Elective Subjects Design & Manufacturing Engineering Group

7^{th} Semester

SUBJECT CODE: PEPE-109
SUBJECT NAME: NON DESTRUCTIVE TESTING

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective III

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos)
1	Describe the appropriate NDT technique as per requirement.
2	Apply various process parameters and control the NDT process for the desired output parameters.
3	Find the internal flaws in the material by NDT and take measures to eliminate them.
4	Solve various problems encountered like leakage, cracks, blowholes etc with the manufacturing process by analyzing the data.
5	Make use of modern tools and softwares for analyzing and solving real life problems.
6	Introduce environmental friendly solutions to achieve organizational sustainability.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Radiography**	Principle of radiography, types of radiography, equipments for neutron radiography, x-ray radiography, equipments for x-ray radiography, advantages and applications of fluoroscopy and photo fluoroscopy.	**6**
Unit 2	**Electromagnetic methods**	Principle of electromagnetic testing, mathematical analysis, flaw detection in conductors, various types' of instruments used and advantages of various electromagnetic methods for crack detection etc.	**8**
Unit 3	**Ultrasonic methods**	Principle of ultrasonic testing, generation of ultrasonic waves, equipment details for ultrasonic checking, methods of wave propagation, methods of flaw detection, various methods of ultrasonic testing, advantages of ultrasonic methods for flaw detection and crack location.	**10**
		Part B	
Unit 4	**Holography**	Principle of holography, method of holographic recording, method of holographic reconstruction, advantages of this technique and applications of holographic methods for non-destructive testing.	**8**
Unit 5	**Liquid penetrant testing**	Principle of liquid penetrates testing, types of dyes and penetrants used in this testing technique and application of liquids for detecting sub-surface defects.	**6**
Unit 6	**Magnetic particle testing**	Principles of magnetic particle testing, details of equipments used and methods of crack detection by magnetic particle testing Hardness testing: Brinnel hardness testing, Rockwell hardness tests, shore hardness testing, Vicker hardness testing and theory behind various hardness testing methods.	**10**

Text Books:

1. Malhotra, "Handbook on Non-destructive Testing of Concrete", Publisher: CRC Press, 2002.
2. Mix, Paul E, "Introduction To Nondestructive Testing: A Training Guide", John Wiley and Sons Ltd, 1999.
3. Blitz and Jack, "Electrical and Magnetic Methods of Nondestructive Testing", Institute of Physics Publishing, 2001.

Additional Books:

1. Achenbach, J D, "Evaluation of Materials and Structures by Quantitative Ultrasonics", Springer-Verlag Vienna, 2001.
2. Henrique L M, "Non Destructive Testing and Evaluation for Manufacturing and Construction", Hemisphere Publishers, New York, 2001.

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SUBJECT CODE: PEPE-110

SUBJECT NAME: COMPUTER AIDED DESIGN & MANUFACTURING

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective III

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos)
1	Describe the role of computer systems in design and manufacturing.
2	Analyze the concept of geometric models and geometric transformations in manufacturing systems.
3	Design various part programs in NC/DNC/CNC systems.
4	Generate process plans with the help of machinability data systems.
5	Apply the concept of group technology and coding system in manufacturing systems.
6	Design plant layout with the help of FMS.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction to CAD/CAM**	Introduction to CAD/CAM and its role in Product design and development cycle; CAD/CAM system and its evaluation criteria ; advanced input and output devices, Display devices; Functions of a graphics package and Graphics standard GKS; IGES and STEP; Application areas of CAD.	**4**
Unit 2	**Geometric Modeling**	Need and types of Geometric Modeling: Wireframe; surface and solid modeling; Geometric Modeling Techniques: Boundary Representation (B-rep); Constructive Solid Geometry (CSG); Parametric Modeling Technique ; Mass; volumetric properties calculations; concepts of hidden-line removal and shading; Mechanical Assembly Kinematics analysis and simulation.	**7**
Unit 3	**Geometric Transformations**	Overview of Mathematics preliminaries; matrix representation of 2 and 3 dimensional transformation for translation; scaling; rotation about principal axes; mirror imaging about a plane; principal axes and origin; Concatenation of transformation matrices. Applications of geometric transformations.	**6**
Unit 4	**Representation of curves and surfaces**	Non-parametric and parametric representation of curves; Parametric representation of Hermit Cubic; Bezier curves; Uniform and Non uniform B-spline curves; Surface and its analysis. Representation of Analytical and synthetic surfaces (Bilinear Surface; Coons Surface Patch; Bi-cubic Surface Patch; Bezier Surface; Bspline surface).	**8**
		Part B	
Unit 5	**NC/CNC/DNC Machine Tools**	NC machine tools- basic components coordinate systems; features of NC machine tools. Computerized Numerical Control (CNC): Tooling for NC machines - tool presetting equipment; flexible tooling; tool length	**8**

		compensation; tool path graphics; NC motion control system; Direct Numerical Control. Adaptive control in machining system.	
Unit 6	**CNC Part Programming**	Basic terminology of Parts programming; Block format; Coordinate system; fixed/floating zero; types and classification of machine codes; Manual part programming; Computer aided and computer assisted part programming	**6**
Unit 7	**Group Technology (GT)**	Basic fundamentals of Group Technology; Part families; part classification and coding system: Group technology machine cells: Advantages of Group Technology.	**6**
Unit 8	**Computer Aided Process Planning**	Introduction and benefits of CAPP. Types of CAPP systems; machinability data selection systems in CAPP	**3**

Text Books:

1. Groover Mikell P., Emory W. Zimmer's, "CAD/CAM: Computer-Aided Design and Manufacturing", PHI, 2nd Edition, 1984.
2. Bedworth D. D., Henderson M. R& P.M. Wolfe, "Computer Integrated Design and Manufacturing", Tata McGraw Hill,2nd Edition, 1991.
3. Ibraham Z., "CAD/CAM - Theory and Practice", Tata McGraw Hill, 2nd Edition, 2009.

Additional Books:

1. Rao P. N, "CAD/CAM Principles and Applications", Tata McGraw Hill,2nd Edition, 2004.
2. Elanchezhian C., Selwyn Sundar T., Shanmuga Sunder G., "Computer Aided Manufacturing",Laxmi Publication, 2nd Edition,2007.

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SUBJECT CODE: PEPE-113

SUBJECT NAME: PLASTIC AND CERAMICS TECHNOLOGY

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective IV

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos)
1	Describe mechanical & physical properties of plastics.
2	Carry out various polymer processing techniques.
3	Use mechanical fastening, vibration welding, induction welding methods for joining and assembling of plastics.
4	Design moulded products, wall thickness, fillets etc. for plastic and ceramic components.
5	Demonstrate casting of acrylics, polyesters etc.
6	Describe the industrial application and limitations of ceramic processing techniques.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Glossary of Terms Associated with Plastic Engineering**	Thermoplastics and thermo sets, their properties. Mechanical & physical properties of plastics. Selection of plastics for different uses and their limitations.	**6**

Unit 2	**Polymer Processing Techniques**	Extrusion, compression and transfer moulding. Injection moulding, blow moulding, thermoforming, rotational moulding, calendaring, Bag moulding reaction moulding.	**7**
Unit 3	**Joining and assembling of plastics**	Mechanical fastening, fusion bonding, hot-gas welding, vibration welding, solvent bonding, ultrasonic welding, induction welding, dielectric welding	**6**
Unit 4	**Design of moulds for thermoset**	Compression moulds, transfer moulds, injection moulds, runner and gate design, vents	**4**
Part B			
Unit 5	**Design**	Design of moulded products, wall thickness, fillets and radii, ribs, under, cuts, drafts, holes, threads, inserts parting lines, surface treatment mould design for avoiding warpage.	**7**
Unit 6	**Standards for Tolerances on moulded articles**	Introduction, design consideration, general tolerances, direct tolerances, tolerancing of draft angles, moulding shrinkage, moulding material stiffness.	**6**
Unit 7	**Casting**	Casting of acrylics, phenolics and epoxies, polyesters and nylons.	**4**
Unit 8	**Ceramics and non-ceramic phases**	Common ceramics, Crystal structures. Binary and ternary ceramics. Silicates, clays, graphite and carbides, General Properties of ceramics. Deformation and creep. Toughening, Mechanics. Ceramic processing techniques, material selection for general applications and industrial application, limitations of ceramics.	**8**

Text Books:

1. A.W. Birley, B. Howarth, "Mechanics of plastics processing properties",Hana Publisher edition, 1991.
2. J.E. Mark, R. West, H.P. Allocock, "Inorganic Polymers", Prentice Hall, 1992.
3. Fried ,"Poly. Science and Technology", Prentice Hall

Additional Books:

1. Charles Harper, "Handbook of Plastics Technologies", McGraw-Hill.
2. Plastic Engg. Data Book, Glanill.

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SUBJECT CODE: PEPE-114

SUBJECT NAME: Finite Element Method

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective IV

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos):
1.	Describe and explain the application and utility of FEM
2.	Demonstrate FEM, general analysis procedural algorithm and able to define shape functions.
3.	Solve 1D and 2D analysis problems understanding boundary conditions and shape functions
4.	Analyze any type of body like truss, beam, and frame with FEM.
5.	Solve and analyses problems involving dynamic considerations.
6.	Solve the equations formed in analysis procedure using different methods

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	General description of the method, Brief history of FEM, FEM v/s Classical Method, FEM v/s FDM, Brief explanation of FEA for a stress analysis problem.	**5**
Unit 2	**Vectors, Matrices, and Tensors:**	Introduction to matrices, Vector spaces, Definition of tensors, the symmetric Eigen problem, Matrix displacement equations, Solution of matrix displacement equations.	**5**
Unit 3	**Basic Equations in Elasticity:**	Introduction, Stresses in a typical element, Equations of equilibrium, strains, strain displacement equations, linear constitutive law.	**4**
Unit 4	**Shape Functions**	Introduction, Element shapes, nodes, nodal unknowns, Coordinate systems, Polynomial shape functions, Convergence requirements of shape functions, derivation of shape functions using polynomials, finding shape functions using lagrange polynomials	**8**
		Part B	
Unit 5	**Strain Displacement Matrix and Assembling Stiffness Equation**	Strain displacement matrix for bar and CST element, Strain displacement relation for beam element, Assembling stiffness equation by direct approach, galerkin's method, virtual work method and variational method.	**6**
Unit 6	**Discritization of a Structure**	Nodes as discontinuities, Refining mesh, Use of symmetry, Finite representation of infinite bodies, Element aspect ratio, Higher order element v/s Mesh refinement.	**8**
Unit 7	**Finite Element Analysis – Bars, Trusses, Beams and Shells**	Tension bars/columns, Two dimensional trusses, plane stress and plane strain problems, beam analysis using two noded elements, Force on shell element, shell analysis.	**6**
Unit 8	**Isoparametric Formulation**	Introduction, Coordinate transformation, Basic theorems of iso parametric concept, Uniqueness of mapping, Iso parametric, Super parametric and Sub parametric Elements, Assembling stiffness matrix, Numerical integration.	**6**

Text Books:

4. D. L. Logan, "A First Course in the Finite Element Method", CL Engineering, 6th Edition, 2017.
5. Klaus-Jurgen Bathe, "Finite Element Procedures in Engineering Analysis", Prentice Hall, 2 nd Edition, 2014..
6. Klaus-Jurgen Bathe, "Finite Element Procedures in Engineering Analysis", Prentice Hall, 2 nd Edition, 2014..

Additional Books:

3. D. D. Hutton, "Fundamental of finite element analysis", McGraw Hill Publications, 1st Edition, 2003.
4. R. D. Cook, D. D. Malkus, M. E. Plesha and R. J. Witt, "Concepts and Applications of Finite Element Analysis", John Wiley Publications, 4 th Edition. 2002

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SUBJECT CODE: PEPE-115

SUBJECT NAME: Automobile Engineering

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0

Semester: 7	**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:** Elective IV

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 the different parts of the automobile
2	Explain the working of various parts like engine, transmission, clutch, brakes
3	Describe how the steering and the suspension systems operate.
4	Understand the environmental implications of automobile emissions
5	Develop a strong base for understanding future developments in the automobile industry
6	To describe environmental impact of emissions from vehicles and methods for controlling it.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction:**	Basic structure, general layout and type of automotive vehicles, Frameless and unitary construction; position of power unit. Classification of vehicles, options of prime movers, transmission and arrangements.	**4**
Unit 2	**Transmission system:**	Basic requirements and standard transmission systems; constructional features of automobile clutch, gear box, differential, front and rear axles; overdrives, propeller shaft, universal joint and torque tube drive; Rear wheel vs front wheel drive, principle of automatic transmission	**6**
Unit 3	**Lubrication and Cooling Systems**	Necessity of lubrication; properties of lubricants; different types of lubricants and oil additives; various systems of lubrication - oil filters, oil pumps and oil pressure indicator; crank case ventilation and dilution. Purpose of cooling, air and water cooling systems; radiator, thermostat, pump and fan.	**6**
Unit 4	**Braking System**	Braking systems, layouts for mechanical braking, hydraulic braking, pneumatic braking, master cylinder, wheel cylinder, tandem cylinder, shoe brakes, disc brakes, requirements of brake fluid, power brakes, concept of ABS and traction control, parking brakes. Steering system, principles and need of steering, components parts, steering gear, steering ratio, steering lock, turning radius, centre point. Steering, wheel geometry, power steering principle and typical schemes, Front axle scheme and end connections, rear axle, functions, types of rear axle, loads on rear axles, axle casing.	**8**
		Part B	
Unit 5	**Steering System**	Requirement and steering geometry; castor action, camber and king pin angle, toe-in of front wheels, steering linkages and steering gears; wheel alignment; power steering, Ball re-circulating mechanism	**4**
Unit 6	**Chassis and Suspension**	Loads on the frame, considerations of strength and stiffness, engine mounting, independent suspension systems (Mac Pherson, Trailing Links, Wishbone), shock absorbers and stabilizers; wheels and tyres, tyre wear types, constructional details of plies Systems, springs, shock absorbers, axles, front and rear, different methods of floating rear axle, front axle and wheel alignment, types of rims and tyres.	**6**

Unit 7	**Fuel Supply System:**	Petrol and diesel engines, fuel pumps, Mechanical and electrical diaphragm pumps, air and fuel filters.	**4**
Unit 8	**Carburettors and Injection Systems**:	carburetors, fuel injection systems for diesel and petrol engines, electronic fuel injection, super chargers, muffers.	**4**
Unit 9	**Electric System and Maintenance:**	Classification, Introduction to Conventional and transistorized ignition systems; Charging, capacity ratings and battery testing; starter motor and drive arrangements: voltage and current regulation Preventive maintenance, trouble shooting and rectification in different systems; engine tuning and servicing, major tools used for maintenance of automobiles	**6**

Text Books:

1. W.H Crouse, Automotive mechanics, McGraw Hill.
2. J. Heitner, Automotive Mechanics, East West Press.
3. Kirpal Singh, Automobile Engineering Vol. I and II, Standard Publishers.
4. J. Webster, Auto Mechanics, Glencoe Publishing Co.
5. Jain & Asthana, "Automobile Engineering", Tata McGraw-Hill, New Delhi, 2002.

Reference Books:

1. P.S Gill, Automobile Engineering, S.K Kataria.
2. Kamaraju Ramakrishna, "Automobile Engineering", PHI Learning, New Delhi, 1st Print, 2012.
3. Heinz Heisler, "Advanced Vehicle Technology", Elsevier, New Delhi, 2011.
4. Crouse & Anglin, "Automotive Mechanics", Tata McGraw Hill, New Delhi, 10th Edition 2007.

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SUBJECT CODE: PEPE-116

SUBJECT NAME: INDUSTRIAL FINISHING

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective IV

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos)
1	Describe the significance and applications of Industrial finishing processes.
2	Demonstrate the mechanical finishing processes like blasting peening brushing etc.
3	Work upon advanced finishing operation such as; Magnetic abrasive finishing, Chemo-Mechanical polishing.
4	Apply various coatings for the protection of materials.
5	Use the techniques of hard facing, flame spray coating etc. during advanced machining processes.
6	Utilize painting methods in finishing processes to enhance the life of material.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction Final Finish Surface Operations**	Introduction to finishing operations, significance and applications in Industry, classification of Industrial finishing processes.	**6**

Unit 2	**Mechanical Finishing processes**	De-burring, polishing, buffing, barrel and vibratory finishing, spindle finishing, dry and wet blasting, shot peening, power brushing, brush principles, techniques and compassion of the processes.	**9**
Unit 3	**Chemical and electrochemical finishing**	Chemical polishing. Cleaning, chemical, flame, steam, ultrasonic cleaning, vapor degreasing.	**5**
Unit 4	**Advanced Finishing operations**	Magnetic Abrasive finishing, Magnetic Float polishing, Chemo-Mechanical Polishing.	**5**
Part B			
Unit 5	**Coatings**	Inorganic methods, coating system, coating composition and properties, applications, electroplating, equipment and working, electrolytes, Anodizing, mechanism, characteristic of anodic coating, equipment and electrolytes.	**10**
Unit 6	**Mechanical plating**	Hard facing, metal hot dipping, galvanizing, tin plating flame spray coating, metallizing, vacuum metalising. Sputtering, chemical vapor phase deposition.	**6**
Unit 7	**Painting**	Organic coating, polymerization methods. Under coating, brush dip, flow, Electrolytic spraying. Rust prevention, principles, type's selection of coatings, safety.	**7**

Text Books:

1. B.F. Blumdell, "Introduction to Metal Finishing Equipment", Pergamon Press.
2. Tool and Manufacturing Engineer's handbook, Society of Manufacturing Engineers.
3. Modern Electroplating, John Wiley

Additional Books:

1. C.R.Martin, Technology of paints, Varnishes, and Lacquers, Van Nostrand Reinhold.
2. Electroplating Engineering Hand Book, Reinhold.

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Elective Subjects Industrial Engineering Group 7th Semester

SUBJECT CODE: PEPE-133
SUBJECT NAME: Supply Chain Management

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits: 4**
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 5%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Elective III

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 Supply Chain in an Organization
2	Understand the concept of Logistics in an Organization
3	Understand the concept of Supply and Demand forecast in an Organization
4	Understand the concept of the Role of Inventory in Supply Chain in an Organization
5	Analysis the barriers' in Supply Chain of an Organization
6	Understand the concept of Green Supply Chain in an Organization

Detailed Contents:

S. No.	Title	Content details(Part A)	Credit Hrs.
Unit 1	**Evolution of Supply Chain**	Essentials of SCM-structure of supply chain, examples-process views-decision phases, issues - aligning supply chain with business strategy – supply chain decision variables, performance measures- new challenges - reverse logistics. Importance of supply chain, Supply chain management and logistics, supply chain and the value chain, Competitive advantage, supply chain and competitive performance, changing competitive environment, Supply Chain drivers and obstacle	**4**
Unit 2	**Supply Chain Configuration Design**	Factors involved - sourcing, models for strategic alliances –supplier selection, outsourcing and procurement process – facility location and capacity allocation - modeling approaches LP, MILP - network design in uncertain environment – evaluation using simulation models.	**5**
Unit 3	**Matching Supply And Demand**	The lead-time gap, Improving the visibility of demand, supply chain fulcrum, Forecast for capacity, execute against demand, Demand management and aggregate planning, Collaborative planning, forecasting and replenishment.	**5**
Unit 4	**Responsive Supply Chain & Strategic Lead-Time Management**	Product 'push' versus demand 'pull' The Japanese philosophy, Foundations of agility, Route map to responsiveness., Time-based competition, Lead-time concepts, Logistics pipeline management.	**6**
		Part B	
Unit 5	**Planning and Managing Inventories and Transportation in a Supply Chain**	managing economies of scale in supply chain cycle inventory, managing uncertainty in supply chain, determining optimal level of product availability, transportation, facility design network design in a supply chain, extended enterprise and the virtual supply chain, Laying the foundations for synchronization, 'Quick response' logistics, Production strategies for quick response, Logistics systems dynamics.	**6**

Unit 6	**Managing Risk in the Supply Chain:**	Vulnerability in supply chains, Understanding the supply chain risk profile, Managing supply chain risk, Achieving supply chain resilience.	**5**
Unit 7	**Overcoming The Barriers To Supply Chain Integration**	: Creating the logistics vision, Problems with conventional organizations, developing the logistics organization, Logistics asthe vehicle for change, Benchmarking.	**5**
Unit 8	***Green Supply Chain Management***	Green supply Chains – Need for Green Supply Chains – Implications of modern supply chainmanagement – The supply chain strategy – Ingredients of green supply chain strategy. Evaluating the impact of GSCM activities on sustainability – Economic, Environmental and social impact of GSCM Stages of GSCM - performance measurement.	**6**
Unit 9	**Supply Chain Terminologies**	CRM-SRM-e-business-RFID-supply chain collaboration-Decision Support System (DSS) for supply chain- selection of DSS for supply chain. Bullwhip Effect, Reverse Logistics, Available to Promise. Business Process Reengineering, Bottleneck, Computer Aided Logistics Support, Continuous Replenishment Program, Drum Buffer Rope Theory, Efficient Consumer Response, Just-in-Time, Hub and Spoke Concept, Milk Round System	**6**

Text Books

1. Chopra, S. and Meindl, P. Supply Chain Management,Prentice Hall, (2010).
2. Christopher, M. Logistics & Supply Chain Management, FT Prentice Hall, (2011).
3. Taylor & Brunt, Manufacturing Operations and Supply Chain Management (The Lean Approach), Business Press Thomson Learning N.Youk.
4. Arjan J. Van Weele, Purchasing and Supply Chain Management (Analysis Planning and Practice), 2/Engineering, Business Press, Thomson Learning N.Youk.
5. Donalad Bowersox, Logistic Management - The Integrated Supply Chain process, McGraw Hill, N.York

Reference Books

1. John T. Mentzer, J. T. Supply Chain Management, illustrated edition**,** SAGE Publications (2001).
2. Michael H. Hugos, M. H. Essentials of Supply Chain Management, John Wiley,(2011).
3. Simchi-Levi, D.,Kaminsky, P., Simchi-Levi, E. Designing and Managing the SupplyChain, McGraw Hill Higher Education. (2011).

SUBJECT CODE: PEPE-134

SUBJECT NAME: QUALITY AND RELIABILITY ENGINEERING

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective III

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos)
1	Develop in-depth knowledge of quality.
2	Apply various quality controls tools in the industries to enhance the quality.
3	Explain the concept of process capability.

4	Develop analytical skills for investigating and analyzing quality management issues in the industry and suggest implementable solutions to those.
5	Know about the concepts of statistical theory of tolerances to design of tolerances.
6	Demonstrate and apply the concept of reliability.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Definition of Quality, Quality function, Dimensions of Quality, Quality. Engineering terminology, Brief history of quality methodology, Statistical methods for quality improvement, Quality costs –four categories costs and hidden costs. Brief discussion on sporadic and chronic quality problems. Introduction to Quality function deployment.	**5**
Unit 2	**Quality Assurance**	Definition and concept of quality assurance, departmental assurance activities. Quality audit concept, audit approach etc. structuring the audit program, planning and performing, audit activities, audit reporting, ingredients of a quality program.	**6**
Unit 3	**Statistical Process Control**	Introduction to statistical process control –chance and assignable causes variation. Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational subgroups. Analysis of patterns of control charts. Case Studies on application of SPC	**6**
Unit 4	**Control Charts for Variables**	Controls charts for X bar and Range, statistical basis of the charts, development and use of X bat and R charts interpretation of charts. Control charts for X bar and standard deviation (S), development and use of X bat and S chart. Brief discussion on –Pre control X bar and S control charts with variable sample size, control charts for individual measurements, moving-range charts.	**6**
Unit 5	**Control Charts for Attributes**	Controls chart for fraction non-conforming (defectives) development and operation of control chart, brief discussion on variable sample size. Control chart for non-conformities (defects) –development and operation of control chart for constant sample 106 size and variable sample size. Choice between variables and attributes control charts. Guidelines for implementing control charts.	**6**
		Part B	
Unit 6	**Process capability**	Basic definition, standardized formula, relation to product tolerance and six sigma concept of process capability, Seven QC tools.	**5**
Unit 7	**Sampling Inspection**	Concept of accepting sampling, economics of inspection, Acceptance plans –single, double and multiple sampling. Operating characteristic curves – construction and use. Determinations of average outgoing quality, average outgoing quality level, average total inspection, producer risk and consumer risk, published sampling plans, Gauge R and R and MSA.	**4**
Unit 8	**Statistical Theory of Tolerances**	Application of statistical theory of tolerances to design of tolerances in random assemblies and application in other areas.	**5**
Unit 9	**Reliability and Life Testing**	Failure models of components, definition of reliability, MTBF, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, paralleled and series-parallel device configurations, Redundancy and improvement factors evaluations.	**5**

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.

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SUBJECT CODE: PEPE-135

SUBJECT NAME: Green Manufacturing

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective III

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 the role of biomedical engineering in society
2	Demonstrate the principles of various diagnostic devices.
3	Identify the various techniques used in diagnosis though imaging.
4	Describe the working principles of various therapeutic and assist devices.
5	Understand device specific safety goals and standards.
6	Illustrate the concepts of ethical theories and moral principles for the health professions.

Detailed Contents:

S. No.	Title	Content details(Part A)	Credit Hrs.
Unit 1	**Introduction to Green Manufacturing**	Why Green Manufacturing, Motivations and Barriers to Green Manufacturing, Environmental Impact of Manufacturing, Strategies for Green Manufacturing. The Social, Business, and Policy Environment for Green Manufacturing Introduction, The Social Environment—Present Atmosphere and Challenges for Green Manufacturing, The Business Environment: Present Atmosphere and Challenges, The Policy Environment—Present Atmosphere and Challenges for Green Manufacturing. Principles of Green Manufacturing Introduction, Background, and Technology Wedges, Principles, Mapping Five Principles to Other Methods and Solutions.	**4**
Unit 2	**Green Movement**	Motivation force – Rediscovery of Ancient values – The global sustainability Agenda – The response of industry. External drivers: The voice of society – Green Expectation – Confronting climate change – Government initiatives: Stick and Carrot – Environmental Management System Standards – Sustainable Rating Schemes – Voluntary codes and principles – Business value drives	**5**
Unit 3	**Metrics for Green Manufacturing**	Introduction, Overview of Currently Used Metrics, Overview of LCA Methodologies, Metrics Development Methodologies, Outlook and Research Needs.	**5**
Unit 4	**Closed-Loop Production Systems**	Life Cycle of Production Systems, Economic and Ecological Benefits of Closed Loop Systems, Machine Tools and Energy Consumption, LCA of Machine Tools, Process Parameter Optimization, Dry Machining and Minimum Quantity Lubrication, Remanufacturing,	**6**

		Reuse, Approaches for Sustainable Factory DGreen Manufacturing in the Semiconductor Industry: Concepts and Challenges	
Part B			
Unit 5	**Environmental Implications of Nano-manufacturing**	Introduction, Nano-manufacturing Technologies, Conventional Environmental Impactof Nano-manufacturing, Unconventional Environmental Impactsof Nano-manufacturing, Life Cycle Assessment (LCA) of Nanotechnologies.	**5**
Unit 6	**Green Energy Resources**	Introduction, Clean Energy Technologies, Application Potential of Clean Energy Supplying Green Manufacturing. Energy needs of india, classification of energy sources, importance of renewable energy resources. Basic concepts of solar energy, wind energy bio energy geothermal energy, ocean thermal energy, wave energy, tidal energy, waste to energy, heat to energy, fuel cells: types and applications and other renewable energy resources	**5**
Unit 7	**Green Design**	Design the rules and processes to meet the market need and the green manufacturing requirements by selecting and evaluating suitable technical, managerial / project management and supply chain management scheme.	**6**
Unit 8	**Green Electronics**	Environmental concerns of the modern society – overview of electronics industry and their relevant regulations in different countries of World.. Restriction of hazardous substances (ROHS) – waste electrical and electronic equipment (WEEE) – energy using product (EUP) and registration evaluation, authorization and restriction of chemical substances (REACH). Green electronics materials and products, green electronics assembly and recycling	**6**
Unit 9	**Green Supply Chain**	Green supply Chains – Need for Green Supply Chains – Implications of modern supply c hain management – The supply chain strategy – Ingredients of green supply chain strategy. Evaluating the impact of GSCM activities on sustainability – Economic, Environmental and social impacts of GSCM Stages of GSCM - performance measurement.	**6**

Text Books

1. Dornfeld, David Green Manufacturing Fundamentals and Applications Springer 2013
2. N. Senthil Prabhu Green Manufacturing Through Lean Tools Notion Press
3. Ame Green Manufacturing Taylor & Francis Inc
4. Hillis David R. and J. Berry DuVALL Improving Profitability Through Green Manufacturing John Wiley & Sons Inc
5. Joseph Sakis Greener Manufacturing and Operations: From Design to Delivery and Back Taylor & Francis Ltd 2001

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SUBJECT CODE: PEPE-136

SUBJECT NAME: Investment Planning

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective III

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 legal issues that impact financial and other risks affecting business.
2	Analyze relevant case law for the purpose of finding legal precedents that will be used to persuade a judge or jury.
3	Interpret statutory law for purposes of risk avoidance, and to establish control mechanisms
4	Understand different investment alternatives in the market
5	Understand how securities are traded in the market
6	Be able to analyze and price different securities

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Evolution of finance objective of the firm, Time value of money present values, Internal rate of return or yield bond returns, The return from a stock investment, Dividend discount models.	**4**
Unit 2	**Financial Planning**	: The process financial planning, Client interactions, Time value of money applications, Personal financial statements, Cash flow and debt management, planning to finance education	**8**
Unit 3	**Risk Analysis & Insurance Planning**	Risk management and insurance decision in personal financial planning, Various Insurance Policies and Strategies for General Insurance, Life Insurance, Motor Insurance, Medical Insurance	**6**
Unit 4	**Investment Planning**	Risk Return Analysis, Mutual Fund, Derivatives, Asset Allocation, Investment strategies and Portfolio construction and management.	**8**
		Part B	
Unit 5	**Investment Analysis**	Introduction to investment analysis, discounted cash flow criteria for economic evaluation-ROL_ payback, MAP equipment selection, risk analysis, break-even point, capacity planning. Portfolio selection and technological forecasting.	**6**
Unit 6	**Project Identification & Evaluation**	Search for a business idea, project identification project planning, project appraisal, project evaluation under risk, under uncertainly, analysis of non-financial aspects.	**8**
Unit 7	**Retirement Planning & Employees Benefits:**	Retirement need analysis techniques, Development of retirement plan, Various retirement schemes such as Employees Provident Fund (EPF), Public Provident Fund (PPF), Superannuation Fund, Gratuity, Other Pension Plan and Post- retirement counseling.	**8**

Text Books:

1) Singhanar V.K: Students' Guide to Income Fax; Taxmann, Delhi.
2) Prasaci, Bhagwati: Income Tax Law & Practice: Wiley Publication, New Delhi.
3) Girish Ahuja and Ravi Gupta: Systematic approach to income tax: Sahitya Bhawan Publications, New Delhi.
4) Ranganathan and Madhumathi: Investment Analysis and Portfolio Management:Pearson, New Delhi.
5) George Rejda: Principles of Risk Management and Insurance: Pearson, New Delhi.

Reference Books:

1. J.M.Pandey, "Financial Management", Vikas Publishing.
2. James Van Home, "Financial Management & Policy", Prentice Hall International.
3. Harold Kerzner, "Project Management", John wilay and sons.
4. Prasanna Chandra, "Financial Management",Tata McGraw Hill.
5. Geoffrey Hirt, Stanley Block, Somnath Basu", Investment Planning".

SUBJECT CODE: PEPE-138
SUBJECT NAME: VALUE ENGINEERING

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective IV

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 the concepts of value engineering, identify the advantages, applications.
2	Apply various phases of value engineering. Analyze the function, approach of function and evaluation of function.
3	Determine the worth and value.
4	Explain the concept of queuing theory..
5	Develop analytical skills for appraise the value engineering operation in maintenance and repair activities
6	Create the value engineering team and discuss the value engineering case studies.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Value engineering concepts, advantages, applications, problem recognition, and role in productivity, criteria for comparison, element of choice. Organization: Level of value engineering in the organization, size and skill of VE staff, small plant, VE activity, unique and quantitative evaluation of ideas	**7**
Unit 2	**Value Engineering Job Plan**	Introduction, orientation, information phase, speculation phase, analysis phase. Selection and Evaluation of value engineering Projects, Project selection, methods selection, value standards, application of value engineering methodology.	**8**
Unit 3	**Analysis function**	Anatomy of the function, use esteem and exchange values, basic vs. secondary vs. unnecessary functions. Approach of function, Evaluation of function, determining function, classifying function, evaluation of costs, evaluation of worth, determining worth, evaluation of value	**8**
		Part B	
Unit 4	**Value Engineering Techniques**	Selecting products and operation for value engineering action, value engineering programmes, determining and evaluating function(s) assigning rupee equivalents, developing alternate means to required functions, decision making for optimum alternative, use of decision matrix, queuing theory and Monte Carlo method make or buy, measuring profits, reporting results, Follow up, Use of advanced technique like Function Analysis System.	**10**
Unit 5	**Versatility of Value Engineering**	Value engineering operation in maintenance and repair activities, value engineering in non-hardware projects. Initiating a value engineering programme Introduction, training plan, career development for value engineering specialties. Fast diagramming: cost models, life cycle costs	**7**

Unit 6	**Value Engineering Level of Effort**	Value engineering team, co-coordinator, designer, different services, definitions, construction management contracts, value engineering case studies.	**8**

Text Books:

1. Alphonse Dell'Isola, "Value Engineering: Practical Applications for Design, Construction, Maintenance & Operations", R S Means Co., 1997.
2. Richard Park, "Value Engineering: A Plan for Invention", St. Lucie Press, 1999.
3. Del L. Younker, "Value Engineering analysis and methodology", Marcel Dekker Inc, New York, 2004.
4. Miles, L.D., "Techniques of Value Analysis and Engineering", McGraw Hill second Edition, 1989.

Additional Books:

1. Anil Kumar Mukhopadhyaya, "Value Engineering Mastermind: From concept to Value Engineering Certification", SAGE Publications, 2003.
2. Khanna, O.P, "Industrial Engineering and Management", Dhanpat Rai & Publication, 2007.

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SUBJECT CODE: PEPE-139

SUBJECT NAME: Intellectual Property Right

Programme: B.Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective IV

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 different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP.
2	Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development.
3	Identify activities and constitute IP infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights in products and technology development.
4	Be familiar with the processes of Intellectual Property Management (IPM) and various approaches for IPM and conducting IP and IPM auditing and explain how IP can be managed as a strategic resource and suggest IPM strategy.
5	Be able to anticipate and subject to critical analysis arguments relating to the development and reform of intellectual property right institutions and their likely impact on creativity and innovation.
6	Be able to demonstrate a capacity to identify, apply and assess ownership rights and marketing protection under intellectual property law as applicable to information, ideas, new products and product marketing.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction To**	Introduction, Types Of Intellectual Property, International Organizations, Agencies And Treaties, Importance Of Intellectual Property Rights, International treaties & conventions, Acts on intellectual property rights,	**8**

	Intellectual Property	Domain name disputes and resolution, Cyber Crime offences and contraventions.	
Unit 2	**Trade Marks**	Introduction to trademarks, Registration of trademarks, Infringement of trademarks, Passing off. Purpose And Function Of Trade Marks, Acquisition Of Trade Mark Rights, Protectable Matter, Selecting And Evaluating Trade Mark, Trade Mark Registration Processes. Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks).	**8**
Unit 3	**Copyrights and Law Of Copy Rights**	**:** Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights Fundamental Of Copy Right Law, Originality Of Material, Rights Of Reproduction, Rights To Perform The Work Publicly, Copy Right Ownership Issues, Copy Right Registration, Notice Of Copy Right, International Copy Right Law.	**8**
Part B			
Unit 4	**Patents**	Elements of Patentability Novelty, Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board	**8**
Unit 5	**Other forms of IP (Design & Geographical Indication**	Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection Geographical indication: meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection	**8**
Unit 6	**New Developments Of Intellectual Property:**	New Developments In Trade Mark Law; Copy Right Law, Patent Law, Intellectual Property Audits. International Overview On Intellectual Property, International – Trade Mark Law, Copy Right Law, International Patent Law, International Development In Trade Secrets Law. India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies	**8**

Text Books:

1. Intellectual Property Rights, Deborah. E. Bouchoux, Cengage Learning.
2. Intellectual Property Rights– Unleashmy The Knowledge Economy, Prabuddha Ganguli, Tata Mc Graw Hill Publishing Company Ltd.,B.S Raghuwanshi "Workshop Technology"Vol.1 & Vol.2 Dhanpat Rai& Co.
3. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
4. W. Cornish, D. Llewelyn and T. Aplin, "Intellectual Property: Patents, Copyright, Trademarks and Allied Rights", Sweet and Maxwell, 2007.
5. R. Jacob and D. Alexander, "A Guide Book to Intellectual Property Patent trademarks, Copyrights and Designs", Sweet and Maxwell 4th edition, 1993.

Reference Books:

1. Subramanian, N., & Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf.
2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub_489.pdf.

3. Fundamentals of lP for Engineers: K.Bansl & P.Bansal
4. Intellectual property right, Deborah, E. BoDcboux, Cengage leaning.
5. Intellectual property right - Unleasbing the knowledge economy, Prabuddha Ganguli, Tata McGraw Hill Publishing Company Ltd.

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Elective Subjects Materials Group 7th Semester

SUBJECT CODE: PEPE-157

SUBJECT NAME: Textures in Materials

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective III

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 different Textures of Materials
2	Understand the Micro and Macro Meso Textures
3	Understand the methods of controlling the Textures of Materials
4	Understand the Modelling of Deformation Textures of Materials
5	Understand the method of developing different Textures of Materials
6	Understand the concept of formability

Detailed Contents:

S.No	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Origin and development of textures**	Origin and development of textures during materials processing stages: solidification, deformation, annealing, phase transformation. Deformation microstructure and texture in FCC, BCC and HCP metals and alloys	6
Unit 2	**Representation of macro, micro and meso-texture.**	Representation of macro, micro and meso-texture. Measurement and analysis of macro, micro and meso-texture Materials processing-texture correlations in different classes of materials (metals and ceramics).	6
Unit 3	**Texture control.**	Texture-properties correlations with case studies on Structural materials (eg: steels, Al alloys, Mg alloys, Ti alloys) Functional materials (for eg: superconducting (YBCO) thin films Role of grain boundary character on interface controlled properties (segregation, creep, fracture, sensitization). Concept of grain boundary engineering	6
Unit 4	**Concepts of texture in materials,**	Concepts of texture in materials, their representation by pole figure and orientation distribution functions. Texture measurement by different techniques: X-ray diffraction, neutron diffraction, synchrotron X-rays, ultrasonic waves	6
		Part B	
Unit 5	**Modelling of deformation texture**	Modelling of deformation texture, Sachs, Taylor and Self consistent models for polycrystal deformation and texture evolution. Annealing phenomenon: Recovery, recrystallization and grain growth, texture evolution during annealing. Solidification and transformation texture.	6
Unit 6	**Texture development**	Texture development during coatings and thin film deposition.	6
Unit 7	**Influence of texture on material properties**	Influence of texture on mechanical, chemical and physical properties: Yield strength, ductility, fatigue, corrosion, stress corrosion cracking, magnetic and dielectric properties	6

Unit 8	**Texture and formability**	Texture and formability Texture control in aluminum industry, automotive grade and electrical steels, magnetic and electronic materials	6

Taxt Books

1. An Introduction to Textures in Metals, Monograph no. 5, The Institute of Metals, London (1979). M. Hatherly and W.B. Hutchinson
2. Crystallographic texture of materials, Satyam Suwas and R.K. Ray, Springer, (2014)
3. Introduction to Texture Analysis, V. Randle and O. Engler, CRC Press, 2nd edition (2010).
4. Recrystallisation and Related Phenomena, F.J. Humphreys and M. Hatherly, Elsevier, 2nd edition (2004).

SUBJECT CODE: PEPE-160

SUBJECT NAME: NUCLEAR MATERIALS

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective III

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 various structures, reactions in nuclear materials.
2	Classify and identify various nuclear reactions and energies released during these reactions.
3	Utilize proper coolants, fuels, moderators in nuclear components.
4	Analyses the effect of radiations and enlist various safety and shielding methods.
5	Analyze various materials used for the production of nuclear energy.
6	Use Nano materials for nuclear applications.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Nuclear Structure**	Structure of nucleus, binding energy, fission reaction, neutron cross sections, moderation of neutrons, multiplication factor.	**6**
Unit 2	**Nuclear Fusion Reaction**	Classification of nuclear reactions, Energy released in nuclear reactions Fusion reactions for controlled power generation, Methods of achieving fusion energy; Magnetic confinement, Inertial confinement fusion (ICF), Muon-catalyzed fusion, Cold fusion and bubble fusion, Conditions for practical fusion yield.	**10**
Unit 3	**Reactors and Materials**	Classification of nuclear reactors, Materials for nuclear reactors, Fuels, Moderators, Control rods, Coolant, Reflectors and Structural materials. Fabrication of fuel and cladding materials.	**8**
		Part B	
Unit 4	**Radiation Effects**	Effect of radiation on reactor materials, Radiation hazards, safety and shielding, disposal of radioactive wastes	**8**
Unit 5	**Production of Nuclear Materials**	Atomic minerals, their occurrence in India, General methods of their processing. Production metallurgy of nuclear grade uranium, Thorium beryllium and zirconium, Production of enriched uranium.	**10**
Unit 6	**Processing of spent fuel**	Indian reactors and atomic energy programme in India. Use of Nano materials for nuclear application.	**6**

Text Books:

1. R .Stephenson, Introduction to Nuclear Engineering, McGraw-Hill.

2. H.S. Ray, R. Sridhar and K.P. Abraham: Extraction of Nonferrous Metals Affiliated East-West Press Private Limited**.**

Additional Books:

1. S. Glasstone and A.Sesonke: Nuclear Reactor Engineering, Van Nostrand.

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SUBJECT CODE: PEPE- 161
SUBJECT NAME: Nano Materials

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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 IV

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 the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.
2	Choose appropriate synthesis technique to synthesize quantum nanostructures of desired size, shape and surface properties.
3	Correlate properties of nanostructures with their size, shape and surface characteristics.
4	Appreciate enhanced sensitivity of nanomaterial based sensors and their novel applications in industry.
5	Demonstrate an understanding of approaches to nanomaterials characterization.
6	Understanding of the properties of materials with strong dependence on size.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction to Nano Materials**	Definitions and course organization, Historical development of nanomaterials,Classification of nanomaterials, Features of nanosystems, Characteristic length scales of materials and their properties, Density of states in 1-D, 2-D and 3-D bands,	**8**
Unit 2	**Properties of Nano Materials**	Size and shape dependence of optical, electronic, photonic, mechanical, magnetic and catalytic properties. Properties and Size dependence of properties Chemical, vibrational, thermal, electrical Theoretical Aspects-e.g. density functional theory.	**8**
Unit 3	**Quantum Size Effect**	Electron confinement in infinitely deep square well, Confinement in one dimensional well, Idea of quantum well structure, Formation of quantum well, Quantum dots and quantum wires.	**8**
		Part B	
Unit 4	**Synthesis Methods**	Top-down and bottom-up approach, cluster beam evaporation, ion beam deposition, chemical bath deposition with capping techniques, mechanical milling, chemical methods and self-assembly.	**8**
Unit 5	**Nano Material characterization techniques**	**:** Scanning and Transmission Electron Microscopy Scanning Probe Microscopies: (Atomic Force, scanning tunneling microscopy), Diffraction and scattering techniques, Vibrational spectroscopy and Surface techniques.	**8**

Unit 6	**Nano Materials and their applications**	Nanoparticles, Nanocoatings and Nanocomposites, Nanotubes, Fullerenes, Thin film chemical sensors, gas sensors, biosensors, Carbon fullerenes and Carbon nanotubes, Thin film chemical sensors, biosensors, Solar cells, Drug deliveries and optoelectronic devices, Nanoscale chemical- and bio-sensing Biological/bio-medical applications.	**8**

Text Books:

1. The Physics and Chemistry of NanoSolids by Frank J. Owens and Charles P. Poole Jr, Wiley-Interscience, 2008.
2. Bimerg, D., Grundmann, M., and Ledentsov, N.N., Quantum Dot Heterostructures, John Wiley (1999). 3. Poole,C.P., Owens,F.J., Introduction to NanotechnologyJohn Wiley &Sons (2003)
3. Jain, K.P., Physics of Semiconductor Nanostructures, Narosa (1997).
4. Fendler, J.H., Nano particles and Nano-structured Films, John Wiley &Sons (1998).

Reference Books:

1. Nanomaterials- Synthesis, Properties and Applications, Edited by A.S. Edelstein and R.C. Cammarata, Institute of Physics Publishing, London, 1998 (paper back edition).
2. Timp, G., Nanotechnology, Springer-Verlag (1999).
3. Nanochemistry: A Chemical Approach to Nanomaterials, by G. Ozin and A. Arsenault, RSC Publishing, 2005.
4. Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience, Edward L. Wolf, Wiley-VCH, 2nd Reprint (2005).

SUBJECT CODE: PEPE-162

SUBJECT NAME: Explosive Materials used in Industries

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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 IV

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 different hazards associated with Explosive Materials
2	Understand different properties of Explosive Materials
3	Understand different preventive techniques of Explosive Materials
4	Understand safety Management of Handling the Explosive Materials
5	Understand Explosion Protection Management System
6	Understand uses of Explosive Materials for the betterment of mankind

Detailed Contents:

S.No	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction To Explosion**	Explosion hazards, Definition of explosives, constituents of explosive, properties of explosive. Low and high explosives, permitted & non-permitted explosives, fuses, detonators, recent advances in explosives.	6
Unit 2	**Flammability Limits And Theories:**	Lean limit and Rich limit, LEL & UEL measurement techniques and equipment, Minimum ignition energy, Relation between auto-ignition temperature and flash point, Effect of temperature and pressure on flash point, Classification of flammable materials, Vapour tank Explosion, a. TWA flight800 Disaster.	7

Unit 3	**Explosion Prevention And Protection**	Explosion prevention techniques-a. Ventilation. Separation. Physical barriers. Alternative techniques, Preventing the formation of explosive atmosphere, Explosion protection systems – Protection techniques - Containment, Isolation, Suppression, Venting, Ventilation for explosion protection system, Explosion protection using inert gases, Flame arrestors and quenching distance	7
Unit 4	**Safety Management**	Concept Of Safety, Industrial Accidents, Reasons For Accident Prevention, Function Of Safety Management, Safety Organizations, Objectives Of Safety Organizations, Role Of Industrial Organization (Safety), Essential Requirements Of Safety Programs, Plant Safety Rules And Procedures, Formulation Of Rules, Types Of Rules, violation Of Rules, Reduction Of Hazards	7
Part B			
Unit 5	**Explosion Protecting Systems**	Principles of explosion-detonation and blast waves-explosion parameters – Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure-explosion venting-inert gases, plant for generation of inert gas rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO2) and halons-hazards in LPG, ammonia (NH3).	7
Unit 6	**Introduction To Dust Explosions**	9 The nature of dust explosions, Significance of the dust explosion hazard: statistical records, Dust and dust cloud properties that influence ignitability and explosion violence, Means for preventing and mitigating dust explosions, Selecting appropriate means for preventing and mitigating dust explosions,	7
Unit 7	**Classification Of Common Industrial Explosives**	High Explosives, Dynamites, Gelatins, Semi-gelatins, Water gels & slurries and Emulsions, Blasting Agents, Water gels & slurries and Emulsions, ANFO, Blends, Low Explosives, Black powder	7

Text Books

1. McElroy, Frank E "Accident Prevention manual for industrial operations" N.S.C., Chicago, 1988.
2. Dinko Tuhtar, "Fire and explosion protection – A System Approach" Ellis Horwood Ltd, Publisher, 1989.
3. Frank P. Lees Butterworth-Hein, "Loss Prevention in Process Industries" (Vol.I, II and III), Elsevier

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SUBJECT CODE: PEPE-164

SUBJECT NAME: Thermodynamics of Materials

Programme: B. Tech. (PE)	**L:** 4 **T:** 0 **P:** 0
Semester: 7	**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:** Elective IV

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 thermodynamics and its applications.
2	Apply laws of thermodynamics in mechanical components like pump, condenser etc..
3	Solve various design as well as technical problems using various thermodynamic rekations.

4	Solve various problems encountered like leakage, cracks, blowholes etc with the manufacturing process by analyzing the data.
5	Select different materials according to their thermodynamic behavior.
6	Calculate reaction rates and analyse reaction mechanisms in various thermodynamic processes.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction to thermodynamics**	Energy; Macroscopic and microscopic forms of energy; location of energy; flow of energy. Application and utility; important terms used in thermodynamics; thermodynamic properties; state postulate; concept of temperature and absolute temperature.	**6**
Unit 2	**Thermodynamic Variables**	State Variables and Functions, Thermodynamic Systems and Processes, First Law of Thermodynamics, application of first law to equipments such as boiler, turbine, compressor, nozzle, expander, pump and condenser. Second Law of Thermodynamics,	**8**
Unit 3	**Properties of Materials**	Stored Energy in Solids, Quasi-static Processes, Heat Capacities, Internal Energy and Enthalpy, Entropy Content in Materials,	**10**
		Part B	
Unit 4	**Introduction to solutions**	partial molar entities – Gibbs Duhem relations - thermodynamic aspects of metallic solutions and salt melts – Raoult's Law and Henry's Law - regular and quasi chemical models	**8**
Unit 5	**Thermodynamic aspects of phase diagrams**	similarity in thermodynamic approach towards different classes of materials – thermodynamic aspects of defect formation in metals and ceramics – approaches used in chemical modeling	**6**
Unit 6	**Principles of metallurgical kinetics**	reaction rates and reaction mechanisms – overview of mass transfer, heat transfer and fluid flow – related applications in metallurgical processes – role of transport phenomena in mathematical and physical modelling.	**10**

Text Books:

4. Upadhayaya, G.S., and Dube, R.K., Problems in metallurgical thermodynamics and kinetics, Pergamon.
5. P. K. Nag; Engineering Thermodynamics; Tata McGraw-Hill, New Delhi.
6. Gaskell, David R., 'Introduction to Metallurgical Thermodynamics', McGraw Hill, 1973

Additional Books:

3. Mohanty, A. K., "Rate Processes in Metallurgy", Prentice Hall of India (EEE), 2000
4. Y. A. Cengel& M. A. Boles; Thermodynamics-An Engineering Approach; McGrawHill Inc.
5. J. P. Holman; Thermodynamics; McGraw-Hill Book Co. New Delhi.

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Elective Subjects Design & Manufacturing Engineering Group

8th Semester

SUBJECT CODE: PEPE-117

SUBJECT NAME: COMPUTER INTEGRATED MANUFACTURING

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective V

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos)
1	Describe and explain various types of manufacturing systems and applications of CIM.
2	Design various part programs in NC/DNC/CNC systems.
3	Generate process plans with the help of machinability data systems.
4	Apply the concept of group technology and coding system in manufacturing systems.
5	Use various inspection methods to improve quality with the help of computer aided system.
6	Design plant layout with the help of FMS.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Overview of manufacturing processes, types of manufacturing systems, the product cycle, computer's role in manufacturing, sources and types of data used in manufacturing, Central Processing unit, memory input/output section, computer programming, minicomputer, microcomputer, P.C., Super Computers.	**6**
Unit 2	**Computer Aided Design**	Historical Perspective, Components of CAD systems, the design process, Application of Computer for Design, Manufacturing Data Base. General Information of various Software for CAD, Relation of CAD with CAM.	**6**
Unit 3	**Numerical Control**	The beginning of CAM: Historical Background, basic components of NC systems, NC Procedure, NC coordinate system and machine motions, applications and economics of NC, part programming- manual and computer assisted the APT Language.	**6**
Unit 4	**Computer Controls in NC Systems**	Problems with conventional NC computer numerical control, direct numerical control, combined CNC/ DNC systems, adaptive control machining system computer process interfacing, New development and latest trends.	**4**
Unit 5	**Computer Aided Process Planning**	Traditional process planning, retrieval process planning system, generative process planning, machinability data system, computer generated time standards.	**4**
		Part B	
Unit 6	**Group Technology**	Introduction, part families, part classification and coding, coding system and machining cells.	**4**
Unit 7	**Computer Aided Production Management Systems**	Traditional Production, Planning and Control, Introduction to computer aided PPC, Introduction to computer aided inventory BOS/PE/52 management, manufacturing resource planning (MRP- II), computer process monitoring and shop floor control, computer process control.	**6**

Unit 8	**Computer Aided Quality Control**	Traditional quality control, computer in quality control, contact inspection methods, Non-contact inspection methods, optical and non-optical computer aided testing.	**4**
Unit 9	**Computer Aided Material Handling**	Traditional Material handling, computer control on material handling, conveying, picking. Ware house control, computerized material handling for automated inspection and assembly.	**4**
Unit 10	**Computer Integrated Manufacturing Systems**	Introduction, types special manufacturing systems, flexible manufacturing systems (FMS), Machine tools and equipment, material handling systems, computer control systems.	**4**

Text Books:

1. Groover& Zimmer, "CAD/ CAM",Prentice Hall.
2. Groover, " Automation Production Systems and CIMS", Prentice Hall.
3. Beasanat & Lui, "CAD/ CAM",EWP

Additional Books:

1. Groover Mitchell, "Industrial Robotics" ,McGraw Hill.
2. Computer Integrated Manufacturing by A.W. Sche.

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SUBJECT CODE: PEPE-118

SUBJECT NAME: DESIGN OF EXPERIMENTS

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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 V

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos)
1	Describe the role of design of experiments in a research.
2	Understand basic concepts of statistical calculations.
3	Design the experimental blueprint using various techniques
4	Apply the technique of Taguchi's Orthogonal Arrays
5	Determine signal to noise ratio during experimentation
6	Calculate the tolerance and errors during experiments

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.	**6**
Unit 2	**Basic Statistical Concepts**	Concepts of random variable, probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples.	**7**
Unit 3	**Experimental Design**	Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level	**6**

		experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples.	
Unit 4	**Analysis And Interpretation Methods**	Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.	**4**
Part B			
Unit 5	**Quality By Experimental Design**	Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. Robust Design: Steps in Robust Design: Parameter design and Tolerance Design. Reliability Improvement through experiments, Illustration through Numerical examples.	**7**
Unit 6	**Experiment Design Using Taguchi's Orthogonal Arrays**	Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples.	**6**
Unit 7	**Signal To Noise Ratio**	Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger-the-better type. Signal to Noise ratios for Dynamic problems. Illustration through Numerical examples.	**4**
Unit 8	**Parameter And Tolerance Design**	Parameter and tolerance design concepts, Taguchi's inner and outer arrays, parameter design strategy, tolerance design strategy. Illustration through Numerical examples.	**8**

Text Books:

4. A.W. Birley, B. Howarth, "Mechanics of plastics processing properties",Hana Publisher edition, 1991.
5. J.E. Mark, R. West, H.P. Allocock, "Inorganic Polymers", Prentice Hall, 1992.
6. Fried ,"Poly. Science and Technology", Prentice Hall

Additional Books:

3. Charles Harper, "Handbook of Plastics Technologies", McGraw-Hill.
4. Plastic Engg. Data Book, Glanill.

SUBJECT CODE: PEPE-119

SUBJECT NAME: Bio mechanics

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective V

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 anatomical movements pertaining to mechanics
2	Understand details of bone structure, biomechanical characteristics of boneand joints
3	Understand the responsibilities of muscles for movement

4	Apply principles of force – velocity relationship in skeletal muscle forstrengthening and injury prevention
5	Understand details of Hard and soft tissues and their mechanical properties
6	Understand details the biomechanical characteristics of cardiovascular and Respiratory Mechanics

Detailed Contents:

S. No.	Title	Content details(Part A)	Credit Hrs.
Unit 1	**Introduction to Biomechanics**	Review of the principles of mechanics, Vector mechanics- Resultant forces of Coplaner & Noncoplaner and Concurrent & non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Work and energy, Moment of inertia.	**4**
Unit 2	**Tissue Biomechanics**	Hard Tissues: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models – anisotropy. Electrical properties of bone, type of fractures, biomechanics of fracture healing. Soft Tissues: Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modeling: Cartilage, Tendon, Ligament,and Muscle.	**6**
Unit 3	**Joints Biomechanics**	Skeletal joints, forces and stresses in human joints, Analysis of rigidbodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, hip, knee and ankle.	**6**
Unit 4	**Cardiac & Respiratory Mechanics**	Cardiovascular system, Mechanical properties of blood vessels: arteries, arterioles, capillaries, and veins. artificial heart valves, biological and mechanical valves development, testing of valves. Alveoli mechanics, Interaction of blood and lung, P-V curve of lung, Breathing mechanism, Airwayresistance, Physics of lung diseases.	**6**
		Part B	
Unit 5	**Movement Biomechanics**	Gait analysis, body & limbs: mass & motion characteristics actions, forces transmitted by joints. Jointsforces results in the normal & disable human body, normal & fast gait on the level. Patterns: Push/Throw Continuum Biomechanics of push - like motions, Biomechanics of throw - like motions.	**6**
Unit 6	**Biofluid Mechanics**	Newton's law, stress, strain, elasticity, Hooke's law, viscosity, Newtonian fluid, Non- Newtonian fluid, viscoelastic fluids, Vascular tree. Relationship between diameters, Velocity and pressure of blood flow, Resistance against flow.	**6**
Unit 7	**Implant Mechanics**	General concepts of Implants, classification of implants, Soft tissues replacements and Hard tissue replacements, basic consideration and limitation of tissue replacement, Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants,fixation of implants.	**6**
Unit 8	**Mechanical Analysis of Human Motion:**	Linear kinematics - Linear kinematic analysis - Position and displacement - Velocity and speed - Acceleration - Differentiation and integration - Kinematics of running - Kinematics of projectiles - Equations of constant acceleration. Angular kinematics - Angular motion - Measurements of angles - Types of angles - Representation of Angular motion vectors - Lower extremity joint angles - Relationship between angular and linear motion	**8**

		- Angular kinematics of running. Linear kinetics - Force - Laws of motion - Types of Forces - Representation of Forces acting on a system - Forces occurring along a curved path - Special force applications. Angular Kinetics - Torque - Centre of mass - Rotation and leverage - Moment of inertia - Angular momentum - Angular analogs to Newtons laws of motion - Special torque applications.	

Text Books

1. Y C Fung, Biomechanics: Mechanical Properties of Living Tissues, springer, 2nd edition, 1993.
2. N. Ozkaya and M. Nordin, Fundamentals of Biomechanics-Equilibrium, Motion and Deformation, springer-verlag, 2nd edition 1999
3. Duane knudson, Fundamental of biomechanics, springer, 2nd edition 2007
4. D. J. Schneck and J. D. Bronzino, Biomechanics- Principles and Applications, CRC Press, 2nd Edition, 2000
5. Joseph D, Bronzino, "The Biomedical Engineering Handbook", CRC Press, 3rd edition, 2006.
6. Roger Bartlett, Introduction to Sports Biomechanics 1997, Roger Bartlett, Taylor & Francis Group
7. Mow, Van C.; Huiskes, Rik, Basic Orthopaedic Biomechanics and Mechano-Biology, 3rd Edition,2005, Lippincott Williams & Wilkins
8. Hiroshi Wada, Biomechanics at Micro and Nano scale Levels, volume 1, 2005, World Scientific Publishing Co. Pt. Ltd.

Additional Books

1. Paul Grimshaw et al. Sports & Exercise Biomechanics, Taylor & FrancisGroup, (2007).
2. Susan J. Hall, Basic Biomechanics, McGraw Hill Education, 2004.
3. Peter McGinnis Biomechanics of Sport and Exercise, Human Kinetics, 2005.
4. Kathryn Lutgens et al. Kinesiology (Scientific Basis of Human Motion), Brownand Bench mark, 1992.
5. Roger Bartlett, Introduction to Sports Biomechanics Analyzing Human Movement Patterns, Routledge, 2007.
6. Richard Shalak & ShuChien, Handbook of Bioengineering,

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SUBJECT CODE: PEPE-121
SUBJECT NAME: Rapid Prototyping

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective VI

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 and use techniques for processing of CAD models for rapid prototyping
2	Understand and apply fundamentals of rapid prototyping techniques.
3	Use appropriate tooling for rapid prototyping process.
4	Use rapid prototyping techniques for reverse engineering.
5	Use various software for rapid tooling
6	Identify factors influencing accuracy and errors in part building

Detailed Contents:

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

Unit 1	**Introduction**	Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.	**8**
Unit 2	**Selective Laser Sintering Fusion Deposition Modelling**	Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications. Fusion Deposition Modelling: Principle, Process parameter, Path generation, Applications.	**8**
Unit 3	**Solid Ground Curing**	Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application.	**8**
Part B			
Unit 4	**Rapid Tooling**	Indirect Rapid tooling, Silicon rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Cast kirksite, 3Q keltool, etc. Quick cast process, Copper polyamide, Rapid Tool, DMILS, Pro metal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.	**10**
Unit 5	**Software For RP**	STL files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools.	**8**
Unit 6	**Rapid Manufacturing Process Optimization**	Factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.	**6**

Text Books:

3. Chua C K, Leong K F, Chu S L, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific.
4. Gibson D W Rosen, Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.
5. Noorani R, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons.

Additional Books:

1. Liou W L, Liou F W, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press.
2. Kamrani A K, Nasr E A, Rapid Prototyping: Theory and practice, Springer,

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SUBJECT CODE: PEPE-122

SUBJECT NAME: Mechatronics

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective VI

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 the role of biomedical engineering in society
2	Demonstrate the principles of various diagnostic devices.
3	Identify the various techniques used in diagnosis though imaging.

4	Describe the working principles of various therapeutic and assist devices.
5	Understand device specific safety goals and standards.
6	Illustrate the concepts of ethical theories and moral principles for the health professions.

Detailed Contents:

S. No.	Title	Content details(Part A)	Credit Hrs.
Unit 1	**Introduction**	Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach	**4**
Unit 2	**Fundamentals of electronics.**	Data conversion devices, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs.	**6**
Unit 3	**Drives:**	Stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems	**6**
Unit 4	**Hydraulic systems**	Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems.	**7**
		Part B	
Unit 5	**Description of PID controllers**	Description of PID controllers. CNC machines and part programming. Industrial Robotics.	**6**
Unit 6	**Electrical Systems**	Mathematical modeling of Electro Mechanical Systems, RLC Circuits, active and passive electrical circuits, PMDC Motor, Stepper motor, three phase squirrel cage induction motor, three phase permanent magnet synchronous motor, servo motor.	**6**
Unit 7	**Micro-Mechatronics**	Introduction, Micro-Mechatronics elements, Microprocessor, Micro-sensor, Micro actuator, Interface, Energy, Materials, Machining, Micro physics, Applications of Micro Mechatronics.	**6**
Unit 8	**Application of Mechatronics:**	Robotics, manipulator, sensors, controller, Kinematics of Robot, Robot End effecters & Actuators mechanical grippers, Tools as end effecters. Hydraulic devices, pneumatic devices, electric motors, other special actuators., Sensors and Artificial Intelligence Mechatronic Elements of Modern CNC Machines Other Mechatronic Applications Electronic Thermostat, Automatic Camera, Air fuel ratio controller in Automobiles, Digital Engine Control, Vehicle Motion Control, Mobile robots etc.	**7**

Text Books

1. HMT ltd. Mechatronics, Tata Mcgraw-Hill, New Delhi, 1988.
2. G.W. Kurtz, J.K. Schueller, P.W. Claar . II, Machine design for mobile and industrial applications, SAE, 1994.
3. T.O. Boucher, Computer automation in manufacturing - an Introduction, Chappman and Hall, 1996.
4. R. Iserman, Mechatronic Systems: Fundamentals, Springer, 1st Edition, 2005
5. Musa Jouaneh, Fundamentals of Mechatronics, 1st Edition, Cengage Learning, 2012

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SUBJECT CODE: PEPE- 123

SUBJECT NAME: Product Design and Development

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective VI

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos)
1	Use basic principles/elements of visual design.
2	Understand the concept of color and form in the context of ergonomics.
3	Principles of graphic design balance, proximity, alignment, repetition and contrast.
4	Apply and conceptualize the knowledge in product graphics and detailing/fabrication.
5	Apply and conceptualize the knowledge in product graphics and detailing/fabrication.
6	Design and develop the product in effective and innovative ways.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction to Product Design**	Importance of product design in industry. Principal requirements of good product design. Factors and considerations affecting product design. Product characteristics and economic analysis of product in terms of standardization, simplification and specialization. Challenges faced by industrial designers. Ergonomic factor in product design.	**8**
Unit 2	**Visual Design**	Basic elements and concepts of visual design, Product Aesthetics Analysis, Basic Form Elements, and Integrating Basic form. Concepts of size, texture, and color in Design. Basic principles of graphic design. Special relationships and composition in two and three dimensions.	**8**
Unit 3	**Aesthetic and Strength Consideration in Design**	Aesthetics and product design: Product Aesthetics Analysis, Elementary forms their characteristics and significance in design. Form transition, Form in relation to ergonomics, material and manufacturing process, color as an element of design, color clarification dynamics, interrelation of colors, colors and traditions; Psychological use of color form and material.	**8**
Part B			
Unit 4	**Product Graphics**	Meaning and objectives of product graphics. Basic principles of graphic design, Product graphics, product development and testing. Packaging materials their characteristics and applications. Packaging design considerations, Visual communication aspects of product graphics, Graphics of displays and control panels,	**8**
Unit 5	**Value Engineering**	Value engineering, concept, advantage and applications. Value, types of values. Analysis of function, using and evaluating functions. Value engineering techniques. Value control.	**8**
Unit 6	**Product development and Optimization**	Definition and objective, Role of designer in product development. Manufacturing and economic aspects of product development, Product promotions, product developments, Standard fastening and joining details in different materials, Temporary and permanent joints, Detailing for plastic products, Detailing for fabricated products in sheet metal.	**8**

Text Books:

1. Mayall W.H., "Industrial Design for Engineers",LondonLiifee Books Ltd. 1967.
2. Dale Huchingson R, "New Horizons for Human Factors in Design",McGraw Hill Company 19811.Indistrial Design-Mayall.
3. Mccormick K.J. (Ed), "Human Factor Engineering", McGraw Hill Book Company Ltd. USA 1992.
4. Moustapha Concurrent Engineering in Product design & development, New Age international

publisher.

Reference Books:

1. A.K.Chitale, R.C.Gupta, "Product Design and Manufacturing", Prentice-Hall of India, 6th Edition, 2013.
2. Karl T. Ulrich, Steven D. Eppinger, "Product Design and Development", McGraw-Hill, 6th Edition, 2013.
3. Kevin Otto & Kristin Wood Product Design: "Techniques in Reverse Engineering and new Product Development." 1 / e 2004 , Pearson Education New.
4. N.L. Svensson, "Introduction to Engineering Design", Kensington, N.S.W.: New South Wales University Press, 3rd Revised Edition, 1981.
5. R. Matousek, "Engineering Design: A Systematic Approach" Published by Blackie and Son, 1969.

SUBJECT CODE: PEPE-124

SUBJECT NAME: Surface Engineering

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective VI

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 Surface Engineering
2	Apply the different techniques of Surface Engineering in industrial sector
3	Understand the utilize the Advancements of Surface Engineering in the industrial sector
4	Understand the concept of Coatings
5	Understand the concept of characterization of Coatings on different products
6	Imply the uses coating for better product life and product finish

Detailed Contents:

S.No	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Fundamentals of surface engineering:**	Introduction: Engineering components, surface dependent properties and failures, importance and scope of surface engineering; Surface and surface energy: Structure and types of interfaces, surface energy and related equations; Surface engineering: classification, definition, scope and general principles	6
Unit 2	**Conventional surface engineering**	Surface engineering by material removal: Cleaning, pickling, etching, grinding, polishing, buffing / puffing (techniques employed, its principle). Role and estimate of surface roughness; Surface engineering by material addition: From liquid bath - hot dipping (principle and its application with examples); Surface engineering by material addition: Electrodeposition / plating (theory and its scope of application);Surface modification of steel and ferrous components: Pack carburizing (principle and scope of application); Surface modification of ferrous and non ferrous components: Aluminizing, calorizing, diffusional coatings (principle and scope of application); Surface modification using liquid/molten bath: Cyaniding, liquid carburizing (diffusion from liquid state) (principle and scope of application); Surface modification using gaseous medium: Nitriding	9

		carbonitriding (diffusion from gaseous state) (principle and scope of application).	
Unit 3	**Advanced surface engineering practices**	Surface engineering by energy beams: General classification, scope and principles, types and intensity/energy deposition profile; Surface engineering by energy beams: Laser assisted microstructural modification - surface melting, hardening, shocking and similar processes; Surface engineering by energy beams: Laser assisted compositional modification - surface alloying of steel and non-ferrous metals and alloys; Surface engineering by energy beams: Laser assisted compositional modification - surface cladding, composite surfacing and similar techniques; Surface engineering by energy beams: Electron beam assisted modification and joining; Surface engineering by energy beams: Ion beam assisted microstructure and compositional modification; Surface engineering by spray techniques: Flame spray (principle and scope of application); Surface engineering by spray techniques: Plasma coating (principle and scope of application); Surface engineering by spray techniques: HVOF, cold spray (principle and scope of application); Characterization of surface microstructure and properties (name of the techniques and brief operating principle).	9
Part B			
Unit 4	**Surface coatings and surface modifications:**	Evaporation - Thermal / Electron beam; Sputter deposition of thin films & coatings - DC & RF; Sputter deposition of thin films & coatings - Magnetron & Ion Beam; Hybrid / Modified PVD coating processes Chemical vapor deposition and PECVD; Plasma and ion beam assisted surface modification; Surface modification by Ion implantation and Ion beam mixing	8
Unit 5	**Characterization of coatings and surfaces:**	Measurement of coatings thickness; porosity & adhesion of surface coatings; Measurement of residual stress & stability; Surface microscopy & topography by scanning probe microscopy; Spectroscopic analysis of modified surfaces	9
Unit 6	**Functional Coatings & Applications :**	Functional and nano-structured coatings and their applications in photovoltaics, bio- and chemical sensors; Surface passivation of semiconductors & effect on electrical properties; Surface engineering of polymers and composites; Thin film technology for multilayers & superlattices for electronic, optical and magnetic devices; Modeling	7

Text Books

1. K.G. Budinski, Surface Engineering for Wear Resistances, Prentice Hall, Englewood Cliffs, 1988.
2. M. Ohring, The Materials Science of Thin Films, Academic Press Inc, 2005.
3. Peter Martin, " Introduction to Surface Engineering and Functionally Engineered Materials", John Willey
4. Mircea K. Bologa, " Surface Engineering and Applied Electrochemistry", Springer.
5. Devis, J.R.," Surface Engineering for Corrosion & Wear Resistance", 2001 Maney Publicsing..

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Industrial Engineering Group 8th Semester

SUBJECT CODE: PEPE-141

SUBJECT NAME: Research Methodology

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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 V

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 Research
2	Understand the concept of Formulation of Research Problem
3	Understand the concept of Various Data Collection Techniques
4	Understand the concept of Various Data Analysis Techniques
5	Understand the concept of Intellectual Property Rights
6	Understand the concept of Project Report Writing

Detailed Contents:

S. No.	Title	Content details(Part A)	Credit Hrs.
Unit 1	**Introduction**	Meaning of research, dissertation, thesis, Term paper, journal paper, concept notes, Research hypo thesis, need & justification, Novelty of Research, Characteristics and components of Research, Need based /specific problem solving (state / national), Topics identification, Search Procedures for statement and formulation of research problem, Literature survey, web search, textual reading, search engine application, online data search , use of internet, personal communication, bound journal/paid journal/ E-journals, institution repository, gateway,cross-ref, Scopus, Science Direct, Advanced search tools. Institution Library consultation/ borrow	**5**
Unit 2	**Research Formulation and Design**	Motivation and objectives – Research methods *vs.* Methodology. Types of research – Descriptive*vs*. Analytical, Applied *vs*. Fundamental, Quantitative *vs*. Qualitative, Conceptual *vs*. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.	**7**
Unit 3	**Data Collection and Analysis**	Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package Sigma STAT, Hypothesis Testing, Student Test, Error Analysis, Mean Squire Error , Box Analysis, Normalization of Data Series, Statistical Software SPSS, GRETL, Introduction to Evolutionary Algorithms - Fundamentals Of Genetic Algorithms, Simulated Annealing, Neural Network Based Optimization, Optimization of Fuzzy Systems. Use of Factors, ANN, ANOVA (BOTH WAYS), SIGNAL TO NOISE RATIO, Orthogonal Arrays,Replication and Data validation with predicted values	**8**

Unit 4	**Sampling:**	Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.	**7**
		Part B	
Unit 5	**Research Ethics, IPR and Scholarly Publishing**	Ethics-ethical issues, ethical committees (human & animal); IPR-intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectualproperty rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.	**7**
Unit 6	**Interpretation and Report Writing**	Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significanceof Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for WritingResearch Reports, Conclusions.	**7**
Unit 7	**Use of tools / techniques for Research:**	methods to search required information effectively,Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	**7**

Text Books

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction toResearch Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess EssPublications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic DogPublishing. 270p.
5. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
6. Day, R.A., 1992.How to Write and Publish a Scientific Paper, CambridgeUniversity Press.
7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
8. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess EssPublications.

Reference Books

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: AProcess of Inquiry, Allyn and Bacon.
4. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the
5. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design,Prentice Hall.
6. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
7. TRIPS agreement and policy options. Zed Books, New York.

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SUBJECT CODE: PEPE-142

SUBJECT NAME: MATERIALS MANAGEMENT

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective V

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 the scope and function of material management.
2	Develop the functions of purchasing, inventory management and receiving & shipping.
3	Apply business functions in the dynamic environment.
4	Explain inventory control techniques and evaluate different inventory alternatives/strategies
5	Analyze distinct concepts within material management and explain how these can be use materials and products in Industries.
6	Apply the concept of store management in an organization.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Material Management**	Scope and importance of materials and inventory Management, Functions and objectives of material Management. Introduction to Material Planning, Factors affecting Material Planning, Classification and Codification of Materials, Standardization and Simplification.	**9**
Unit 2	**Purchasing**	Introduction to Purchasing, Classification of Purchases, Principles of Scientific Purchasing, Objectives and functions of purchasing, Purchase Techniques, Purchasing Procedure, Quality considerations in purchasing.	**9**
Unit 3	**Material Handling**	Primary Handling activities- Receiving, In-storage Handling and shipping, Basic Handling Considerations, receiving functions.	**10**
		Part B	
Unit 4	**Inventory Control**	Inventory Costs, Inventory Classification, Inventory Management, Demand of Inventory, , lead time, stock outs, Lot Sizing, Push System vs. Pull System Inventory Control, Inventory Control Systems, Basic Stock Control Methods, Economic Order Quantity (EOQ) Models, Deterministic and Stochastic Models, EOQ and Quantity Discount, EOQ Model with Non-Instantaneous Receipt, EOQ Model with Planned Shortages, Finding the Optimal Order & Back Order Level Production Lot Size with Planned Shortages, simulation models for inventory analysis.	**10**
Unit 5	**Store Management**	Concept, Responsibilities and functions of store management, Types of stores, Coding, Store Accounting and Store Verification, Management of Surplus, Scrap and Obsolete Items.	**10**

Text Books:

1. Bhagde, S.D, "Production and Materials Management", U.S.G Publishers, 1995.
2. Plossl, G.W& Wight, O.W., "Production and Inventory Control", Prentice Hall, 1967.
3. Mahajan, M., "Industrial Engineering and Production Management", Dhanpat Rai & Co., 2007.

Additional Books:

1. Chary, S.N., "Production and Operations Management", Tata McGraw Hill.
2. Arora, K.C., "Production and Operations Management", Laxmi Publications.

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SUBJECT CODE: PEPE- 143

SUBJECT NAME: Probability and Statistics

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**Teaching Hours:** 48

Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 60%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Elective V

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 fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
2	Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
3	Apply the concept of testing of hypothesis for small and large samples in real life problems.
4	Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
5	Have the notion of sampling distributions and statistical techniques used in engineering and management problems.
6	Discuss critically the uses and limitations of statistical analysis.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1		Content	Hours
Unit 2	**Probability and Random Variables**	Definitions of Probability, Properties of Probability Function-I, Properties of Probability Function-II, Conditional Probability, Independence of Events, Problems in Probability, Random Variables, Probability Distribution of a Random Variable, Probability Distribution of a Random Variable-II.	**8**
Unit 3	**Two-Dimensional Random Variables**	Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).	**8**
Part B			
Unit 4	**Design of Experiments**	One way and Two way classifications, Completely randomized design, Randomized block design, Latin square design, 22 factorial designs.	**8**
Unit 5	**Statistics**	Population & Samples, Distribution of Sample Statistics, Point Estimation, Confidence Intervals, Hypothesis Testing, 1-way Anova, Simple Regression Model.	**8**
Unit 6	**Statistical and Quality Control**	Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits – Acceptance sampling	8

Text Books:

1. An Introduction to Probability and Statistics by V.K. Rohatgi & A.K. Md. E. Saleh.
2. Probability and Statistical Inference by Hogg, R. V., Tanis, E. A. & Zimmerman D. L.
3. Probability and Statistics in Engineering by W.W. Hines, D.C. Montgomery, D.M. Goldsman, C.M. Borror.
4. Introduction to Probability and Statistics for Engineers and Scientists by S.M. Ross.
5. Introduction to Probability and Statistics by J.S. Milton & J.C. Arnold.
6. Introduction to the Theory of Statistics by A.M. Mood, F.A. Graybill and D.C. Boes.

Reference Books:

1. "Statistics for Business and Economics" Paul Newbold, William L. Carlson and Betty Thorne, Upper Saddle River, N.J. : Prentice Hall, cop. 2007, 7th ed.

2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
4. Introduction to Probability Theory and Statistical Inference by H.J. Larson.
5. Probability and Statistics for Engineers and Scientists by R.E. Walpole, R.H. Myers, S.L. Myers, Keying Ye.
6. Modern Mathematical Statistics by E.J. Dudewicz & S.N. Mishra.

SUBJECT CODE: PEPE-145
SUBJECT NAME: PRODUCTION PLANNING AND CONTROL

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems: 2**0%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Elective VI

Additional Material Allowed in ESE: Scientific Calculator

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

CO#.	Course Outcomes (Cos)
1	Describe and analyze distinct concepts within production planning and explain how these can be used to plan and control the physical flow of information and products in the production companies.
2	Know about business forecasting and market survey in the dynamic environment.
3	Schedule production by using different techniques and evaluate different capacity alternatives/strategies to meet the customer demand.
4	Know about inventory control techniques and evaluate different inventory alternatives/ strategies.
5	Know about the concepts of JIT-I,JIT-II and Store room operations.
6	Demonstrate and apply the concept of Value Engineering.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Production Planning and Control (PPC)**	Introduction and Need of Production Planning and Control, Objectives, Phases and Functions of Production Planning and Control, parameters for PPC.	**6**
Unit 2	**Forecasting**	Introduction to Forecasting, uses of forecasts, types of forecasting, forecasting: needs and uses, Forecasting v/s Prediction, Basic Elements of Forecasting, Forecasting Error Measures, Forecasting Performance Measures, Steps in the Forecasting Process, Forecasting Models, Market Survey.	**8**
Unit 3	**Operations Planning and Scheduling Systems**	Components of Operations Planning and Scheduling System, Aggregate Planning (Objectives ,Process, Strategies, guidelines, methods, Advantages and Limitations), Master Production Schedule (MPS), Material Requirement Planning (MRP), Manufacturing Resources Planning (MRP II), Enterprise Resource Planning(ERP), Capacity Planning (Introduction, Measurement of Capacity Planning, Capacity Utilization and Efficiency, Estimate Capacity Requirements, Estimating Future Capacity Needs, Factors Influencing Effective Capacity), Routing (Advantages, Steps /procedure, Techniques), Scheduling (Purpose, Types, Principles, Inputs, Categories,	**10**

		Methodology/Techniques), Dispatching (Duties, Procedure and Rules of Dispatching)	
Part B			
Unit 4	**Inventory Control**	Inventory Costs, Inventory Classification, Inventory Management, Demand of Inventory, Lot Sizing, Push System vs. Pull System Inventory Control, Inventory Control Systems, Basic Stock Control Methods, Economic Order Quantity (EOQ) Models, Deterministic and Stochastic Models, EOQ and Quantity Discount, EOQ Model with Non-Instantaneous Receipt, EOQ Model with Planned Shortages, Finding the Optimal Order & Back Order Level Production Lot Size with Planned Shortages, JIT-I,JIT-II, computer application in Production and Inventory Control.	**8**
Unit 5	**Store-Room Operations**	Location and layout of store-room bins, pans and boxes used for storing, books and documents used in storing, decentralized stores, inspections function of store.	**8**
Unit 6	**Value Engineering**	Introduction to Value Engineering, Objectives of value analysis, , Difference between value analysis and value engineering, When to apply value analysis, Difference between Value Engineering and Cost Reduction, Value Engineering Job Plan, Techniques of value analysis/engineering, Advantages of Value Engineering.	**10**

Text Books:

1. Chase, Aquilano & Jacob, "Production/Operations Management", Tata McGraw Hill, New Delhi, 2000.
2. Krejewski, "Operations Management", Pearson Education Asia, New Delhi, 2002.
3. Ebert and Adams, "Production/ Operations Management", Prentice Hall of India, New Delhi, 2005.

Additional Books:

5. Chary, S.N., "Production and Operations Management", Tata McGraw Hill.
6. Arora, K.C., "Production and Operations Management", Laxmi Publications.

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SUBJECT CODE: PEPE-146

SUBJECT NAME: Entrepreneurship

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective VI

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 entrepreneurial quality.
2	Develop the ability to select potential areas for self-employment.
3	Select appropriate agency / ies for technical and financial support.
4	Prepare project setup planning and project report.
5	Explain SWOT analysis and strategies to achieve goals.
6	Identify risk factors of project and their remedial measures

Detailed Contents:

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

Unit 1	**Introduction**	Meaning and Importance, Evolution of term 'Entrepreneurship, Factors influencing entrepreneurship, Psychological, Social, Economic and Environmental factors, Characteristics of an entrepreneur, Entrepreneur and Entrepreneur, Types of entrepreneur- According to Type of Business , Use of Technology, Motivation, Growth and according to New generations of Entrepreneurship viz. social entrepreneurship, Edupreneurship, Health entrepreneurship, Tourism entrepreneurship, Women entrepreneurship etc. Barriers to entrepreneurship	**5**
Unit 2	**Entrepreneurial Motivation**	Motivation, Maslow's theory, Herjburg's theory, McGragor's Theory, McClelland's Need – Achievement Theory, Culture & Society, Values / Ethics and Risk taking behavior	**5**
Unit 3	**Creativity**	Creativity and entrepreneurship, Steps in Creativity, Innovation and inventions, Using left brain skills to harvest right brain ideas, Legal Protection of innovation, Skills of an entrepreneur, Decision making and Problem Solving (steps indecision making)	**6**
Unit 4	Organization Assistance	Assistance to an entrepreneur, New Ventures, Industrial Park (Meaning, features, & examples), Special Economic Zone (Meaning, features & examples) , Financial assistance by different agencie, MSME Act, Small Scale Industries, Carry on Business (COB) licence, Environmental Clearance, National Small Industries Corporation (NSIC), Government Stores Purchase scheme (e-tender process), Excise exemptions and concession, Exemption from income tax, Quality Standards with special reference to ISO, Financial assistance to MSME, Modernisation assistance to small scale unit, The Small Industries Development Bank of India(SIDBI), The State Small Industries Development Corporation(SSIDC), Export oriented units, Incentives and facilities to exports entrepreneurs,, Export oriented zone, Export-Import Bank of India, State Industrial Development Corporation (SIDC), State Financial Corporation (SFCs), Directorate General of Supplies and Disposals(DGS & D), Registration with DGS & D, Khadi and Village Industries Commission (KVIC), Industrial Estate, Financing of Industrial Estates	**6**
Part B			
Unit 5	**Rules and Legislation**	Applicability of Legislation, Industries Development (Regulations) Act, 1951, Factories Act, 1948., The Industrial Employment (Standing Orders) Act, 1946, Suspension, Stoppage of work, Termination of employment, Environment (Protection) Act, The sale of Goods Act, Industrial Dispute Act and other acts associated with Trade, Industry, Service and Corporate affaires amended by Parliament and State Assemblies	**6**
Unit 6	**Starting the venture**	generating business idea – sources of new ideas, methods of generating ideas, creative problem solving, opportunity recognition; environmental scanning, competitor and industry analysis; feasibility study: market feasibility, technical/operational feasibility, financial feasibility; drawing business plan; preparing project report; presenting business plan to investors, Selection of the Product / Service, Aspects of a Project, Phases of a Project, Project Report, Contents of a Project Report, Performa of a Suggested Project Report for a manufacturing Organization	**7**
Unit 7	**Functional plans**	marketing plan – marketing research for the new venture, steps in preparing marketing plan, contingency planning; organizational plan: form of ownership, designing organization structure, job design, manpower planning;	**7**

		Financial plan: cash budget, working capital, Performa income statement Performa cash flow, perform balance sheet, break even analysis, Sources of finance: debt or equity financing, commercial banks, venture capital; financial institutions supporting entrepreneurs; legal issues: intellectual property rights patents, trade marks, copy rights, trade secrets, licensing; franching.	
Unit 8	**New venture Expansion Strategies and Issues**	Features and evaluation of joint ventures, acquisitions, merges, franchising. Public issues, rights issues, bonus issues and stock splits.	**6**

Text Books

1. Entrepreneurship, Hisrich, Robert D., Michael Peters and Dean Shepherded, , Tata McGraw Hill,ND
2. Entrepreneurship, , Brace R., and R., Duane Ireland, , Pearson Prentice Hall, New Jersy (USA).
3. Entrepreneurship, Lall, Madhurima, and Shikha Sahai, , Excel Book, New Delhi.
4. Entrepreneurship Development and Small Business Enterprises, Charantimath, Poornima,Pearson Education, New Delhi.
5. Entrepreneurship development and Management Singal R.K , S.K.Kataria and Sons.

Reference Books

1. Developing Entrepreneurship Pareek & Co. Learning systems,Delhi.
2. Clifford and Bombak, Joseph R. Momanso.Entrepreneurship & Venture – Management
3. Manual for the preparation of industrial - feasibility studies UNIDO
4. New project opportunities GITCO
5. EDI STUDY MATERIAL EDI, BHAT, Ahmedabad Website : http://www.ediindia.org

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SUBJECT CODE: PEPE-147

SUBJECT NAME: QUALITY ASSURANCE

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective VI

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 Inspection in an industrial organization.
2	Develop in-depth knowledge of quality control and management.
3	Develop in-depth knowledge on various aspects of quality management systems
4	Apply various quality controls tools in the industries to enhance the quality.
5	Develop analytical skills for investigating and analyzing quality management issues in the industry and suggest implementable solutions to those.
6	Explain the concept of reliability.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Inspection**	Objectives and functions of inspection in industry, Inspection Planning, Types of Inspection, Difference Between Inspection And Quality Control, Non-Destructive Testing, Radiography, Magnaflux, Fluorescent Penetrant	**4**

		Inspection and Ultrasonic Testing, Organization of Inspection, computer aided inspection, economics of inspection, reference to relevant BIS codes.	
Unit 2	**Quality Control**	Quality control concept and objectives, Total Quality Control, organization for quality control, Quality Control Procedures, concept and use of Quality Circles. Total Quality Management, Quality assurance.	**6**
Unit 3	**Quality Management System (QMS)**	Introduction to QMS/certification system, benefits of a QMS, ISO 9001:2000 requirement, steps to registration, documentation requirements , principles in ISO 9000, Introduction to ISO 14000, elements and clauses of ISO 14001, benefits of implementation of ISO 14000,.	**5**
Part B			
Unit 4	**Statistical Quality Control**	Theory of statistical tolerances, general theory of control charts, control charts for variable and attributes, group control charts, control charts with variable group size, moving average and moving range charts acceptance control charts for trended universe average, cumulative sum control charts, difference control charts, use of Q.C. curves.	**8**
Unit 5	**Acceptance sampling**	Introduction to Acceptance sampling, multiple and sequential sampling plans, multi-level sampling plans, acceptance sampling by variables, advantages and limitations, sampling plans by using different criteria, techno-economic comparison of various types of sampling plans.	**8**
Unit 6	**Reliability**	Basic concept of reliability, its importance in quality design, methods for its improvement, failure rate curve, life testing, quality-reliability relationship.	**5**

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.

Elective Subjects Materials Group 8th Semester

SUBJECT CODE: PEPE-165

SUBJECT NAME: EXTREME ENVIRONMENTAL MATERIALS

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective V

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 behavior of high temperature materials
2	Assess behavior of various irradiation damage resistance materials
3	Understand the space environment and choosing materials for space applications
4	Analyze the high strain rate deformation behavior and capable of choosing or fabricating materials
5	Analyze the high strain rate deformation behavior and capable of choosing or fabricating materials
6	Select the appropriate method for solid waste collection, transportation, redistribution and disposal.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Fundamentals of high temperature deformation**	Creep - Mechanism - Deformation Mechanism Maps - Superplasticity - Engineering materials applied in extreme environments: structural materials at high temperatures such as gas turbine applications	**6**
Unit 2	**Introduction radiation resistance materials**	Radiation damage - half life period - irradiation damage resistance - BCC structures and ferritic grade steels for radiation damage resistance applications - Liquid sodium storage materials in nuclear industry - nuclear waste disposal.	**8**
Unit 3	**anomalous behavior of materials in space**	Engineering materials applied in extreme environments: spacecraft materials - reusable space vehicles - carbon-carbon composites (CCC).	**6**
Unit 4	**Understanding high strain rate deformation**	Elastic wave propagation - Materials under thermo-mechanical extremes (static vs dynamic; high-pressure phases; shock; detonation; cavitation; super-cooled liquids and glasses) - Shock resistant materials - armor grade materials.	**8**
		Part B	
Unit 5	**Materials for cryogenic applications -**	DBTT - FCC structures - Deformation behavior in cryogenic temperatures - cryorolling.	**6**
Unit 6	**Materials under electromagnetic extremes**	Dielectric breakdown; new phases under extreme magnetic fields; material synthesis with extreme electromagnetic fields	**8**

Unit 7	**Materials under thermomechanical extremes**	Static vs dynamic; high-pressure phases; shock; detonation; cavitation; supercooled liquids and glasses	**6**

Text Books:

1. G.E. Dieter, "Mechanical Metallurgy", Mc Graw Hill Publishers, NY,2002
2. Materials Under Extreme Conditions, Vincenzo Schettino and Roberto Bini, Imperial College Press, winter 2012.

Additional Books:

1. Basics of Solid and Hazardous Waste Mgmt. Tech. by Kanti L.Shah 1999, Prentice Hall.
2. Solid And Hazardous Waste Management 2007 by S.C.Bhatia Atlantic Publishers & Dist.

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SUBJECT CODE: PEPE-167

SUBJECT NAME: Bio Materials

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**Teaching Hours:** 48
Theory/Practical: Theory	**Credits:** 4
Internal Marks: 40	**Percentage of Numerical/Design/Programming Problems:** 15%
External Marks: 60	**Duration of End Semester Exam(ESE):** 3hr
Total Marks: 100	**Status:** Elective V

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 and know the structural variations in biomaterials.
2	Determine and classify the various properties of biomaterials.
3	Explain the methods for testing implants with different aspects of biomaterials
4	Recall the cell-biomaterial interactions for constructing artificial organs.
5	Remember the Interfacing materials and ethical implications.
6	Apply the biomaterials in the healthcare sectors.

Detailed Contents:

S. No.	Title	Content details(Part A)	Credit Hrs.
Unit 1	**Introduction**	Definition of biomaterials, requirements of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.	**4**
Unit 2	**Properties of Biomaterials**	Wound-healing and blood compatibility. Surface modification of biomaterials – plasma treatment, radiation grafting, self-assembled monolayers (SAMs), Langmuir – Blogett films and covalent biological coatings; Protein properties that affect biomaterial surface interaction; biomaterial surface interaction that affect interactions with proteins; Protein adsorption kinetics; DLVO model for cell adhesion; Assays to determine the effects of cell-material interactions – agar diffusion assay, adhesion assays and migration assays	**6**
Unit 3	**Biocompatibility**	Biocompatibility, Biocompatibility, Mechanical and Performance Requirements, Regulation. Biomaterials associated infection. Cytocompatibility evaluation laboratory, Tissue compatibility evaluation laboratory, Hemocompatibility evaluation laboratory, Sterility evaluation	**6**

		laboratory, Histopathology evaluation laboratory, Physiochemical evaluation laboratory., Toxicology Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization,carcinogenicity, mutagenicity and special tests.	
Unit 4	**Metallic implant materials**	Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress corrosion cracking. Host tissue reaction with biometal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.	**7**
Part B			
Unit 5	Polymeric implant materials	Polyolefins, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetals. (Classification according to thermosets, thermoplastics and elastomers). Viscoelastic behavior: creep-recovery, stressrelaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.	**6**
Unit 6	**Ceramic implant materials**	Definition of bioceramics. Common types of bioceramics: Aluminium oxides, Glass ceramics, Carbons. Bioresorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).	**6**
Unit 7	**Composite implant materials:**	Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenicfillers (e.g.hydroxyapatite). Host tissue reactions.	**6**
Unit 8	**Testing of biomaterials/ Implants**	In vitro testing (Mechanical testing): tensile, compression, wears, fatigue, corrosion studies and fracture toughness. In-vivo testing (animals): biological performance of implants. Ex- vivo testing: in vitro testing simulating the in vivo conditions. Standards of implant materials.	**7**

Text Books

1. J B Park, *Biomaterials - Science and Engineering*, Plenum Press , 1984.
2. Joon Bu Park, Roderic S, Lakes, "Biomaterials", Springer-Verlag, New York Inc., 2010.
3. Bronzino JD, ed. The Biomedical Engineering Handbook, Second Edition, Vol-II, CRC Press
4. John B.Park Joseph D. Bronzino, "Biomaterials - Principles and Applications" CRC Press, 4th edition, 2003.
5. Hench J. Jones, "Biomaterials, Artificial Organs and Tissue Engineering", Woodhead Publishing, 2005.
6. Michael Lysaght and Thomas Webster, "Biomaterials for artificial Organs", Woohead Publishing series in biomaterials, 2010
7. Sujata V. Bhatt, "Biomaterials" Second Edition, Narosa Publishing House,2005.
8. Rajendran V. and Marikani A., Materials Science, Tata McGraw Hill Pub. Company Ltd., New Delhi, 2004
9. Ratner A, and S.Hoffman, B. D. "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press; 3 edition,November 8, 2012.

Additional Books

1. Jonathan Black, *Biological Performance of materials*, Marcel Decker, 1981
2. C.P.Sharma & M.Szycher, *Blood compatible materials and devices*, Tech.Pub.Co. Ltd., 1991.
3. Piskin and A S Hoffmann, *Polymeric Biomaterials* (Eds), Martinus Nijhoff Publishers.
4. Eugene D. Goldbera , *Biomedical Ploymers*, Akio Nakajima.
5. L. Hench & E. C. Ethridge, *Biomaterials - An Interfacial approach.*
6. Buddy D.Ratner, Allan S. Hoffman, Biomaterial Sciences – Int. to Materials in Medicine.
7. Chua, Chena.J.Y, Wanga.L.P, N.Huang, *"Plasma-surface modification of biomaterials"*, Materials Science and Engineering: R: Reports, Volume36, Number 5, 29 March 2002, pp. 143-206 (64).

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SUBJECT CODE: PEPE-168
SUBJECT NAME: WASTE MATERIAL & MANAGEMENT

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective V

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 municipal solid waste management systems with respect to its physical properties, and associated critical considerations in view of emerging technologies
2	Outline sources, types and composition of solid waste with methods of handling, sampling and storage of solid waste.
3	Describe the techniques of disposal of radioactive waste
4	Describe methods of disposal of hazardous solid waste.
5	Design the landfills for proper waste disposal.
6	Select the appropriate method for solid waste collection, transportation, redistribution and disposal.

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Relevant Regulations**	Municipal solid waste (management and handling) rules; hazardous waste (management and handling) rules; biomedical waste handling rules; flyash rules;recycled plastics usage rules; batteries (management and handling) rules	**6**
Unit 2	**Municipal Solid Waste Management Fundamentals**	Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options	**4**
Unit 3	**Hazardous Waste Management Fundamentals**	Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects	**6**
Unit 4	**Radioactive Waste Management Fundamentals**	Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options	**6**
Part B			

Unit 5	**Environmental Risk Assessment**	Defining risk and environmental risk; methods of risk assessment; case studies	**5**
Unit 6	**Physicochemical Treatment of Solid and Hazardous Waste**	Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation	**8**
Unit 7	**Biological Treatment of Solid and Hazardous Waste**	Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation	**8**
Unit 8	**Landfill design**	Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration	**5**

Text Books:

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994.
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997.

Additional Books:

1. Basics of Solid and Hazardous Waste Mgmt. Tech. by Kanti L.Shah 1999, Prentice Hall.
2. Solid And Hazardous Waste Management 2007 by S.C.Bhatia Atlantic Publishers & Dist.

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SUBJECT CODE: PEPE-170
SUBJECT NAME: HAZARDOUS MATERIALS

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective VI

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 behavior of hazardous materials
2	Assess the chemical properties of hazardous materials
3	Describe the regulations for the use and disposal of hazardous materials
4	Analyze the high risk of using radioactive and explosive materials
5	Analyze the high associated with hazardous organic compounds/ materials
6	Select the appropriate method for collection, transportation, redistribution and disposal of hazardous materials

Detailed Contents:

S.No.	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Introduction**	Characteristics of Hazardous Substances, Hazardous Substances in the Workplace, Hazardous Materials in Transit, NFPA System of Identifying Hazardous Materials, CHEMTREC, National Response Center, Hazardous Materials on the Internet.	**6**

Unit 2	**Principals of Chemical Reactions**	The Chemical Reaction, Balancing Chemical Equations, Types of Chemical Reactions, Oxidation-Reduction Reactions, Factors Affecting the Rates of Reactions, Combustion, Energetics of Chemical Reactions, Spontaneous Combustion, The Fire Tetrahedron, Water as an Extinguisher, Carbon Dioxide as an Extinguisher, Halon Fire Extinguishers, Dry Chemical Extinguishers.	**6**
Unit 3	**Hazardous Materials Regulations**	The Shipping Paper, DOT Labels, DOT Markings, DOT Placards, DOT Classification of Hazardous Substances, Responding to Hazardous Material Disasters, Reporting Hazardous Substance Releases.	**4**
Unit 4	**Water-Reactive Substances**	Alkali Metals, Combustible Metals, Aluminum Alkyl Compounds, Metal Hydrides, Metal Phosphides, Metal Carbides, Water-Reactive Substances that Produce Hydrochloric Acid.	**6**
Part B			
Unit 5	**Toxic Substances**	Definition of Toxic Substances, Routes of Entry into the Body, Health Effects of Toxic Substances, Factors Affecting Toxicity, Measuring Toxicity, Toxic Substances at the Fire Scene, Carbon Monoxide, Hydrogen Cyanide, Sulfur Dioxide, Hydrogen Sulfide, Nitrogen Dioxide, Ammonia, Responding to Disasters Involving Toxic Substances Poisonous Metals, Asbestos, Pesticides.	**8**
Unit 6	**Hazardous Organic Compounds**	Definition of Organic Compounds, Aliphatic Hydrocarbons, Gaseous Hydrocarbons, Aromatic Hydrocarbons, Petroleum and Petroleum Products, Functional Groups, Halogenated Hydrocarbons, Alcohols, Ethers, Aldehydes and Ketones, Organic Acids, Esters, Amines, Peroxo-Organic Compounds, Carbon Disulfide.	**5**
Unit 7	**Explosive Materials**	General Characteristics of Explosive Materials, Classification of Explosives and Blasting Agents, Storing Explosives, DOT Regulation of Explosives, Black Powder, Nitroglycerine, Dynamite, Nitrocellulose, Cyclonite, Tetryl, PETN, Primary Explosives, Responding to Disasters Involving Explosives.	**5**
Unit 8	**Radioactive Materials**	The Atomic Nucleus, Types of Radiation, Modes of Nuclear Decay, Detection and Measurement of Radioactivity, Adverse Effects of Exposure to Radiation, Effects of Ionizing Radiation, Effects of Radiation on Matter, Nuclear Fission, Transporting Radioactive Materials, Radon.	**8**

Text Books:

1. Jones and Bartlett Learning, Hazardous Materials Awareness and Operations, 3 rd Edition.
2. NFPA 472, Standard for Professional Competence of Responders to Hazardous Materials Incidents, Current Edition.

Additional Books:

1. Jones and Bartlett Learning, Fundamentals of Fire Fighter Skills, 2nd Edition.

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SUBJECT CODE: PEPE-171

SUBJECT NAME: Smart Materials

Programme: B. Tech. (PE)	**L:** 3 **T:** 0 **P:** 0
Semester: 8	**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:** Elective VI

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 properties of Smart Material
2	Understand the properties of Smart Composites
3	Apply the Advancements of Smart Materials and Structures in Industrial Sector
4	Understand the properties of Electro-Rheological Smart Material
5	Understand the properties of Piezoelectric Smart Material
6	Understand the properties of Shape Memory Smart Material

Detailed Contents:

S.No	Title	Content details (Part A)	Credit Hrs.
Unit 1	**Overview Of Smart Materials**	Introduction to Smart Materials, Principles of Piezoelectricty, Perovskyte Piezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rhelological Fluids	6
Unit 2	**Smart Composites**	Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams	7
Unit 3	**Advances In Smart Structures & Materials**	Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, SelfHealing Polymers, Intelligent System Design, Emergent System Design	7
Part B			
Unit 4	**Smart Materials And Structural Systems**	The principal ingredients of smart materials – Thermal materials – Sensing technologies – Micro sensors – Intelligent systems – Hybrid smart materials – An algorithm for synthesizing a smart material – Passive sensory smart structures– Reactive actuator based smart structures – Active sensing and reactive smart structures – Smart skins – Aero elastic tailoring of airfoils – Synthesis of future smart systems	7
Unit 5	**Electro-Rheological Smart Materials**	Suspensions and electro-rheological fluids – Bingham-body model – Newtonian viscosity and non-Newtonian viscosity – Principal characteristics of electro rheological fluids – The electro-rheological phenomenon – Charge migration mechanism for the dispersed phase	7
Unit 6	**Piezoelectric Smart Materials**	Background – Electrostriction – Pyro electricity – Piezoelectricity – Industrial piezoelectric materials – PZT – PVDF – PVDF film – Properties of commercial piezoelectric materials – Properties of piezoelectric film (explanation) – Smart materials featuring piezoelectric elements – smart composite laminate with embedded piezoelectric actuators – SAW filters	7
Unit 7	**Shape – Memory (Alloys) Smart Materials**	Background on shape – memory alloys (SMA) Nickel – Titanium alloy (Nitinol) – Materials characteristics of Nitinol – Martensitic transformations – Austenitic transformations – Thermo elastic martensitic transformations – Cu based SMA, chiral materials – Applications of SMA – Continuum applications of SMA fasteners – SMA fibres – reaction vessels, nuclear reactors, chemical plants – Micro robot actuated by SMA – SMA memorisation process (Satellite antenna applications) SMA blood clot filter – Impediments to applications of SMA	7

Text Book:

1. M.V.Gandhi and B.S. Thompson, Smart Materials and Structures Chapman and Hall, London, First Edition, 1992
2. T.W. Deurig, K.N.Melton, D.Stockel and C.M.Wayman, Engineering aspects of Shape Memory alloys, Butterworth –Heinemann, 1990

Reference Book:

1. C.A.Rogers, Smart Materials, Structures and Mathematical issues, Technomic Publising Co., USA, 1989
2. Srinivasan A V and Michael McFarland, "Smart Structures: Analysis and Design", Cambridge University Press, UK, 2001
3. Smith, C.: Smart material systems, Ralph, SIAM, 2005
4. Vijay, K., Varadan K., Vinoy J. Gopalakrisham S.: Smart Material Systems and MEMS: Design and Development Methodologies , Willey 2006
5. Addington, M. , Schodek, Daniel L.: Smart materials and new technologies, Architectural Press, 2005

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