-conventional machining processes
6	Students will be able to know calculate MRR Surface Textures and Properties of Materials Machined by different non-conventional machining processes

Sr. No.	Experiment
1	To study the parameters and properties of Ultrasonic Machine a and Laser Beam Machining
2	To perform machining of a work piece of Al, MS on Abrasive Jet Machine and study its properties
3	To perform machining of a work piece of Al, MS on Electro Chemical Machine and study its properties
4	To perform machining of a work piece of Al, MS on Electro Discharge Machine and study its properties
5	To perform machining of a work piece of Cu, Brass on Electro Discharge Machine and study its properties
6	To perform machining of a work piece of Al, MS on Water Jet Machining and study its properties
7	To Study the Properties and Performance of Plasma Arc Machining and Electron Beam Machining
8	One Minor Project based on the syllabi of Non Traditional Machining Subject

Reference Material Lab Manual

Departmental Professional Elective Subjects

Subject Code: PEPE-101
Subject Name: Jig Fixture & Die Design

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 5	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:25**%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#	Course Outcomes(CO)
1	To Design jigs for different jobs and products
2	To Design Fixture for different jobs and products
3	To evaluate the economics of designing of jigs and fixtures
4	Study advancements in designing of jigs and fixtures
5	To design Dies and die components
6	To design and evaluate forming dies and equipments

Detailed Contents

Sr. No	Title	Content Detail	Credit Hours
		Part A	
Unit 1	Introduction to Jigs & Fixture	Definition of Jigs & Fixtures, Difference Between Jigs And Fixtures, Advantages, Steps for Design Materials Used In Jigs and Fixture	**3**
Unit 2	Elements of Jig & Fixtures	Degree of Freedom, 3-2-1 Principles, Choice Of Location, Redundant Location, Diamond Pin Calculation, Locating Methods And Chip Control. Locating Devices Surface Location, Rest Blocks, Pins, V-Blocks, N Equalizers, Profile Locators., Locating Principle, Locating Methods And Devices, Standard Parts, Basic Clamping Principles, Cutting Forces, Rigid Clamping, Wedge Clamping, Cam Clamping, Quick Action Clamps, Toggle Clamps, Simultaneously Acting Clamps. Jig Bushes	**7**
Unit 3	Design of Jigs	Plate Jigs, Box Jigs, Indexing Jigs, Milling Fixtures, And Indexing-Milling Fixtures, Turning Fixtures, Grinding Fixtures, Universal Jigs, Design Problems Design Of Universal Jigs, Hydro & Pneumatic Jigs, Indexing Jigs	**8**
Unit 4	Design Of Fixtures	Indexing Fixtures: Indexing Methods, Linear, Rotary, Indexing Jigs, Indexing Fixtures. Assembly And Welding Fixture – Principles Broaching Fixtures, And Assembly Fixtures. Boring Fixtures. Hydro & Pneumatic Fixtures, Turning Fixtures, Milling Fixtures Grinding Fixtures And Design Problems Of Fixtures	**8**
		Part B	
Unit 5	Elements of Die	Punch, Punch Plate, Die Plate, stripper plate, Top Plate, Shank, Guide pillar, Guide Bushes, gauges, Stock guides ,Die stops, Nest Gages and Pushers, Stock material utilization and strip layouts. Materials selection	**4**
Unit 6	Types of Dies	Introduction to Bending Dies, Introduction to Inverted Dies and Compound Dies function of various parts of Inverted dies and Compound dies Definition and Introduction of Progressive dies Introduction of Trimming Dies, Notching, , Combination Dies, Introduction to Draw Dies, Inverted Draw Dies,	**7**
Unit 7	Die Design	Spring selection process. Design of blanking, Piercing Dies, compound progressive Calculation of cutting force and stripping force, importance of cutting force, calculation of press tonnage, calculation of cutting clearance, importance of cutting clearance. Method of reducing the cutting force, Calculation of die size and punch size for blanking and piercing operation.	**8**
Unit 8	Advancements in Jig Fixture & Die Design	Computer Aided Jigs & Fixtures, Jigs & Fixtures for CNCs Role of Jig Fixtures in FMS, Automated Die Sets, Computer Controlled Dies	**3**

Text Books:

1. Elanchezhizn C., Sunder Selwyn T. & Vijaya Ramnath B. “Design of Jigs, Fixtures and Press Tool” ESWAR Press 2007
2. Vijayaraghavan G. K., Sundaravalli S. & Muruganandam A. “Design of Jig Fixture and Press Tool” Suchitra Publications 2016
3. Erik K. Henriksen “Jig & Fixture Design Manual” Industrial Press 2010
4. Paul Campbel “Basic Fixture Design” Industrial Press 2005
5. Balachandran V. “ Design of Jig Fixture and Press Tools” Notion Press 2015
6. Edverd J Hoffman “Jig And Fixture Design" CENGAGE INDIA 2003
7. Sandor Nagyszalanczy “Jigs & Fixtures” Taunton Press 2015

8. Venkataraman K. “Design Of Jig Fixture And Press Tool Design” John Willy & Sons 2015
9. Joshi, P. H. “Jig and Fixtures” Tata McGraw-Hill Education, 1999

Additional Books:

1. Franklin-D-Jones “Jigs and Fixtures Design”. Forgotten Books 2016
2. Cyril Donaldson & V. C. Goold “Tool Design” Tata McGraw-Hill Education, 1976
3. Haughton, P. S. “Jigs and Fixtures Design” Springer 1956
4. Albert Atkins Dowd, Frank W. “Tool Engineering, Jigs and Fixtures” BiblioBazaar 2016
5. Hiram E. Grant, “Jigs *and* Fixtures Non-standard Clamping Devices”, TataMcGraw –Hill. 2014

SUBJECT CODE: PEPE-102
SUBJECT NAME: TOOL AND CUTTER DESIGN

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 5th/6th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 30%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Demonstrate the principle elements of cutting tools and tool geometry.
2	Evaluate the design elements and geometrical parameters of the tool life.
3	Develop in-depth knowledge of Twist drill geometry, construction and design.
4	Do analysis of correct profile of Form tools.
5	Explain the problems related to measurement of Milling and Broaching.
6	Explain the problems related to measurement of Reamers.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Cutting Tool materials, desirable properties of cutting tool materials, Relative properties of the various tool materials and their uses. Fundamentals of cutting tool design. Principles elements of cutting tools and tool geometry.	**6**
Unit 2	**Design of Single Point Tools**	Design Elements and Geometrical parameters of the tool point. Design for dimensions of H.S.S Tools. Construction and design of carbide and ceramic tipped tools, Chip breaker purpose construction and design, Design of High production Tools, Principles types and their design.	**10**
Unit 3	**Design of Drills**	Purpose and principal types of drills, twist drill geometry, construction and design.	**6**
	Part B		
Unit 4	**Design of Form Tool**	Purpose and types of form tools, radial feed and tangential type form tool construction and design.	**6**
Unit 5	**Design of milling cutters**	Purpose, types and geometry of milling cutters, Design of profile sharpened plain milling enter, face milling cuter, side milling cutters..	**7**
Unit 6	**Design of Broaches**	Purpose and types of broaches, Design and construction of internal broaches and external surface broaches.	**7**
Unit 7	**Design of Reamers**	Elementary discussion on various types of reamers, construction and geometry of reamers.	**6**

Text Books:

1. Cyril Donaldson, George H. LeCain, V. C. Goold, "Tool Design", Tata McGraw hill.
2. Arshinov& Others, "Metal Cutting Principles and cutting Tool Design and Production ",Mir Publications.
3. Helmi A. Youssef, Hassan El-Hofy, " Machining Technology" ,Taylor and francis Group.

Additional Books:

1. Leo J. St. Clair, "Design and use of cutting tools", McGraw-Hill.
2. William R. Jeffries., "Tool design", Prentice-Hall.

SUBJECT CODE: PEPE-103
SUBJECT NAME: INTRODUCTION TO ROBOTICS

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 5th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 20%
External Marks: 60	**Duration of End Semester Exam (ESE):** 3hr
Total Marks: 100	**Status:** Professional Core

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Demonstrate the basic concepts of robotics, their classification and structure.
2	Explain the type of the drive and control systems used in robotics.
3	Describe the type of sensors used in robotics.
4	Perform the robot language programming.
5	Elucidate the need and implementation of related Instrumentation & control in robotics
6	Illustrate the Kinematics and Dynamics of robotics

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Basic Concepts in Robotics**	Automation and robotics, Robot anatomy, Basic structure of robots, Resolution, Accuracy and repeatability.	**4**
Unit 2	**Classification and Structure of Robotic System**	Point to point and continuous path systems. Control loops of robotic systems, The manipulators, The wrist motion and grippers.	**4**
Unit 3	**Drives and Control Systems**	Hydraulic systems, Dc servo motors, Basic control systems concepts and models, Control system analysis, Robot activation and feedback components, Positional and velocity sensors, actuators. Power transmission systems, Robot joint control design.	**10**
Unit 4	**Vision Systems**	Vision equipment, Image processing, Concept of low level and high-level vision.	**4**
		Part B	
Unit 5	**Robot arm Kinematics and Dynamics**	The direct kinematics problem, The inverse kinematics solution, Lagrange-Euler formation, Generalized D'Alembert equations of motion, Denavit Hartenberg convention and its applications.	**10**
Unit 6	**Sensors and Instrumentation in robotics**	Tactile sensors, proximity and range sensors, Force and torque sensors, Uses of sensors in robotics	**4**
Unit 7	**Robot Programming**	Method of robots programming, Lead through programming methods, a robot programs as a path in space, Motion interpolation, WAIT, SIGNAL and DELAY commands, Branching capabilities and limitation of lead through methods.	**12**

Text Books:

1. Nikku, S.B., Introduction to Robotics, Prentice–Hall of India Private Limited (2002).
2. Schilling. R. J., Fundamentals of Robotics: Analysis and Control, Prentice–Hall of India Private Limited (2006).
3. Criag, J., Fundamentals of Robotics: Analysis and Control, Prentice–Hall of India Private Limited (2006).

Additional Books:

1. Gonzalex, R. C. and Fu, K. S., Robotics Control Sensing, Vision and Intelligence, McGraw–Hill (2004).

2. Koren,Y., Robotics for Engineers, McGraw–Hill (1985).

SUBJECT CODE: PEPE-104
SUBJECT NAME: MICRO MACHINING

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 5th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 30%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Demonstrate the concept of Micro machining in a manufacturing unit.
2	develop in-depth knowledge of latest technologies in micro machining like DTM, AJMM, FIB Machining etc.
3	Develop in-depth knowledge of concept of Micro Metrology.
4	Explain the concept of Micro-Electric Discharge and Electro Chemical Micromachining.
5	Develop skills to fabricate products using micro machining efficiently.
6	Apply the techniques of Micro machining in a manufacturing unit.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Micromachining – definition - principle of mechanical micromachining - Classification of micromachining and nanofinishing processes - Molecular dynamics simulations of machining at atomic scale. Selection of micro machining processes	**6**
Unit 2	**Mechanical Micro Machining Processes**	Abrasive Jet Micromachining - erosion mechanism - powder feeding - microstructure fabrication. Ultrasonic micromachining – basic elements - mechanism of material removal - micro-hole drilling, contour machining, micro-de-burring, machining of ceramic materials.	**9**
Unit 3	**Diamond Turn & Electrochemical Micro Machininig**	Diamond Turn Machining (DTM) - components of DTM – requirements of DTM - material removal mechanism – molecular dynamics - tool geometry. Electrochemical Micromachininig, Electrochemichal Micro Deburring, Focussed Ion Beam (FIB) Machining.	**8**
		Part B	
Unit 4	**Micro-Electric Discharge Micromachining**	Micro-electric discharge micromachining – principle - Micro EDM system development - process parameters - Analytical Modeling. Laser micromachining techniques and their applications. Focused Ion Beam machining. Electro chemical spark micromachining – mechanism - equipment. Electron beam micromachining – mechanism-process parameters - applications.	**10**
Unit 5	**Micro fabrication**	Micro fabrication - Materials for Microsystems manufacture - Substrates and Wafers, active substrate materials, silicon and silicon components. Photolithography based micro fabrication processes - Photo resist development. Additive and subtractive techniques – CVD – PVD – etching - chemical, plasma - resists removal. Large aspect ratio micro manufacturing - LIGA, Deep Reactive Ion Etching.	**8**
Unit 6	**Micro Metrology**	Micro Metrology - Scanning Electron Microscopy, optical microscopy, atomic force microscope, molecular measuring machine, Micro-CMM, Transmission electron microscope – principles - applications.	**7**

Text Books:

1. Introduction To Micromachining , V.K.Jain (Editor) Published By Narosa Publishers, N Ew Delhi (2009). (Second Edition)
2. Micromanufacturing Processes By V. K. Jain (Editor), Crc Press.
3. Advanced Machining Processes By V.K Jain , Allied Publishers, New Delhi.
4. Madou M. J. - 'Fundamentals of Microfabrication' - CRC Press - 2009 - 2nd Edition
5. Ran Hsu, T. R. 'MEMS & Microsystems: Design and Manufacturing' - Tata McGraw- Hill - 2002

Subject Code: PEPE-125
Subject Name: Human Engineering

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 5	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: Nil**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status: Professional Elective**

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Student will be able to analysis the psychology of human behavior as it relates to workplace safety.
2	Student will be able to identify ergonomic hazards, recommend appropriate controls.
3	Student will be able to analysis the anatomical and mechanical structure of the human body and anthropometry techniques available to engineers.
4	Student will be able to analysis the concept of the office workstation & ergonomic design of the office workstation.
5	Student will be able to investigate human senses in general and special focus on the vision sense and the auditory sense.
6	Student will be able to analysis the work related disorders & industrial safety aspects.

Detailed Contents

Sr. No	Title	Content Detail	Credit Hours
		Part A	
Unit 1	**Ergonomics**	Introduction to Ergonomics, Human Factors and Ergonomics, Application and History of Ergonomics, Effectiveness and Cost-Effectiveness of Ergonomics, micro- and macro- ergonomics.	**3**
Unit 2	**Systems of the Human Body**	Anthropology, Anatomy of Spine and Pelvis Related to Posture, Biomechanics, Muscular System, Ergonomics and the Musculoskeletal System, Costs of Back Injuries	**6**
Unit 3	**Muscular Work & Nervous Control of Movements**	Types of Muscular Work, Muscular Fatigue, Types of Muscle Contractions, Measurement of Muscular Strength	**6**
Unit 4	**Anthropometry**	Introduction, Terminology, Myth of the Average Human, Principles of Universal Design, Anthropometric Measurements	**6**
		Part B	
Unit 5	**Design of Work places & Hand Tools**	Work Design Analysis, Designing for Hand Use, Types of Injuries and Disorders, Theories of healthy standing and sitting, free posturing, ergonomics design of the office computer workstation, Lifting Guidelines,	**6**
Unit 6	**Work-Related Disorders**	Types of Work-Related MSD's, Task-related Factors, Personal Risk Factors, Impact on Industry, Ergonomic Program for WMSD's, Industrial Environmental Disorders and Climate and Environmental Disorders, Workplace Stress, Mental Fatigue/Shiftwork Fatigue	**6**
Unit 7	**Industrial Safety & Ergonomics**	Concept of Safety, Accidents & Hazards, Causes & effects of Industrial accidents, Cost of Accidents, Impact of Accidents on employees, Physical Hazards, Chemical Hazards, Biological & Ergonomically Hazards, Occupational Health &Toxicology, Occupational Physiology.	**5**
Unit 8	**Information Ergonomics, Controls, & Displays**	Mental Workload Measurement, Primary and Secondary Task Performance, Controls and Displays (Types), Control Layout and Design	**5**
Unit 9	**Human Senses**	Body Sensors, Vision Sense, Color Theories, Auditory Sense, Smelling Sense, Tasting Sense, Touching Sense, Human Body Interaction with Environment, Thermo regulation of Human Body, Working in Polluted Air, Working at High Altitude, Effect of Vibration on Human Body	**5**

Text Books:

1. Bush, P. M. "Ergonomics, Foundational Principles, Applications, and Technologies" CRC Press-Taylor & Francis Group 2011
2. Konz S. A. & Johnson S., "Work Design: Industrial Ergonomics". 6th Edition, Holcomb Hathaway Publishers, 2004
3. Konz SA & Johnson S. "Work Design: Occupational Ergonomics". 7th Edition, Holcomb Hathaway Publishers, 2008
4. Bhattacharya and McGlothlin, "Occupational Ergonomics - Theory and Applications", Second Edition CRC Press-Taylor & Francis Group 2012

5. B. M. Pulat "Fundamentals of Industrial Ergonomics" Waveland Pr. Inc. 1997
6. M. I. Khan "Industrial Ergonomics" by PHI Publisher 2010 2nd Edition
7. Robert Bridger "Introduction to Human Factors and Ergonomics" CRC Press (2017)

Additional Books:

1. Phillips, C. A. "Human Factors Engineering" 1st edition, Wiley 1999
2. *Mark R. L. & Steven J. L. "Introduction* to Human Factors and Ergonomics for Engineers" CRC Press 2012
3. Bridger, Robert S. "Introduction to Ergonomics", 3rd edition, CRC Press, Taylor & Francis Group 2009
4. Stack, T., Ostrom, L. T. & Cheryl A. W. "Occupational Ergonomics: A Practical Approach" Wiley, 1 ed. 2016
5. Reese C. D. "Occupational Health and Safety Management: A Practical Approach", Third Edition 3rd Edition CRC Press 3 edition 2015

Subject Code: PEPE-126
Subject Name: Agile manufacturing

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 5	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: Nil**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status: Professional Elective**

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Understand conceptual frame work of agile manufacturing environment.
2	Get insight into Enterprise design process, apply interdisciplinary design concepts.
3	Develop characteristic difference between lean manufacturing and agile manufacturing and appreciate benefits that can be derived by adopting newer manufacturing strategies.
4	Student will be able to implement the agile practices and technology in an industry.
5	Student will be able to measure the performance of a system.
6	Student will be able to create a learning factory for future challenges.

Detailed Contents

Sr. No	Title	Content Detail	Credit Hours
		Part A	
Unit 1	The Agile Production System	Agile Manufacturing Production System - Production, Production Support, Production Planning and Control, Quality Assurance, Purchasing, Maintenance, Overview of Production Support, Business Operations, Engineering, Marketing, Human Resource, Finance and Accounting.	5
Unit 2	Agile Practices	Agile practice for product development - Manufacturing Agile Practices - understanding the value of investing in people, removing inappropriate fear from the shop floor - not sacrificing agility for perfectionism.	5
Unit 3	Implementing Technology to Enhance Agility	Implementing New Technology - Reasons - Guidelines Preparation for Technology Implementation - A Checklist, Technology Applications that enhance Agility - Agile Technology Make-or-Buy Decisions.	6
Unit 4	Strategic Direction	Key Concepts, Strategic Thinking, Strategic Learning Approach to creating Strategy - Establishing the Strategy Team, Collecting Strategic Information, Creating Strategic Scenarios, Developing Strategy Options, Selecting the best Strategy Option, Testing and Refining the Strategy, Implementing the Strategy, Strategy Partnering, Conclusion.	6
		Part B	
Unit 5	Performance Measures	Historical view of performance measurement, Dysfunctional Impacts of Cost-Accounting Performance Measures, Customer-Centered Paradigm, Developing Customer-Based Performance Measures.	6
Unit 6	Creating the Learning Factory	Imperative for success, factory becoming a learning factory, building a road map for becoming a learning factory - Core Capabilities, Guiding Vision, Leadership That Fits, Ownership And Commitment, Pushing The Envelope, Prototypes, Integration, Learning Challenges for learning Manufacturing Business, conclusion.	**5**
Unit 7	Management in The Agile Organization	Old management styles, role of manger in an Agile Organization - Vision Champion, Team Leader, Coach, Business Analyzer, supporting the new culture - Performance Appraisal Systems, Selection Systems, Reward and Recognition Systems, Organizational Measurement, Organizational Learning Processes.	5
Unit 8	Application of IT/IS Concepts In Agile Manufacturing	Management of complexities and information flow, approaches, applications of multimedia to improve agility in manufacturing, system concepts. Agile Supply Chain Management: Principles, IT/IS concepts in supply chain management, enterprise integration and management in agile manufacturing, concepts, Agility, Adaptability and learners – comparison of concepts	**5**
Unit 9	Computer Control Of Agile Manufacturing	CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing, Cellular manufacturing, concepts. Corporate Knowledge Management In Agile Manufacturing	**5**

Text Books:

1. Gunasekaran A, "Agile Manufacturing, 21st Strategy Competitiveness Strategy", Elsevier Publications, 2001.

2. Montgomery J C and Levine L O, “The Transition to Agile Manufacturing – Staying Flexible for Competitive Advantage”, ASQC Quality Press, Wisconsin, 1995.
3. Devadasan S R, Mohan Sivakumar V, Murugesh R and Shalij P R, “Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities”, Prentice Hall of India (PHI) Private Limited, New Delhi, India, 2012
4. Poul T Kidd “Agile Manufacturing- Forging Mew Frontiers”, Addison Wesley- Publication 1994.
5. David M Anderson and B Joseph Pine “Agile Development for Mass Customization”, Irwin Professional Publishing, Chicago, USA, 1997.

Additional Books:

1. Goldman S L, Nagal R N and Preiss K, “Agile Competitors and Virtual Organizations”, Van Nostrand Reinhold, 1995. 4.
2. Brian H Maskell, “Software and the Agile Manufacturer, Computer Systems and World Class Manufacturing, Productivity Press, 1993
3. Paul T Kidd “Concurrent Engineering” Addison Wesley Publication -1994
4. Paul T Kidd “World Class Manufacturing” Addition Wesley Pub - 1994

SUBJECT CODE: PEPE-127
SUBJECT NAME: TECHNOLOGY MANAGEMENT

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 5th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Demonstrate and apply the concept Technology Management in an organization.
2	Develop in-depth knowledge of Technology Forecasting, Development, Acquisition and Transfer. Technology Absorption and Diffusion and Assessment.
3	Develop in-depth knowledge of Technology Absorption and Diffusion and Assessment.
4	Explain the concept of laws regarding technology.
5	Develop in-depth knowledge of government Technology policies.
6	Explain the concept of technology developments

Detailed Contents:

S. No.	Title	Content details	Credit Hrs.
		Part A	
Unit 1	**Technology Management**	Various aspects and Issues, Strategic Considerations, Technological change and Inn ovation, Impact of Technological Change on Employment and Productivity, Social consequences.	**10**
Unit 2	**Technology Assessment**	Technology Forecasting, Technology Development, Acquisition and Transfer. Technology Absorption and Diffusion, Evaluation/Assessment of competing Technologies, Foreign Diffusion, Collaboration and Strategic Technological Alliances.	**14**
		Part B	
Unit 3	**Important Laws**	Law regarding protection of trade intellectual property rights, patents, trademarks, TRIPS and W.T.O. - its impact on Indian Economy.	**10**
Unit 4	**Technology Development**	Technological environment in India - Technology policy, role of various government, organizations such as DST, CSIR in development and dissemination of technology. Technology development at organization level, role of information system, quality systems and market feedback.	**14**

Text Books:

1. Sharif Nawaz, "Management of Technology Transfer and Technology", APCTT Bangalore. 1977.
2. Fredruck Betz, "Managing Technology", Prentice Hall, 1987.
3. Mauk Dudgson, "Technology Strategy and the Firm", Longman Publications, 1989.
4. UN-ESCAP, "Technology for Development", ESCAP Secretariat,

SUBJECT CODE: PEPE-128

SUBJECT NAME: MARKETING MANAGEMENT

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 5th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Demonstrate and apply the concept Marketing Management.
2	Develop in-depth knowledge of Marketing strategies formulation.
3	Develop in-depth knowledge of consumer and industrial markets.
4	Explain the concept of marketing mix decisions.
5	Develop in-depth knowledge of buyer behaviors.
6	Explain the concept of marketing research and trends.

Detailed Contents:

S. No.	Title	Content details	Credit Hrs.
		Part A	
Unit 1	**Introduction**	Marketing – Definitions - Conceptual frame work – Marketing environment: Internal and External - Marketing interface with other functional areas – Production, Finance, Human Relations Management, Information System. Marketing in global environment – Prospects and Challenges.	**10**
Unit 2	**Marketing Strategy**	Marketing strategy formulations – Key Drivers of Marketing Strategies - Strategies for Industrial Marketing – Consumer Marketing — Services marketing – Competitor analysis - Analysis of consumer and industrial markets – Strategic Marketing Mix components.	**10**
		Part B	
Unit 3	**Marketing Mix Decisions**	Product planning and development – Product life cycle – New product Development and Management – Market Segmentation – Targeting and Positioning – Channel Management – Advertising and sales promotions – Pricing Objectives, Policies and methods.	**9**
Unit 4	**Buyer Behaviour**	Understanding industrial and individual buyer behavior - Influencing factors – Buyer Behaviour Models – Online buyer behaviour - Building and measuring customer satisfaction – Customer relationships management – Customer acquisition, Retaining, Defection.	**10**
Unit 5	**Marketing Research & Trends In Marketing**	Marketing Information System – Research Process – Concepts and applications : Product – Advertising – Promotion – Consumer Behaviour – Retail research – Customer driven organizations - Cause related marketing - Ethics in marketing –Online marketing trends	**9**

Text Books:

1. Kortler Philip and Keller K.L., "Marketing Management", PHI 14th Edition, 2012.
2. Chandrasekar K.S., "Marketing management-Text and Cases", Tata McGraw Hill-1st Ed., 2010.
3. Baines P., Fill C. and Page K., "Marketing", Oxford University Press, 2nd Edition, 2011.

Additional Books:

3. Micheal R.C. and Masaaki K., "Marketing Management", Vikas Thomson Learning,2000.
4. Duglas,J. Darymple,, "Marketing Management", John Wiley & Sons, 2008.

SUBJECT CODE: PEPE-149
SUBJECT NAME: COMPOSITE MATERIALS

Programme: B. Tech. (PE)	**L: 4 T:** 0 **P:** 0
Semester: 5th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits: 4**
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam (ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Know the applications of composite materials.
2	Identify various constituents of composite materials and their characteristics.
3	Suggest and use standard methods for determining mechanical properties of different types of composite materials.
4	Use various techniques for processing of composite materials.
5	Asses the applicability and selection of a composite material for a specific application
6	Self-directed learning, incorporating researching properties of composite materials.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	History of composite materials, classification of composite materials, properties of composites compared to conventional materials, applications of composites	**6**
Unit 2	**Matrices and Reinforcements**	Introduction to different types of matrices, difference between thermosetting and thermoplastic matrices, chemical structure and characteristic features of polymer matrices, curing system, role of matrix in continuous fibre composites, introduction to different types of reinforcements, characteristic features and role of fibres, particles, whiskers as reinforcing agents	**10**
Unit 3	**Basic Concepts of Composite Materials**	Stress distribution in fibre and matrix, rule of mixtures, analysis of uniaxial tensile stress-strain curve of unidirectional continuous and short fibre composites, estimation of minimum and critical amount of reinforcement, experimental determination of mechanical properties (compressive, flexural and shear) of composite materials using standard test procedures, failure theories of polymer matrix composites.	**10**
		Part B	
Unit 4	**Processing of Composite Materials**	Processing techniques of polymeric matrix composites (PMCs), process mechanism, capability and application areas of various techniques, hand lay-up, autoclaving, filament winding, pultrusion, compression molding, pre-pegging, sheet molding compounds, primary processing techniques for ceramic and metal matrix composites (CMCs and MMCs), stir and squeeze casting, powder metallurgy, liquid infiltration process	**14**
Unit 5	**Secondary Processing of Composite Materials**	Machining, welding, adhesive joining and mechanical fastening of composite materials (as relevant and specific for PMCs, CMCs and MMCs).	**8**

Text Books:

1. Mathews F.L and Rawlings R.D, "Composite Materials: Engineering and Science", Woodhead Publishing, ISBN: 9781855734739, 1st Edition, 1999.
2. Hull D. and Clyne T.W., "An Introduction to Composite Materials", 2nd Ed., Cambridge University Press, 2013.
3. Chawla K.K., "Composite Materials: Science and Engineering" 3rd Ed., Springer, 2012
4. Chawla K.K., "Ceramic Matrix Composites", 2nd Ed., Springer, 2003

Additional Books:

1. Chawla N. Chawla K.K., "Metal Matrix Composites", 2nd Ed. Springer, 2013.
2. Shojiro O., "Mechanical Properties of Metallic Composites", Marcel Dekker, 2002.
3. Deborah D.L. Chung, "Composite Materials: Science and Applications", 2nd Ed. Springer, 2010.

SUBJECT CODE: PEPE-150

SUBJECT NAME: MATERIAL TESTING & CHARACTERIZATION

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 5th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 30%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Interpret various materials characterization techniques.
2	Understand the principle and operation of characterization equipments and the adjustment of operation variables to obtain good images / results
3	select the characterization tool for specific application
4	compare the principle and operation of different characterization tools such as optical microscope, Scanning electron microscopes and transmission electron microscope
5	analyze the characterization results by various equipment
6	relate fundamental of physics to the basic operation of the equipment

Detailed Contents:

S. No.	Title	Content details	Credit Hrs.
		Part A	
Unit 1	Macro & Micro Examination Of Metals	Macro And Micro Examination Of Metals Specimen Preparation Qualitative And Quantitative Examination Optical,	**10**
Unit 2	**Optical Microscopy**	Optical Microscopy - Introduction, Optical principles, Instrumentation, Specimen preparation-metallographic principles, Imaging Modes, Applications, Limitations, Transmission Electron Microscopy (TEM) - Introduction, Instrumentation, Specimen preparation-pre thinning, final thinning, Image modes- mass density contrast, diffraction contrast, phase contrast, Applications, Limitations	**10**
Unit 3	**Scanning Electron Microscopy**	Scanning Electron Microscopy (SEM) - Introduction, Instrumentation, Contrast formation, Operational variables, Specimen preparation, imaging modes, Applications, Limitations, X-Ray Diffraction (XRD) - Introduction, Basic principles of diffraction, X - ray generation, Instrumentation, Types of analysis, Data collection for analysis, Applications, Limitations	
Unit 4	Magnetic Resonance	Magnetic Resonance, NMR, Analysis Of The Phenomenon ,Experimental Method , NMR Spectra , Applications , NQR, Analysis Of The Phenomenon , NQR Spectra , Applications To Study Of Deformed Metals And Crystalline Electric Field , ESR ,, Phenomenon, Experimental study – ESR spectra and Applications.	
		Part B	
Unit 5	**Scanning Probe & Atomic Force Microscopy**	Scanning Probe Microscopy (SPM) & Atomic Force Microscopy (AFM) , Introduction, Instrumentation, Scanning Tunneling Microscopy, Basics, probe tips, working environment, operational modes, Applications, Limitations, Electron Probe Micro Analyzer (EPMA) , Introduction, Sample preparation, Working procedure, Applications, Limitations	**9**
Unit 6	**X, Ray Spectroscopy for Elemental Analysis**	X, Ray Spectroscopy for Elemental Analysis , Introduction, Characteristics of X-rays, X, ray Fluorescence Spectrometry, Wavelength Dispersive Spectroscopy, Instrumentation, Working procedure, Applications, Limitations, Energy Dispersive Spectroscopy , Instrumentation, Working procedure, Applications, Limitations,	**10**
Unit 7	**Thermal Analysis**	Thermal Analysis , Instrumentation, experimental parameters, Different types used for analysis, Differential thermal analysis, Differential Scanning Calorimetry, Thermogravimetry, Dilatometry, Dynamic mechanical analysis, Basic principles, Instrumentation, working principles, Applications, Limitations.	**9**
Unit 8	**X, Ray diffraction**	Bragg's Condition, Laue Treatment, Reciprocal Lattice, Intensity Of Diffracted Beam, Crystal Structure Determination. Atomic Scattering Factor, Geometrical Structure Factor, Experimental Methods. Laue, Rotating Crystal And Powder Photograph Methods, Estimation Of Stress, Texture And Other Defects, Electron Diffraction. Neutron Diffraction.	

Text Books:

1. Thermal Analysis of Materials by Robert F. Speyer, Marcel Dekker Inc., New York, 1994.
2. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods by Y. Leng (Jun 2, 2008)

3. Materials Characterization Techniques [Hardcover] Sam Zhang (Author), Lin Li (Author), Ashok Kumar (Author)
4. Surface Analysis: The Principal Techniques [Paperback] John C. Vickerman (Editor), Ian Gilmore (Editor)

Additional Books:

1. V. T. Cherapin and A. K. Mallik: Experimental Techniques in Physical Metallurgy, Asia Publishing House, 1967.
2. ASM Handbook: Materials Characterization, ASM International, 2008.

SUBJECT CODE: PEPE-151
SUBJECT NAME: SCIENCE OF ENGINEERING & MATERIALS

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Apply knowledge of Mechanical Material Properties in designing specific products and experiments
2	Able to use Bio Material for the manufacturing of better human friendly product
3	Apply knowledge of ceramics properties in designing specific products and experiments
4	Able to make better utilization of electrical and electronics materials for designing new products
5	Able to use Nano Materials for the betterment of human race
6	Able to know about the safety and dangers of Nuclear Materials

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction to Metals**	Introduction Of Metals And Mechanical Materials, Criteria Of Selection Of Materials Like Properties, Cost, Manufacturing Process, Availability, Legal And Safety Factors. Different Metals used in Manufacturing Industries Copper Aluminum Steel Iron	
Unit 2	**Properties of Metal**	Mechanical, Thermal, Electrical and Chemical properties of different Metals like Metallic luster, Electrical conductivity, Thermal conductivity, Malleability and ductility, Melting point, Hardness, Strength, Density.	
Unit 3	**High Temperature Metals**	Introduction to High Temperature Materials, Mechanical, Thermal, Electrical and Chemical properties of High Temperature Metals	
Unit 4	**Metallic Alloys**	Introduction of Metallic Alloys, Types of Metallic Alloys Properties of Metallic Alloys Manufacturing of Metallic Alloys, common metallic alloys	
Part B			
Unit 5	**Corrosion**	Definition of Corrosion, Types of Corrosions, Factors Affecting Corrosions, Prevention of Corrosions, Conditions for Corrosions of different Metals, Corrosion Testing and Monitoring, General concepts, fracture characteristics revealed by microscopy, factors affecting fatigue life Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure	
Unit 6	**Wear**	Types of wear, analyzing wear failure. Wear failure, Abrasive and adhesive wear, fretting wear, Wear failures-fatigue, Life cycle of a metal,	
Unit 7	**Metallurgical Failure Analysis**	Stages of failure analysis, classification and identification of various types of fracture. Overview of fracture mechanics, characteristics of ductile and brittle fracture.	

Text Books:

1. Bruce A. Rogers "The Nature of Metals" MIT Press 2020
2. Mark Anthony Benvenuto "Metals and Alloys Industrial Applications" De Gruyter Textbook 2016
3. Valim Levitin "High Temperature Strain of Metals and Alloys: Physical Fundamentals" Wiley-VCH 2006
4. Sharma C.P. "Engineering Materials-properties and Applications of Metal and Alloys". Prentice-Hall of India Pvt.Ltd 2004
5. Denise Walker "Metals and Non-metals" Evans Brothers, 2007

Additional Books:

1. William D. Callister Jr. and David G. Rethwisch "Materials Science and Engineering" John Wiley & Sons, 9th Ed. 2014
2. D.R.H. Jones and Michael F. Ashby "Engineering Materials 1: an Introduction to Properties, Applications and Design" Butterworth-Heinemann, 3 ed. 2005

SUBJECT CODE: PEPE-151

SUBJECT NAME: Deformation & Defects of Materials

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Will be able find plastic deformation in metals and alloys
2	Will be able find and remove point and line defects in materials
3	Will be able find and remove Planar defects in materials
4	Will be able find the causes of fatigue in materials
5	Will be able find and remove dislocation defects in materials
6	Will be able execute tests on materials to find the defects

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction:**	Scope Of The Subject, Elastic, Plastic, And Anelastic Deformation. Constitutive Equations In Elasticity For Isotropic And Anisotropic Materials, Strain Energy, Elastic Stiffness And Compliance Tensor, Crystal Structure And Elastic Constants.	**5**
Unit 2	**Defects**	Types of Defects in Metals, alloys and composites, Schottky Defects, Frenkel Defect, Impurity Defects, Non- stoichiometric Defects, Metal Deficiency Defect, Defects in Elemental Solids and Ionic Compounds, Defect Classes, Point Defects, Kröger-Vink Notatio	**6**
Unit 3	**Plastic Deformation in Metals and Alloys:**	Critical resolved shear stress. Defects in crystalline materials Point defects and line defects. The concept of dislocation – Edge dislocation and screw dislocation. Interaction between dislocations, sessile dislocation, glissile dislocation, dislocation climb, Jogs, Forces on dislocations Energy of a dislocation. Frank Reed source, slip and twinning.	**7**
Unit 4	**Point & Line Defects**	Equilibrium Point Defect Concentrations, Intrinsic Point Defects, Extrinsic Point Defects, Diffusion, Impurity Diffusion, Description Of Dislocations, Elements Of Elastic Theory, Stress Field Of A Dislocation, Strain Energy Of A Dislocation, Line Tension, Forces On Dislocations, Forces Between Dislocations, Dislocation Reactions, Dislocations In Fcc Crystals, Dislocations In Other Crystal Systems, Dislocation Multiplication, Strength Of Crystalline Solids	**7**
Unit 5	**Planar Defects**	Interface Defects, Twin Boundaries, Stacking Faults , Grain Boundaries, Interface Boundaries, Surface Defects:, Description Of Surface Structure, Surface Crystallography, Surface Relaxation And Reconstruction, Crystal Growth,	**8**
Unit 6	**Fracture**	Mechanisms Of Ductile And Brittle Fracture, Fracture In Creep And Stress Corrosion Conditions, Fractograohy. Elementary theories of fracture Griffith Theory Of Brittle Fracture. Concepts Of Stress Concentrations And Stress Intensity Factors, Rack Tip Plastic Zone. J And CTOD Parameters. Ductile To Brittle Transition Behaviour. Notch sensitivity. Hardness Test: Methods of hardness testing Brinells, Vickers, Rockwell, Rockwell superficial, Shore and Poldi methods, Microhardness test, relationship between hardness and other mechanical properties.	**8**
Unit 7	**Tension Test:**	Mechanism of elastic action, linear elastic properties. Engineering stress and Engineering strain, True stress-strain curve. Tension Test and tensile properties, conditions for necking, effect of temperature and strain rate on tensile properties. Compression Test: Elastic and in elastic action in compression, compression Test. Impact Test: Notched bar impact test and its significance, Charpy and Izod Tests, significance of transition temperature curve, Metallurgical factors affecting the transition temperature, temper embrittlement. DBTT curve and its importance. Fracture toughness testing – COD and CTOD tests.	**8**

Text Books:

1. D. Hull and D. J. Bacon, Introduction to Dislocations, 3rd Edition, Pergamon Press, 1984
2. J. Weertman and J. R Weertman, Elementary Dislocation Theory, Oxford, 1992.
3. P. Shewmon, Diffusion in Solids, A Publication of The Minerals, Metals & Materials
4. Society, 1989.

5. A. Kelly and G. W. Groves, Crystallography and Crystal Defects, Addison-Wesley, 2000.
6. Y. M. Chang, D. Birnie, and W. D. Kingery, Physical Ceramics: Principles for Ceramic Science and Engineering, John Wiley & Sons, Inc., 1996

Additional Books:

1. J. P. Hirth, Theory of Dislocations, 2nd edition, A Wiley-Interscience Publication, 1982.
2. Mechanical Metallurgy – GE Dieter
3. Mechanical Behavior of Material – A. H. Courtney

SUBJECT CODE: PEPE,106

SUBJECT NAME: MAINTENANCE AND RELIABILITY ENGINEERING

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 6th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 10%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Demonstrate and apply the concept of Maintenance.
2	Develop in,depth knowledge of performance and cost.
3	Apply various maintenance measurement methods to enhance the performance.
4	Explain the concept of reliability.
5	Apply various reliability hazard rate and failure density function models.
6	Develop in, depth knowledge on various aspects of reliability calculations for maintained and stand, by systems

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Types of Maintenance**	Definition of maintenance, Role and scope of maintenance in total organizational context. Objectives and characteristics of maintenance, Centralized vs Decentralized maintenance. Corrective, planned, preventive and predictive maintenance. Factors affecting maintenance, Opportunistic maintenance. Measurement of maintenance work: Mean time to repair, Median time to repair, Mean system down time, Mean time to restore.	**10**
Unit 2	**Rating of maintenance work and allowances**	Maintenance performance indices. Maintenance cost budgets, Maintenance planning and scheduling, MIS in maintenance	**7**
Unit 3	**Measurement of maintenance**	Measurement of maintenance effectiveness and maintenance audit	**5**
		Part B	
Unit 4	**Basic concepts of Reliability**	Definition of Reliability, Availability and Maintainability. Random events, Frequency distributions and measures of location, Random variables with examples and probability distributions. Failure data, failure modes: Mean time to failure, MTBF, Failure analysis, Fault tree analysis, FMECA	**10**
Unit 5	**Reliability in terms of hazard rate and failure density function**	Reliability function, Hazard rate function, PDF, CDF. Hazard models and bath tub curve: Constant, linear and non,linear hazard models. Applicability of Welbull distribution. Reliability calculation: Series, parallel and parallel,series systems, Low level and High level redundancy	**10**
Unit 6	**Reliability calculations for maintained and stand,by systems**	Markov analysis, Load sharing system, standby systems, Three component standby systems.	**6**

Text Books:

1. Kelly A , “Maintenance Planning and Control”, Buttersworth & Co., 1984.
2. Carter A. D. S., “Mechanical reliability”, Macmillan, 1987.
3. Leonard A Doty, “Reliability for the Technologies”, Industrial Press Inc, 2005.
4. Dhillon B.S. and Singh Chanan “Engineering reliability: new techniques and applications”, Wiley, 1981

Additional Books:

1. Khanna, O.P, “Industrial Engineering and Management”, Dhanpat Rai & Publication, 2007.
2. Krishnan G., “Maintenance and Spare parts Management”, Prentice Hall, 1991.

SUBJECT CODE: PEPE-107
SUBJECT NAME: STATISTICS AND NUMERICAL ANALYSIS

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 5th/6th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 20%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Will be able to apply the knowledge of Sampling Theory in daily life problems
2	Will be able to apply the knowledge of ANOVA in solving statistical problems
3	Will be able to check the solutions by using Hypothesis method
4	Will be able to apply design of experiments in practical experimentations
5	Will be able to apply the knowledge of Regression Analysis to find the solutions of numerical problems
6	Will be able to apply the knowledge of Runga Kutta and Newton Rapson Method in solving numerical problems

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	Introduction, Descriptive Statistics	Descriptive and Inferential Statistics Types of measurements Descriptive Statistics(Using Graphs) Descriptive Statistics(Using Numbers) Measures of location, variability, and relative standing	**6**
Unit 2	Probability And Sampling Theory	Probabilities, Distributions, and Decision Making Applications, and Rules Conditional probability Discrete Distributions(Binomial, Poisson, Hypergeometric, Geometric) Continuous distributions Normal and Standard Normal distributions Sampling Distributions Sampling distribution parameters Central Limit Theorem Applying sampling distribution theory	**7**
Unit 3	Testing Of Hypothesis	Sampling distributions – Estimation of parameters – Statistical hypothesis – Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion – Contingency table (test for independent) -Goodness of fit.	**7**
Unit 4	Design Of Experiments	One way and two way classifications Completely randomized design Randomized block design Latin square design -factorial design	**5**
		Part B	
Unit 5	Two-Sample Tests And ANOVA	Comparing Two Population Means (Confidence Intervals) Comparing Three or More Population Means (ANOVA) Dependent and Independent populations Analysis of Variance Bonferroni Multiple Comparisons	7
Unit 6	Regression Analysis	Simple and Multiple Linear Regression Relationship between two(simple), three or more(multiple) variables Model estimation Model Inference model assumptions model validation: t-Tests R2 analysis of variance model validation: global F test Model Checking Error Distribution: Zero Mean, Normality, Independence heteroscedascity (non-constant variance) Multicollinearity Effect of outliers Model Use Description, Estimation and Prediction Model Building variable selection: R2, MSE general procedures(STEPWISE) model comparisons Using Qualitative Independent Variables Caveat (Causality)	8
Unit7	**Numerical methods**	Errors and significant digits, Roots of algebraic equations Bisection method, secant method, Newton Raphson method, Graff's root, squaring method, Iterated synthetic division with quadratic factors method for finding complex roots, solutions of systems of equations (Gauss elimination, Gauss Jordan, and Partition method for linear system of equations, power method for partition, method for linear system of equations, power method for finding eigen values), Forward, backward , central and Divided differences, Newton's formula of interpolation for equal and unequal intervals. Lagrange's interpolation formula, Stirling's and Bessell's formula,	8
Unit 8	**(Differential & Integration Equations)**	Numerical differentiation, Numerical Integration :,Trapezoidal, Simpson's rule and Gaussian integration (only formula applications) Differential equations and their solutions. Numerical methods for ordinary differential equations (Picard method, Taylor series method, Euler's method, Ranga Kutta Method, Predictor, corrector method, Adams, Bashforth method.	

Text Books:

1. S.S.Sastry, "Introductory methods of numerical analysis",Prentice Hall of India.
2. John P. Kennedy Thomas Y, "Statistical methods for Engineers", Crowell Co.

3. B.S. Grewal, “Elementary Numerical Methods”,Khanna Publication New Delhi.
4. Johnson. R.A., and Gupta. C.B., “Miller and Freund‟s Probability and Statistics for Engineers”, 11th Edition, Pearson Education, Asia, 2011.
5. Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., “Probability and Statistics for Engineers and Scientists”, 8th Edition, Pearson Education, Asia, 2007.
6. Spiegel. M.R., Schiller. J., and Srinivasan. R.A., “Schaum‟s Outlines on Probability and Statistics”, Tata McGraw Hill Edition, 2004.
7. Chapra. S.C., and Canale. R.P, “Numerical Methods for Engineers”, 5th Edition, Tata McGraw Hill, New Delhi, 2007.
8. Gerald. C.F., and Wheatley. P.O. “Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 2006.

Additional Books:

1. Rovert V. hong, “Introduction to Statistics”, Macmillan Pub. Co.
2. S.D. Conte, & Cari De Boor , “Elementary Numerical Analysis” , Mc Graw Hill.
3. Anderson, Sweeney, and Williams, Statistics for Business and Economics, Seventh Edition, West Publishing Co., available at Hammes Bookstore.

SUBJECT CODE: PEPE-108
SUBJECT NAME: CRYOGENIC MANUFACTURING

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Explain cryogenic processes in details
2	Understand the processes of cryogenic liquid production and their storage
3	Describe the effect of cryogenic manufacturing on material properties.
4	Familiarize with various cryogenic refrigeration cycles.
5	Understand type of cryogenic insulation used during cryogenic manufacturing
6	Utilize cryogenic manufacturing for various applications.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction to cryogenic manufacturing**	Historical perspective and origin of cryogenic material manufacturing, Need of cryogenic manufacturing, Types of low temperature treatment and processors, Advantages and disadvantages of cryogenic manufacturing, applications of cryogenic manufacturing	**6**
Unit 2	**Cryogenic liquid**	Definition and its types, storing cryogenic liquids, various cryogenic fluids and their properties, health, chemical and flammability hazards of cryogenic liquids, liquid nitrogen production, liquid helium production, cryogenic oxygen plant.	**6**
Unit 3	**Material behavior in cryogenic manufacturing**	Behavior and performance of materials during cryogenic manufacturing, effect on material properties (mechanical, thermal, and electrical,Super conductivity), effect on formability of materials, impact of cryogenic processing on product performance.	**7**
Unit 4	**Cryogenic processes**	Cryogenic machining, cryogenic grinding, Cryogenic deflashing, Cryogenic deburring, Cryogenic rolling, cryogenic cooling systems: Materials, machines and tooling, cryogenic machining of elastomers, economic aspects of cryogenic processing.	**7**
		Part B	
Unit 5	**Cryogenic refrigeration**	Principle and Methods of production of low temperature and their analysis: Joule Thomson Expansion, Cascade processes, cold gas refrigerators, Linde,Hampson cycles, Claude and cascaded systems, magnetic cooling, Stirling Cycle Cryocoolers, Gifford single volume refrigerator, Pulse tube refrigerators	**6**
Unit 6	**Cryogenic insulations**	Various types such as expanded foams, gas filled& fibrous insulation, vacuum insulation, evacuated powder& fibrous insulation, opacified powder insulation, multi layer insulation, comparison of performance of various insulations .	**4**
Unit 7	**Applications of cryogenic engineering**	Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions	**6**

Text Books:

4. A.R. Jha, "Cryogenic Technology and applications", Elsevier.
5. S.S. Thipse, "Cryogenics: A Textbook", Alpha Science
6. Mamata Mukhopadhyay, "Fundamentals of Cryogenic Engineering", PHI Learning Pvt.Ltd.

Additional Books:

1. R.F. Barron, "Cryogenic Systems", McGraw,Hill.
2. R.B. Scott, "Cryogenic Engineering", D. Van Nostrand

Subject Code: PEPE-129

Subject Name: Plant Layout & Material Handling

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:25%**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#	Course Outcomes(CO)
1	Student will be able to understand the types of layouts.
2	Student will be able to understand the principles of site selections
3	Student will be able to understand the type of building types and structures
4	Student will be able to understand the concepts of different material handling processes
5	Student will be able to understand the able to safety aspects associated with layout and material handling
6	Student will be able to analyze the material handling parameters as per the layout requirements

Detailed Contents

Sr. No	Title	Content Detail	Credit Hours
		Part A	
Unit 1	**Introduction To Plant Design**	Types of manufacturing processes. Plant Location, influence of location on layout. Classical types of layout, product layout and practical layout. Selection of plant site, Equipments required for plant operation, Capacity, serviceability and flexibility and analysis in selection of equipments, space requirements, and man power requirements. Advantages and Limitations of different layouts	**4**
Unit 2	**Planning The Layout**	Collecting of data for determining and diagramming – the flow of material, visualizing possible layout and evaluating alternative layouts. Storage, plant servicing and office layout. Line balancing, various operational research techniques for balancing of assembly lines fabrication lines balancing. Tools and techniques for developing layout, process chart, flow diagram, and string diagram, template and scale models machine data.	**6**
Unit 3	**Heuristics For Plant Layout**	ALDEP, CORELAP, CRAFT, Group Layout, Fixed position layout, Quadratic assignment model. Branch and bound method.	**7**
Unit 4	**Industrial Building And Utilities**	Centralized electrical, pneumatic water line systems. Types of buildings, lighting, heating, air conditioning and ventilation utilities, planning and maintenance, waste handling, statutory requirements. Packing and storage materials Safety in various shops, safety in critical storage area, storage explosive material, gases and inflammable liquids.	**7**
		Part B	
Unit 5	**Importance Of Materials Handling**	Principles of material handling, analysis of material handling problem, Importance and scope. Planning, operating and costing Principles, types of material handling systems, factors influencing their choice.	**4**
Unit 6	**Material Handling Factors**	Materials, containers frequency and duration, distance, speed, environment labour and equipment. Production Control and materials handling Types of material control. Production planning, scheduling, and dispatching as related to materials handling.	**6**
Unit 7	**Material Handling Equipment**	Belt Carrier, chain and cable roller, Screw vibrating and reciprocating pneumatic tubes, load transferring, machines, air operated, and hydraulic devices. Cranes Elevators and Hoists, Industrial Trucks, dump trucks, overhead trackage system. Pallets and containers.	**7**
Unit 8	**Analysis Of Material Handling**	Motion analysis, flow analysis, graphic analysis, safety analysis, equipment cost analysis, pillarization analysis, analysis of operation, material handling surveys.	**7**

Text Books:

1. James .M. Apple, "Plant Layout and Material handling", John Woley & Sons, N. York 1995
2. James .M. Moore, "Plant Layout and Design", MacMillan and Co. 1971
3. Richard Muther and Lee Hales, "Systematic Layout Planning", Management and Industrial Research Books 4th Edition 2015
4. R. B. Chowdhary, "Plant Layout & Material Handling", Khanna Publishers. 2nd Edition 2016
5. S. C. Sharma, Plant Layout and Material Handling, Khanna publishers. 3rd Edition 2000
6. Richard Muther, Practical Plant layout, McGraw Hill Book Company, New York 1956
7. G.K Aggarwal, Plant layout & material handling, Jain Publishers, New Delhi 2017

Additional Books:

1. James A. Tompkins and John A White “Facilities Planning”, John Wiley & Sons, New York. 4th edition 2010
2. Francis White, Facility Location & Layout, PHI, New Delhi 1991
3. Shubin J A, Plant layout, P H I publications.1965
4. Berman. Ya, Material handling, Mir publishers.1980
5. S.C. Sharma, Material Management and Material Handling, Khanna Publishers.1995

Subject Code: PEPE-130
Subject Name: Productivity Management

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:25%**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

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 dynamics of productivity measurement in manufacturing and service sectors.
2	Understand different productivity measurement models.
3	Understand the salient characteristics and limitations of different productivity measurement models.
4	Understand the differences among small, medium and large manufacturing enterprises as well as service sectors in the context of productivity measurement.
5	Will be able to evaluate the productivity of an organization
6	Will be able to implement green productivity to help the human race

Detailed Contents

Sr. No	Title	Content Detail	Credit Hours
		Part A	
Unit 1	**Introduction**	Definition of Productivity, Productivity and performance, production, benefit cycle, Industrial productivity, scope of productivity management, factors affecting productivity, different approaches to productivity. Macro and Micro factors of productivity – Dynamics of Productivity , Productivity Cycle	**4**
Unit 2	**Systems Approach To Productivity Measurement**	Conceptual frame work, Management by Objectives (MBO), Performance Objectivized Productivity (POP) – Methodology and application to manufacturing and service sector.	**6**
Unit 3	**Productivity Measurement**	Need of productivity measurement, Short term and long term productivity planning Productivity measurement approaches, total & partial productivity, productivity measurement models and their comparison, productivity measurement parameters, productivity measurement indices, work study and productivity.	**6**
Unit 4	**Productivity Planning**	Causes for productivity changes, productivity models, applications of different planning models, productivity planning executives and their responsibilities.	**7**
		Part B	
Unit 5	**Productivity Measurement in Manufacturing Sector and Service Sector**	Productivity Measurement in Small Size, Medium Size and in Large size Organization considering KPA's, performance objectives and productivity indices calculations Need for measuring productivity in service sector, Productivity of an R & D System & Educational institution, methodology.	**7**
Unit 6	**Productivity Evaluation**	Productivity evaluation, productivity Evaluation models, evaluation tree model, successive, time period models, applications of different evaluation models, role of evaluating executives and their responsibilities.	**6**
Unit 7	**Productivity Improvement**	Causes of poor productivity, remedies of Poor productivity, methods to improve productivity, design of productivity improvement programs. Productivity improvement approaches, Principles, Techniques Productivity audit and control. Productivity measurement in International, National and Industrial level Total productivity Model	**6**
Unit 8	**Green Productivity**	Green productivity and ways to measure green productivity, Feedback tools and system, Integrated Management of Productivity Activities (IMPACT Model), Productivity Indicators, Integrated Approach to Productivity Measurement.	**6**

Text Books:

1. Prem Vrat, Sardana, G. D. and Sahay, B. S, Productivity Management , A Systems Approach, Narosa Publishing House, New Delhi, 1998.
2. Sumanth, David J., Productivity Engineering and Management, Tata McGraw Hill, New Delhi, 1990.
3. Hassan M.Z.P., "Productivity Models", A&N Printing, Chicago
4. Goodwin H.F., "Improvement in Productivity", Wiley, New York
5. Mali. P., "Improving Total Productivity", Wiley, New York 1978

6. Srinivas Gondhalekar and Uday Salunkhe Productivity Techniques, , Himalaya Publishing House 2007
7. Gerard Leone and Richard D. Rahn, Productivity Techniques, Jaico Book House
8. Sawhney S.C., Productivity Management: Concepts and Techniques, Tata McGraw Hill 1991

Additional Books:

1. Productivity Measurement in the Service Sector, Asian Productivity Organization (APO), Tokyo, 2001.
2. Productivity Measurement in the Retail and Food Industry, Asian Productivity Organization (APO), Tokyo, 2012.
3. Measuring Productivity, OECD Manual, Measurement of Aggregate and Industry Level Productivity Growth,
4. A Guide to Productivity Measurement, SPRING Singapore, 2011
5. A Measurement Guide to Green Productivity , 50 Powerful Tools to Grow your Triple Bottom Line, Asian Productivity Organization (APO), Tokyo, 2003.
6. International Labour Office, "Productivity and Quality Management", ,, International Labour Organization
7. Sudit, Ephraim F., "Productivity Based Management", Springer 1984

Subject Code: PEPE-131
Subject Name: Project Management

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:20%**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Professional Elective

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 dynamics of project management in manufacturing and service sectors.
2	Will be able to identify and select the best project
3	Understand the salient characteristics of Organizational Issues
4	Will be able to evaluate the project networks and project durations.
5	Will be able to evaluate risk analysis of an organization and projects
6	Will be able to evaluate project quality and purchase mechanisms

Detailed Contents

Sr. No	Title	Content Detail	Credit Hours
		Part A	
Unit 1	Basics of Project Management	Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles	**4**
Unit 2	Project Identification, Selection & Planning	:Introduction, Project Identification Process, Project Initiation, Pre-Feasibility Study, Feasibility Studies, Project Break-even point, Project Planning, Need of Project Planning, Project Life Cycle, Project Planning Process, Work Breakdown Structure (WBS)	**6**
Unit 3	Organizational Structure and Organizational Issues:	Introduction, Concept of Organizational Structure, Roles and Responsibilities of Project Leader, Relationship between Project Manager and Line Manager, Leadership Styles for Project Managers, Conflict Resolution, Team Management and Diversity Management, Change management	**6**
Unit 4	Project Network	Introduction, Development of Project Network, Time Estimation, Determination of the Critical Path, PERT Model, Measures of variability, CPM Model, Network Cost System, Resource Allocation, Scheduling, Project Cost Estimate and Budgets, Cost Forecasts	**7**
		Part B	
Unit 5	Project Risk Management:	Introduction, Risk, Risk Management, Role of Risk Management in Overall Project Management, Steps in Risk Management, Risk Identification, Risk Analysis, Reducing Risks	**7**
Unit 6	Project Quality, Purchase & Value Engineering	Introduction, Quality, Quality Concepts, Value Engineering, Project Management Information System (PMIS), Planning of PMIS, Design of PMIS, Purchase Cycle, Contract Management, Procurement Process	**6**
Unit 7	Project Performance Measurement, Evaluation and Execution:	Introduction, Performance Measurement, Productivity, Project Performance Evaluation, Benefits and Challenges of Performance Measurement and Evaluation, Controlling the Projects, Project Execution, Project Control Process, Purpose of Project Execution and Control	**6**
Unit 8	Project Close-out, Termination, Follow-up and PM Software:	Introduction, Project Close-out, Steps for Closing the Project, Project Termination, Project Follow-up, Advantages of Using Project Management Software, Common Features Available In Most of the Project Management Software, Illustration	**6**

Text Books:

1. K. Nagarajan Project Management New Age International, 2004

2. K. Nagarajan Elements **of** Project Management New Age International, 2005
3. Gupta Rajeev M. Project Management PHI Learning, 2011
4. R. B. Khanna Project Management PHI Learning Pvt. Ltd., 2011
5. Subhash Chandra Das Project Management and Control PHI Learning
6. R. C. Mishra Modern Project Management New Age International (P) Limited, Publishers, 2006
7. Erik Larson & Clifford Gray Project Management: The Managerial Process 7th Edition McGraw-Hill Education; 7th edition 2017
8. Joseph Heagney Fundamentals of Project Management 2016 AMACOM; 5th edition

Additional Books:

1. A Guide to the Project Management Body of Knowledge 6th Edition, Project Management Institute
2. Harold Kerzner Project Management: A Systems Approach to Planning, Scheduling, and Controlling 11th Edition Wiley 2013
3. Paul Roberts Guide to Project Management: Getting it right and achieving lasting benefit 2013 Wiley; 2nd edition 2013
4. Terry Schmidt Strategic Project Management Made Simple: Practical Tools for Leaders and Teams, Wiley 2009:

SUBJECT CODE: PEPE-132
SUBJECT NAME: ESTIMATING AND COSTING

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 6th	**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):** 3hr
Total Marks: 100	**Status:** Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Student will be able to estimates the projects
2	Students will be able to calculate the Inventory cost of an organization
3	Students will be able to calculate the Material and Labor cost of an organization
4	Students will be able to calculate the Break Even Point of an organization and depreciation value of products of organization
5	Student will be able to evaluate the cost of workshop operations and process
6	Student will be able to evaluate design and develop budgets and contracts for an organization

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	Estimating	Estimating: Importance and aim, objectives, functions, organization of Estimating department, Estimating Procedure, Constituents of Estimation, Difference between Estimating and Costing, Different types, Methods adopted for estimation, Use of Standard data, parameter estimating, statistical estimating, feedback systems, importance, purpose and functions of estimating, Mensuration.	**5**
Unit 2	Costing:	Elements of Costs, Costing methodology for raw materials, Products and Services, Nature of Costs Direct, Traceable and Non traceable, Wastage. Determining of Cost of raw materials, manufactured products, labor, indirect expenses, and methods of overhead allocation. Costing-Definition, aims, procedure for Costing, types of costs, Costing controls, Overheads, Profit and Pricing Policy.	**6**
Unit 3	Inventory Control	Cost factors in inventory control, inventory carrying cost, ordering cost, EOQ, lead time, safety stock, reorder level, minimum level, max. level, Types of inventory control systems-Perpetual inventory control system, ABC method etc. Valuation of materials issued from store-FIFO, LIFO, etc.	**6**
Unit 4	Material & Labor Costing	Introduction, factors influencing wage rate, methods of wage payments for direct and indirect labour time wage system, piece rate system, Wage incentives: different plans, Material – Direct material, indirect material -Labour direct, indirect labour costs Expenses – direct, indirect expenses Classification of expenses Components of cost Determination of selling price	**6**
		Part B	
Unit 5	Depreciation & Break Even Analysis	Introduction, purpose, methods for calculating depreciation-straight line method, Diminishing balance method, sum of year digit method, machine hour basis method, Break even analysis: Introduction, assumptions in break even analysis, important terms and definitions, calculation of breakeven point, advantages and limitations.	**6**
Unit 6	Estimation In Workshop Cost	Calculation of volume of machined component operation time calculation for turning, knurling, facing, drilling, boring, reaming, threading, milling, tapping, shaping, cutting, various grinding operations, planning etc. Pattern cost estimation, estimation of foundry costs forging process estimation procedure, estimating losses and time. Welding Preparation cost, Actual welding cost, finishing on cost, power cost, factors affecting welding cost. Gas cutting cost Sheet Metal Work: Operations in sheet metal work, joints, blank layout and size, estimation of time, capacity and types of processes , Labor cost Material cost Overhead Cost Maintenance Cost.	**7**
Unit 7	Budgetory And Engineering Contracts	Budget, objectives, classification of budgeting, Budgetory control, securing flexibilities of budgeting, limitation of budget. Operational and capital budgets, Cash flow schedules, Estimating cost, preparing an annual budget for the Engg. Department. Introduction, Types of contracts and similarities. Terms of payments, firm price contracts, cost reimbursable contracts, Target of cost contracts, schedule of rate contracts, bill of quantities contracts, compound contracts, contract policy, legal rights and commercial interests	**6**
Unit 8	Process	Process & Job Costing Characteristics, Principles, Procedure for Process costing. Wages-types,	**6**

	Costing & Accounting	Incentives-types, Budget-Types, Accounting terminology like, book value, Net Present Value, Work in progress, Gross Domestic Product (GDP), balance sheet, Tendering manual tendering and e-tendering.	

Text Books:

1. Sinha B.P., "Mechanical Estimating and Costing", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1995.
2. Banga T.R. and Sharma S.C., "Mechanical Estimating and Costing", Khanna Publishers, Delhi, 2001.
3. Sharma S.K. & Sharma Savita,"industrial Engineering & Operations management",Kataria publishers, 2010.
4. Kesoram R., "Process Planning & Cost Estimation", New Age International Pub. New Delhi, 1995.
5. M.Adithan Process planning & cost estimation New age International

Additional Books:

1. Khanna, O.P, "Industrial Engineering and Management", Dhanpat Rai & Publication, 2007.
2. Handbook of Engineering Management- Edited by Dennis Lock, Butterwork & Heinemanky Ltd
3. T.R.Banga and S.C.Sharma Industrial Organisation and Engineering Economics Khanna publishers
4. Singh and Khan Mechanical costing and estimation. Khanna Publishers

SUBJECT CODE: PEPE-153
SUBJECT NAME: ADVANCE ENGINEERING MATERIALS

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Apply knowledge of Mechanical Material Properties in designing specific products and experiments
2	Able to use Bio Material for the manufacturing of better human friendly product
3	Apply knowledge of ceramics properties in designing specific products and experiments
4	Able to make better utilization of electrical and electronics materials for designing new products
5	Able to use Nano Materials for the betterment of human race
6	Able to know about the safety and dangers of Nuclear Materials

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Bio Materials**	Introduction of Biomaterials, Types of Biomaterials, Bioactive Ceramics, Bioactive Glass, Biocompatibility Collagen Hydrogel Peptide Protein Stem Cells, Nontoxicity, Synthetic Biomaterials, Immunomodulation Biomaterials, Properties of Biomaterials, Application of Biomaterials	**7**
Unit 2	**Ceramics**	Introduction Of Ceramics, Types Of Ceramics, Advanced Engineering Ceramics Crystalline Ceramics, Noncrystalline Ceramics, Properties Of Ceramics Refractory, Hardness, Toughness, Dielectric Constant, Ceramography Mechanical Properties, Electrical Properties, Thermal Properties Optical Properties Manufacturing Of Ceramics. Application of Ceramics	**7**
Unit 3	**Electrical & Electronics Materials**	Introduction of Introduction of Electronic & Optical Semiconductors, Conducting Materials, Semi-conducting Materials, Insulating materials, Natural insulating materials, Magnetic Materials, Soft Magnetic Materials, Special Materials properties and application of Electrical & Electronics Materials	**5**
Unit 4	**Mechanical Alloys**	Introduction to Mechanical Alloys Material, types of Alloys, Methods of Alloying Properties of Alloys and Application of Alloys	**5**
		Part B	
Unit 5	**Polymers & Plastics**	Introduction of Polymers & Plastic, difference between polymers and plastics, types and classification of polymers and plastics, degree of crystallinity, tacticity, Polymer chirality Thermal Electrical Optical and Mechanical Properties of Polymers and Plastics, Applications of Polymers and Plastics, Methods of Manufacturing of Polymers	**7**
Unit 6	**Nano Materials**	Introduction Of Nano Materials, Sources Of Nano Materials, Engineered, Incidental And Natural, Types Of Nano Materials, Synthesis Of Nano Materials, Characterization Of Nano Materials Properties Of Nano Materials And Application Of Nano Materials	**7**
Unit 7	**Nuclear Materials**	Introduction Of Nuclear Materials Types Of Nuclear Materials, Uranium, Plutonium, And Thorium, Enriched Uranium (U-235), Uranium-233, And Plutonium-239, Safety Aspects For Using Nuclear Materials Applications Of Nuclear Materials.	**5**
Unit 8	**Special Materials**	Light Materials, Carbon Materials, Amorphous Materials High-Temperature Superconductivity Materials , Meta Materials, Carbon Nano Tubes, Quantum Dots, Silicene, Super Alloy, Synthetic Diamond	**5**

Text Books:

1. SK Bhattacharya, Electrical and Electronic Engineering Materials by Khanna Publishers, New Delhi
2. Grover and Jamwal ,Electronic Components and Materials Dhanpat Rai and Co., New Delhi
3. C. Mauli Agrawal, Joo L. Ong, Mark R. Appleford and Gopinath Mani "Introduction to Biomaterials: Basic Theory with Engineering Applications",Cambridge University Press 2013
4. Joyce Y. Wong, Joseph D. Bronzino, and Donald R. Peterson " Biomaterials: Principles and Practices" CRC Press 2012
5. Joshua Pelleg Mechanical Properties of Ceramics Springer, 2014
6. Daniel L. Schodek , Paulo Ferreira , Michael F. Ashby and Butterworth-Heinemann "Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers and Architects" 2009
7. K. Linga Murty and Indrajit Charit "An Introduction to Nuclear Materials: Fundamentals and Applications" Wiley VCH 2012

Additional Books:

1. SM Dhir Electronic Components and Materials by, Tata Mc Graw Hill, New Delhi
2. Marc André Meyers and Po-Yu Chen "Biological Materials Science: Biological Materials, Bioinspired Materials, and Biomaterials"Cambridge University Press 2014
3. Karl Whittle "Nuclear Materials Science" IOP Publishing Ltd 2016

SUBJECT CODE: PEPE-154
SUBJECT NAME: ADVANCE CERAMICS

Programme: B.Tech. (PE)	**L: 4 T: 0 P: 0**
Semester: 6	**Teaching Hours: 48**
Theory/Practical: Theory	**Credits: 4**
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 10%**
External Marks: 60	**Duration of End Semester Exam (ESE): 3hr**
Total Marks: 100	**Status: Professional Core**

Additional Material Allowed in ESE: Scientific Calculator

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

CO#	Course Outcomes COS
1	**Knowledge of the crystal structures of a wide range of ceramic materials.**
2	**Introductory knowledge on the processing of bulk ceramics**
3	**Understand the properties of ceramics and their structural origin.**
4	**Given a ceramic component be able to calculate its intrinsic and extrinsic defect populations.**
5	**Knowledge of the structure of clays, minerals, and glasses**
6	**Applications of ceramic materials in structural, biological and electrical components.**

Detailed Contents

Part A			
S. No.	**Title**	**Content details (Part A)**	**Credit Hrs.**
Unit 1	**Introduction**	Definition & scope of ceramics and ceramic materials, classification of ceramic materials – conventional and advanced ceramics.	**4**
Unit 2	**Refractories**	Definition of refractory, properties of refractories, classification of refractory, manufacturing process, basic areas of applications.	**4**
Unit 3	**Ceramic compounds**	Chemistry of ceramics, Silicate ceramics and non,silicate ceramics, Silicate ceramics, Non,silicate ceramics. Structural ceramics, Functional ceramics, Introduction to Ceramics and clays	**7**
Unit 4	**Materials Selection**	Selection of Materials, Introduction, First Stage, Performance Requirements, Functional Requirements, Processability Requirements, Cost, Reliability, Service Conditions, Quantitative Methods, Material Properties, Cost per Unit Property, Ashby's Material Selection ,Computer,Based Selection, Second Stage, Weighted Properties, Digital Logic Method , A Case Study ,Material Performance Requirements ,Initial Selection ,Alternate Solutions, Optimum Solution.	**9**
		Part B	
Unit 5	**Cement & Concrete**	Introduction, Basic Concrete construction, Fiber,Reinforced Concrete, Carbon and Organic,Based Fibers, Glass Fiber,Reinforced Concrete, Current Research Topics, Refractory Concretes.	**7**
Unit 6	**New Developmen,ts in Ceramic and Refractory Fields**	Introduction, New Developments in the Ceramic Field, Production, Oxide Ceramics, Non,oxide Ceramics, Ceramic,Based Composites, Firing, Firing Environments, Finishing, Future Developments, New Developments in the Refractory Field, Applications of Monolithic Refractories, Ferrous Metallurgy, Petrochemical Applications, Cement Plant Applications, Incinerators, Nonferrous Metallurgy.	**9**
Unit 7	**Defects in Ceramic**	Defects in Ceramics, Introduction, Point Defects, Stoichiometric Defects, Nonstoichiometric Defects, Extrinsic Defects, Point Defects and Their Notation, Interstitial Atoms, Misplaced Atoms, Free Electrons, Electron Holes, Kroger–Vink Notation, Defect Reactions, Stoichiometric Defect Reactions, Nonstoichiometric Defects, Extrinsic Defects, Electronic Defects, Linear Defects, Planar Defects, Grain Boundary Structure, Impurity Segregation at Grain Boundaries	**8**

Text Books

1. Michel W Barsoum , "Fundamentals of Ceramics", Institute of Physics Publishing, The Institute of Physics, London
2. W. D. Kingery, H. K. Brown and D. R. Uhlmann "Introduction to Ceramics", , John Wiley & Sons.
3. V. V. Vargin, "Technology of enamels", MacLaren Publication 1967.
4. W E Worrall, "A book of ceramic raw materials", Elsevier Science Publication.
5. A. R. West, "Solid State Chemistry and its Applications", John Wiley & Sons (Asia) Pte. Ltd.
6. A. O. Surendranathan, "An Introduction to Ceramics and Refractories", Taylor & Francis Group, CRC Press.

Additional Books:

1. Felix Singer, "A book of industrial ceramics", Springer Publication.
2. J. H. Chester "Refractories" , Maney Publishing.
3. William D. Callister, "Materials Science and Engineering,An Introduction", John Wiley & Sons, Inc., New York.
4. James F. Shackelford, Robert H. Doremus, "Ceramic and Glass Materials", Springer.

SUBJECT CODE: PEPE-155
SUBJECT NAME: MATERIAL PROCESSING

Programme: B.Tech.(PE)	**L: 4 T: 0 P: 0**
Semester: 6	**Teaching Hours: 48**
Theory/Practical: Theory	**Credits: 4**
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 10%**
External Marks: 60	**Duration of End Semester Exam (ESE): 3hr**
Total Marks: 100	**Status: Professional Core**

Additional Material Allowed in ESE: Scientific Calculator

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

CO#	Course Outcomes COS
1	Able to understand and apply the concept of solidification in real life problems
2	Able to understand and apply the concept of evaporation in real life problems
3	Able to process the powder metallurgy in industrial organizations
4	Able to synthesis the alloys for the betterment of human race
5	Able to utilize the thin film deposition method of processing of materials
6	Able to synthesis the biological materials or alloys for the betterment of human race

Detailed Contents

Part A			
S. No.	**Title**	**Content details (Part A)**	**Credit Hrs.**
Unit 1	Solidification from Liquid and Vapor Phase	Nucleation and growth, Homogeneous and heterogeneous nucleation, Interface stability, Development of micro structure, Faceted and no faceted structure, Super cooling, Equilibrium phase diagrams, Eutectic and peritectic solidifications and their microstructures, Foundry techniques such as sand casting, Permanent mould casting, Investment casting and die casting, Casting defects and their inspection.	**6**
Unit 2	Evaporation,	Evaporation, precipitation, Solution growth, Nucleation, Rate of crystallization, Superstaturation, Top seeded solution growth, sol-gel techniques, high temperature solution, Hydrothermal, Solvothermal methods, Ammonothermal method, Glycothermal, Melt methods- super cooling, Czechorlskii methods, Skull melting	**6**
Unit 3	Ceramic/ Powder Processing	Synthesis of common ceramic powders such as Al2O3, ZrO2, Si3N4, and SiC, Powder characterization, Binders, Lubricants, Deflocculates and flocculants as processing aids, shaping techniques such as powder compaction, Extrusion, Injection moldings, Slip casting, Solid state and liquid phase sintering. Introduction to Powder Processing; Powder characterization, Powder Fabrication; Powder Consolidation, Powder compaction; Sintering	**7**
Unit 4	Synthesis of Alloys	Synthesis of alloys, Heat treatment of high carbon steels and Al- alloys, Ageing of Aluminum alloys, Electro deposition, plating and refining, Anodizing, Surface modification using fluidized bed.	**7**
		Part B	
Unit 5	Metal Working	Stress and Strain Analysis and Yield Criteria, Plastic Instability and Superplasticity, Mechanics of metal working, Friction and Formability and Case Studies.	**7**
Unit 6	Thin film deposition	Introduction to Vacuum Technology; PVD, Introduction to Plasma, PVD-Sputtering, Chemical Vapor Deposition, Special techniques and applications.	**7**
Unit 7	Biological Synthesis	Biological synthesis, Biomimetic method, bacterial synthesis of nanoparticles; Electrochemistry - solvent selection, apparatus, deposition, growth of thin films, coatings, examples; Multi-energy processing - Mechanochemical; Sonochemical; Photochemical; Biochemical, Microbial, Organic synthesis. Growth of organic crystals.	**8**

Text Books

1. R.A. Laudise Growth of Single Crystals, Prentice-Hall (1973).
2. Byrappa, R. Fornari, T. Ohachi, H. Klapper, Growth and Characterization of Technologically Important Crystals, K Allied Sciences, New Delhi (2003).
3. Chalmner, B., Principles of Solidification, Wiley 1977
4. Degarmo, E.P., Black, J.T. Kosher R.A, Materials and Processing in Manufacturing, PHI 1986
5. Fleming, M.C., Solidification Processing, McGraw Hill 1974
6. Richerson, B.W., Modern Ceramic Engineering: Properties, Processing and Use in Design, Marcel Dekker 1983.
7. Brian Cantor, K. O'Reilly Solidification and Casting, IOP Publications, 2003

8. George E. Totten, Hong Liang.Surface Modification and Mechanisms: Friction, Stress and Reaction Engineering, Marcel Dekker, Inc., 2005
9. A. Upadhyaya, G.S. Upadhyaya, Powder Muetallurgy: Science Technology and Materials, 2011
10. G.E. Dieter, Mechanical Metallurgy, McGraw Hill, Inc., London, UK, 1992.

Additional Books:

1. Martin, D.H. & Jones, Polymer Processing, Chapman and Hall1989
2. Springer Handbook of Crystal Growth by Springer 2010
3. Springer Handbook of Nanotechnology2nd Edition by Springer 2009
4. K. Byrappa and T. Ohachi, Handbook of Crystal Growth, Springer-Verlag 2003
5. S. H. Avner Introduction of Physical Metallurgy, McGraw Hill, 1987-.
6. W. Kurz and D.J. Fisher, Fundamentals of Solidification, CRC Press, 1998.

SUBJECT CODE: PEPE-156
SUBJECT NAME: AERO SPACE MATERIALS

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 6th	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** Nil
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Elective

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes COS
1	Identify appropriate aircraft materials for a given application
2	Understand the Heat Treatment processes of aircraft metals and alloys
3	Apply the knowledge about the mechanical behavior of different aircraft & aerospace materials.
4	Explain the applications of Aluminum alloys, Ceramics and Composites Materials.
5	Explain the properties of super alloys, ablative materials and high energy material.
6	Understand material corrosion process and apply prevention technique.

Detailed Contents:

S. No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	Introduction to Aircraft Materials	General properties of materials, Definition of terms, Requirements of aircraft materials, Testing of aircraft materials, Inspection methods, Application and trends in usage in aircraft structures and engines, Selection of materials for use in aircraft.	**4**
Unit 2	Super Alloys	General introduction to super alloys, Nickel based super alloys, Cobalt based super alloys, and Iron based super alloys, manufacturing processes associated with super alloys, Heat treatment and surface treatment of super alloys.	**6**
Unit 3	Composite Material	Definition and comparison of composites with conventional monolithic materials, Reinforcing fibers and Matrix materials, Fabrication of composites and quality control aspects, Carbon-Carbon Composites production, properties and applications, inter metallic matrix composites, ablative composites based on polymers, ceramic matrix, metal matrix composites based on aluminum, magnesium, titanium and nickel based composites for engines	**6**
Unit 4	Polymeric Materials Plastics Ceramics & Glass	Knowledge and identification of physical characteristics of commonly used polymeric material: plastics and its categories, properties and applications; commonly used ceramic, glass and transparent plastics, properties and applications, adhesives and sealants and their applications in aircraft. Ablative Materials Ablation process, ablative materials and applications in aerospace.	**5**
		Part B	
Unit 5	Aircraft Wood, Rubber, Fabrics & Dope and Paint	Classification and properties of wood, Seasoning of wood, Aircraft woods, their properties and applications, Joining processes for wood, Plywood; Characteristics and definition of terminologies pertaining to aircraft fabrics and their applications, Purpose of doping and commonly used dopes; Purpose of painting, Types of aircraft paints, Aircraft painting process.	**5**
Unit 6	High Energy Materials	Materials for rockets and missiles. Types of propellants and its general and desirable properties, insulating materials for cryogenic engines. Types of solid propellants: Mechanical characterization of solid propellants using uni-axial, strip-biaxial and tubular tests.	**5**
Unit 7	Non-ferrous materials in aircraft construction	Aluminum and its alloys: Types and identification. Properties - Castings – Heat treatment processes - Surface treatments. Magnesium and its alloys: Cast and Wrought alloys – Aircraft application, features specification, fabrication problems, Special treatments. Titanium and its alloys: Applications, machining, forming, welding and heat treatment, Copper Alloys.	**6**
Unit 8	Ferrous materials in aircraft construction	Steels : Plain and low carbon steels , various low alloy steels, aircraft steel specifications, corrosion and heat resistant steels, structural applications. Maraging Steels: Properties and Applications.	**6**
Unit 9	High Temperature Materials Characterization	**:** Classification, production and characteristics, Methods and testing, Determination of mechanical and thermal properties of materials at elevated temperatures, Application of these materials in Thermal protection systems of Aerospace vehicles, High temperature material characterization.	**5**

Text Books:

1. Titterton G F, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition, 1998,

2. H Buhl, Advanced Aerospace Materials, Springer, Berlin 1992,
3. Balram Gupta, Aerospace material Vol. 1,2,3,4 ARDB , S Chand & Co ,2009,
4. Parker E R, Materials for Missiles and Space, McGraw-Hill Inc., US, 1963,
5. C G Krishnadas Nair, Handbook of Aircraft materials, Interline publishers, Bangalore,1993
   Polmear, I. J., Light Alloys: From Traditional Alloys to Nano crystals, 4th ed., Elsevier 2005
6. Reed, R. C., The Super alloys: Fundamentals and Applications, Cambridge Univ. Press 2006
7. Cantor, B., Assender, H., and Grant, P. (Eds.), Aerospace Materials, CRC Press 2001

Additional Books:

1. Hill E T, The Materials of Aircraft Construction, Pitman London.
2. ASM Speciality Handbook: Heat Resistant Materials, ASM International (1997).
3. Kainer, K. U. (Ed.), Metal Matrix Composites, Wiley-VCH (2006).
4. Gauthier M. M. (1995). Engineered Materials Handbook Materials Park, OH: ASM International. [Comprehensive overview on engineering plastics, elastomers, composites, ceramics and ceramic matrix composites.]
5. Boyer R., Welsch G., and Collings E. W. (1994). Materials Properties Handbook: Titanium
6. alloys. Materials Park, OH: ASM International. [Extensive coverage of Ti alloy data.]
7. Davis J. R. (1997). ASM Speciality Handbook Heat Resistant Materials. Materials Park,
8. OH: ASM International. [Comprehensive overview on super alloys, ferrous and non-ferrous heat-resistant materials.]

Open Professional Elective Subjects

Subject Code: OEPE-101

Subject Name: Industrial Engineering

Programme: B.Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 6	**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	**Status:** Professional Elective

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

Sr. No	Title	Content Detail	Credit Hours
		Part A	
Unit 1	**Introduction:**	Definition and scope of industrial engineering, role of an Industrial engineer in industry, functions of industrial engineer, qualities of an industrial engineer	**3**
Unit 2	**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**
Unit 3	**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**
Unit 4	**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**
		Part B	
Unit 5	**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**
Unit 6	**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**
Unit 7	**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**
Unit 8	**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**

Text Books:

1. Martand Telsang "Industrial Engineering and Production Management", S. Chand 2006
2. Hicks, "Industrial Engg. And Management ", Tata McGraw Hill.
3. Suresh Dalela and Saurabh, "Work Study and Ergonomics", Standard Publishers.1995
4. R. Bernes, "Motion and Time Study", John Wiley and sons. 1980
5. D. J. Oborne, "Ergonomics at work", John Wiley and sons.1982
6. Dwivedi, D.N., Managerial Economics, Vikas Publishing House Pvt. Ltd. 2015
7. Chan S. Park "Contemporary Engineering Economics" Prentice Hall of India 6th Edition 2016

Additional Books:

1. Donald G. Newman and Jerome P. Lavelle "Engineering Economics and Analysis" Oxford University Press 10th Edition 2019
2. P.N. Chopra Principles of Economics: (Kalyani Publishers). 2012
3. O.P. Khana "Industrial Engineering and Management", Dhanpat Rai Publications 2010
4. Salvatore, D. and Srivastav, R., Managerial Economics: Principles and Worldwide Applications, Oxford University Press. 2012
5. Work study by ILO Oxford & IBH Publishing Co Pvt. Ltd, 3rd Revised edition edition 2015

Subject Code: OEPE-102
Subject Name: Human Engineering

Programme: B.Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 6	**Teaching Hours:** 36
Theory/Practical: Theory	**Credits:** 3
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: Nil**
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status: Professional Elective**

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	**Course Outcomes COS**
1	Student will be able to analysis the psychology of human behavior as it relates to workplace safety.
2	Student will be able to identify ergonomic hazards, recommend appropriate controls.
3	Student will be able to analysis the anatomical and mechanical structure of the human body and anthropometry techniques available to engineers.
4	Student will be able to analysis the concept of the office workstation & ergonomic design of the office workstation.
5	Student will be able to investigate human senses in general and special focus on the vision sense and the auditory sense.
6	Student will be able to analysis the work related disorders & industrial safety aspects.

Detailed Contents

Sr. No	Title	Content Detail	Credit Hours
		Part A	
Unit 1	**Ergonomics**	Introduction to Ergonomics, Human Factors and Ergonomics, Application and History of Ergonomics, Effectiveness and Cost, Effectiveness of Ergonomics, micro, and macro, ergonomics.	**2**
Unit 2	**Systems of the Human Body**	Anthropology, Anatomy of Spine and Pelvis Related to Posture, Biomechanics, Muscular System, Ergonomics and the Musculoskeletal System, Costs of Back Injuries	**4**
Unit 3	**Muscular Work & Nervous Control of Movements**	Types of Muscular Work, Muscular Fatigue, Types of Muscle Contractions, Measurement of Muscular Strength	**5**
Unit 4	**Anthropometry**	Introduction, Terminology, Myth of the Average Human, Principles of Universal Design, Anthropometric Measurements	**5**
		Part B	
Unit 5	**Design of Work places & Hand Tools**	Work Design Analysis, Designing for Hand Use, Types of Injuries and Disorders, Theories of healthy standing and sitting, free posturing, ergonomics design of the office computer workstation, Lifting Guidelines,	**5**
Unit 6	**Work, Related Disorders**	Types of Work, Related MSD's, Task, related Factors, Personal Risk Factors, Impact on Industry, Ergonomic Program for WMSD's, Industrial Environmental Disorders and Climate and Environmental Disorders, Workplace Stress, Mental Fatigue/Shiftwork Fatigue	**4**
Unit 7	**Industrial Safety & Ergonomics**	Concept of Safety, Accidents & Hazards, Causes & effects of Industrial accidents, Cost of Accidents, Impact of Accidents on employees, Physical Hazards, Chemical Hazards, Biological & Ergonomically Hazards, Occupational Health &Toxicology, Occupational Physiology.	**4**
Unit 8	**Information Ergonomics, Controls, & Displays**	Mental Workload Measurement, Primary and Secondary Task Performance, Controls and Displays (Types), Control Layout and Design	**4**
Unit 9	**Human Senses**	Body Sensors, Vision Sense, Color Theories, Auditory Sense, Smelling Sense, Tasting Sense, Touching Sense, Human Body Interaction with Environment, Thermo regulation of Human Body, Working in Polluted Air, Working at High Altitude, Effect of Vibration on Human Body	**4**

Text Books:

1. Bush, P. M. "Ergonomics, Foundational Principles, Applications, and Technologies" CRC Press,Taylor & Francis Group 2011
2. Konz S. A. & Johnson S., "Work Design: Industrial Ergonomics". 6th Edition, Holcomb Hathaway Pub., 2004
3. Konz SA & Johnson S. "Work Design: Occupational Ergonomics". 7th Edition, Holcomb Hathaway Pub., 2008
4. Bhattacharya and McGlothlin, "Occupational Ergonomics , Theory and Applications", Second Edition CRC Press,Taylor & Francis Group 2012

5. B. M. Pulat "Fundamentals of Industrial Ergonomics" Waveland Pr. Inc. 1997
6. M. I. Khan "Industrial Ergonomics" by PHI Publisher 2010 2nd Edition
7. Robert Bridger "Introduction to Human Factors and Ergonomics" CRC Press 2017

Additional Books:

1. Phillips, C. A. "Human Factors Engineering" 1st edition, Wiley 1999
2. *Mark R. L. & Steven J. L. "Introduction* to Human Factors and Ergonomics for Engineers" CRC Press 2012
3. Bridger, Robert S. "Introduction to Ergonomics", 3rd edition, CRC Press, Taylor & Francis Group 2009
4. Stack, T., Ostrom, L. T. & Cheryl A. W. "Occupational Ergonomics: A Practical Approach" Wiley, 1 ed. 2016
5. Reese C. D. "Occupational Health and Safety Management: A Practical Approach", Third Edition 3rd Edition CRC Press 3 edition 2015