SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA(A CENTRAL UNIVERSITY)
CBCS-NEW, STUDY & EVALUATION SCHEME
PROPOSED W.E.F. SESSION 2021-2022
M.Tech. I Year (SEMESTER I)

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	SUB-TOTAL	
1.	**MEPATT1**	Advanced Mechanics of Solids	3	-	-	40	60	100	3
2.	**MEPATT2**	Advanced Computer Aided Design	3	-	-	40	60	100	3
3.		Professional Elective-1	3	-	-	40	60	100	3
4.		Professional Elective-2	3	-	-	40	60	100	3
5.		Professional Elective-3	3	-	-	40	60	100	3
6.	**IPPATC1**	Research Methodology & IPR	2	-	-	-	50	50	2
		Total	**17**	**-**	**-**	**240**	**360**	**600**	**17**
PRACTICALS									
1.	**MEPAPT1**	Numerical Simulation Lab	1	-	2	30	20	50	2
		Total	**1**	**-**	**2**	**30**	**20**	**50**	**2**
GRAND TOTAL			**18**	**-**	**2**	**270**	**380**	**650**	**19**

Total Credits : **19**
Total Contact Hour : **20**
Total Marks : **650**

*INTERNAL ASSESSMENT- Two Class Test of 15 Marks and Assignments, Attendance etc. of 10 Marks.
L-LECTURE, T-TUTORIAL, P-PRACTICAL, ESE –END SEMESTER EXAMINATION

Professional Elective-1	**Professional Elective-2**	**Professional Elective-3**
MEPATP1-Mechanics of Composite Materials	MEPATP2-Advanced Engineering Materials	MEPATP3-Mechanical Vibrations
MEPATP4-Design of Thermal Systems	MEPATP5-Design and Analysis of Experiments	MEPATP6-Advanced Mechanical Design
MEPATP7-Tribology and Surface Engineering	MEPATP8-Design for Manufacturing & Assembly	MEPATP9-Advanced Synthesis of Mechanisms

Subject:	**Advanced Mechanics of Solids (MEPATT1)**	**Credits**			
Type:	Programme Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Analyse state of stresses and strains in a 3-D continuum

2 Establish stress-strain relations for deformable solids

3 Apply energy methods to deformable solids

4 Evaluate stresses in symmetrical and asymmetrical beams

5 Analyse thin wall beams, torsional bars and axisymmetric problems

Syllabus Contents:

Module 1: Analysis of Stress: Introduction, Body Force, surface force and stress tensor, The state of stress at a point, Normal, Shear and Rectangular stress components, Stress components on an arbitrary plane, Equality of cross shears, A more general theorem, Principal stresses, Stress invariants, Principal planes, cubic equations, The state of stress referred to principal axes, Mohr's circles for the 3-D state of stress, Octahedral stresses, the state of pure shear, Lame's Ellipsoid, The plane state of stress, Differential equations of equilibrium, Equations of equilibrium in cylindrical coordinates, Axisymmetric case and plane stress case.

Module 2: Analysis of Strain: Introduction, Deformations in the neighborhood of a point, Change in length of a linear element, Change in length of a linear element-linear components, The state of strain at a point, Interpretation of shear strain components, Cubical dilatation, angle between two line elements, Principal axes of strain and principal strains, Plane state of strain, Plane strains in polar coordinates, Compatibility conditions.

Module 3: Stress-Strain Relations for Linearly Elastic Solids: Introduction, generalized statement of Hooke's law, Stress-strain relations for isotropic materials, Modulus of rigidity, bulk modulus, Young's modulus and poison's ratio, Relation between the elastic constants, Displacement equations of equilibrium.

Module 4: Energy Methods: Hooke's law and the principle of superposition, Work done by forces and elastic strain energy, Maxwell-Betti-Rayleigh Reciprocal theorem, First and second theorem of Castigliano, expressions for strain energy when an elastic member is subjected to axial force, Shear force, Bending moment and Torsion. Theorem of virtual work, Kirchhoff's theorem.Bending of Beams: Straight beams and asymmetrical bending, shear center or center of flexure, shear stresses in thin walled open sections: Bending of curved beams (Winkler –Bach formula).

Module 5: Torsion: Torsion of general prismatic bars-solid sections, Torsion of circular, elliptical, triangular bars, Torsion of thin walled tubes and multiple closed sections, center of twist and flexure center.Axi-symmetric Problems: Thick walled cylinder subjected to internal and external pressures-Lames-problems, sphere with purely radial displacements, rotating disc of uniform thickness, rotating shafts and cylinders.

References:

- L.S. Srinath, Advanced Mechanics of Solids, 3rd Edition, TMH, 2009
- Crandall, S.H.,DallN.C.and Lardner T.J.,An Introduction to Mechanics of Solids, McGraw-Hill
- Irving H. Shames, Mechanics of Deformable Solids, Krieger Pub Co, 2008
- Boresi,A.P.,andSidebottom,O.M., Advance Mechanics of Materials, John Willey and sons
- Clive L. Dym and Shames I.H., Solid Mechanics: A Variational Approach, Engineering ScienceSeries

Subject: **Advanced Computer Aided Design (MEPATT2)**

		Credits			
Type:	Programme Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Apply geometric transformations and projection methods in CAD

2 Develop geometric models to represent curves

3 Design surface models for engineering design

4 Model engineering components using solid modelling techniques for design

5 Analyze the solid model and able to calculate its property through basic fundamental of FEM

Syllabus Contents:

Module-I: Introduction: Introduction to CAE, CAD. Role of CAD in Mechanical Engineering, Design process, software tools for CAD, Geometric modelling.Introduction to Geometric Modeling for Design: Introduction to CAGD, CAD input devices, CAD output devices, CAD Software, Display Visualization Aids, and Requirements of Modelling.

Module-II: Transformations in Geometric Modeling: Introduction, Translation, Scaling, Reflection, Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. Computer-Aided assembly of rigid bodies, Applications of transformations in design and analysis of mechanisms, etc. Implementation of the transformations using computer codes.

Module-III: Projections: Projective geometry, transformation matrices for Perspective, Axonometric projections, Orthographic and Oblique projections. Implementation of the projection formulations using computer codes.Basics of curves, parametric and non-parametric curves, analytical and synthetic curves, parametric representation of analytical and synthetic curves, Hermite curves, curve manipulations, Bèzier curves, B-splines, rational curves, wire frame models.

Module-IV: Surfaces in Geometric Modeling for Design: Differential geometry of surfaces, Parametric representation, Curvatures, Developable surfaces. Surfaces entities (planar, surfac of revolution, lofted etc). Free-for surface models (Hermite, Bezier, B-spline surface). Boundary interpolating surfaces (Coon’s). Implementation of the all the surface models using computer codes.

Module-V: Solids in Geometric Modeling for Design: Solid entities, Boolean operations, Topological aspects, Invariants. Write-frame modeling, B-rep of Solid Modelling, CSG approach of solid modelling. Popular modeling methods in CAD softwares. Data Exchange Formats and CAD Applications; analytic solid modeling (ASM), introduction to finite element method (FEM), 1-D FEM analysis.

References:

- Zeid I. & Subramanian R. S., CAD/CAM Theory and practice, Tata McGraw Hill.
- Michael E. Mortenson, Geometric Modeling, Tata McGraw Hill, 2013
- A. Saxena and B. Sahay, Computer-Aided Engineering Design, Anamaya Publishers, New Delhi, 2005
- Rogers, David F., An introduction to NURBS: with historical perspective,Morgan Kaufmann Publishers, USA, 2001
- David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, TMH, 2008
- Newman W.M.&SproullR.F.,Principles of Interactive Computer Graphics,Tata McGraw Hill.
- Groover M.P. &Zimmers E.,CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education

Subject:	**Tribology and Surface Engineering (MEPATP7)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Analyze properties of lubricant and select proper lubricant for a given application.

2 Identify tribological performance parameters of sliding contact in different lubrication regimes

3 Design and select appropriate bearings for a given application

4 Predict the type of wear and volume of wear in metallic and polymer surfaces

5 Understand the physical chemistry related to interface/surface such as formation of interface and adsorption to solid surface

Syllabus Contents:

Module I: Introduction to Tribology, friction, wear and lubrication

Module II: Chemical and physical state of the solid surface and of lubricants

Module III: Hydrodynamic lubrication, Elasto-Hydrodynamic lubrication, Boundary lubrication

Module IV: Coating deposition by hard facing – Flame spraying, thermal plasma and HVOF spraying; Coating deposition from the vapour phase (CVD, PVD, PECVD); Surface treatments by thermal and chemical processes

Module V: Tribological applications of materials, Coatings, and surface treatments, Case studies.

References:

- Bhushan, B., Gupta, B.K, Handbook of tribology : materials, coatings, and surface treatments, New York : McGraw-Hill, c1991
- Holmberg, K, Coatings tribology : properties, techniques, and applications in surface engineering, New York, 1994
- Stolarski, T. A, Tribology in machine design, Oxford : Heinemann Newnes, 1990
- Stachowaik, G.W., Batchelor, A.W., Engineering Tribology, 3rd Ed., Elsevier, 2010.
- Andras Z. Szeri, Fluid film lubrication theory and design, Cambridge University press, 1998.
- Neale MJ, Tribology Hand Book, CBS Publications, 2012
- Williams JA, Engineering Tribology, Oxford Univ. Press, 2001
- Cameron A, Basic lubrication theory, Ellis Horwood Ltd., 2002

Subject:	**Mechanics of Composite Materials (MEPATP1)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand the characteristics of composite materials

2 Select suitable manufacturing processes to develop fiber reinforced composites.

3 Analyze the micro and macro mechanical behavior of fiber reinforced composites

4 Develop the governing equations for bending, buckling and vibration of laminated plates

5 Design the composite structures for engineering applications

Syllabus Contents:

Module-I: Introduction to composite materials: Classification and characteristics of composite materials, Mechanical behavior of composite materials, Basic terminology of laminated fiber reinforced composite materials, Manufacturing of laminated fiber reinforced composite materials.

Module-II: Techniques for composites manufacturing: Hand laminating (or Wet Lay-up) and the Autoclave processing of composites, Filament winding and fiber placement, Pultrusion, Liquid composite molding.

Module-III: Micromechanical behavior of lamina: Stress-strain relation for anisotropic materials, Stiffness, Compliances, Engineering constants, Restriction on Engineering constants, Stress- strain relation for plane stress in orthotropic materials.

Module-IV: Macro mechanical behavior of laminates and plate theories: Elastic approach to stiffness, Mechanics of materials approach to stiffness, Mechanics of materials approach to strength, Classical laminate theory, Special cases of laminate stiffness, Strength of laminates, Inter laminar stresses, Axisymmetric shells.

Module-V: Bending, Buckling, and Vibration of Laminated Composites: Governing equations for Bending, Buckling, and Vibration of laminated plates, Deflection of simply supported laminated composites.

References:

- Ronald F. Gibson, Principles of composite material mechanics, CRC Press, 2011
- Robert M Jones, Mechanics of Composite Materials, Taylor & Francis, 2000
- Lawrence E. Nielsen, Nielson, Paul Nielsen, Mechanical Properties of Polymers and Composites, Second Edition, CRC press, 2000

Subject:	**Design of Thermal Systems (MEPATP4)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand engineering design for thermal systems

2 Formulate design problem for a given thermal system

3 Prepare mathematical model of a thermal system

4 Apply numerical modelling techniques for thermal systems

5 Apply design considerations for different applications and evaluate economic considerations

Syllabus Contents:

Module-I: Introduction – Engineering design, Design as part of Engineering Enterprises, Thermal systems

Module-II: Basic considerations in Design – Formulation of the design problem, Conceptual design, Steps in the design process, Computer aided design of thermal systems, Materials selection

Module-III: Modelling of Thermal Systems – Introduction, Types of models, Mathematical modelling, Physical modelling, and dimensional analysis, curve fitting

Module-IV: Numerical Modelling and Simulation – Numerical modelling, Solution procedures, Numerical model for a system, System simulation, Methods for numerical simulation

Module-V: Design of Thermal Systems – Introduction, Design strategies, Design of system from different application areas, Additional considerations for large practical systems, Economic considerations.

References:

- Yogesh Jaluria, Design and Optimization of Thermal Systems, 2nd Edition, CRC Press 2008
- W.F. Stoecker, Design of Thermal Systems, 3rd Edition, McGraw Hill
- William S. Janna, Design of Fluid Thermal Systems, 4th Edition, Cengage Learning

Subject:	**Advanced Engineering Materials (MEPATP2)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand the bonding and atomic structure of solids

2 Identify and draw the phase diagrams

3 Analyze the types of failure of solids

4 Apply the principles of heat treatment processes of materials

Syllabus Contents:

Module-I: Introduction, Atomic Structure, Interatomic Bonding and Structure of CrystallineSolids:Historical perspective of Materials Science. Why study properties of materials? Classification ofmaterials. Advanced Materials, Future materials and modern materials, Atomicstructure. Atomicbonding in solids, Crystal structures, Crystalline and noncrystalline materials. Miller indices.Anisotropic elasticity. Elastic behaviour of composites. Structure and properties of polymers.

Module-II: Imperfections in Solids and Mechanical Properties of Metals, Diffusion, Dislocationsand Strengthening Mechanisms:Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk orvolume defects. Atomic vibrations;Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yieldingunder multiaxial stress. Yield criteria and macroscopic aspects of plastic deformation. Propertyvariability and design factors, Diffusion mechanisms. Steady and non-steady state diffusion.Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocationand plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization andgrain growth. Strengthening by second phase particles. Optimum distribution of particles. Latticeresistance to dislocation motion.

Module-III: Phase DiagramsEquilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions.Kinetics of nucleation and growth. The iron-carbon system. Phase transformations.Transformation rate effects and TTT diagrams. Microstructure and property changes in iron-carbonsystem, Failure:Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittletransition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalizedcreep behaviour. Stress and temperature effects

Module-IV: Applications and Processing of Metals and Alloys, Polymers, Ceramics, andcomposites:Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment.Precipitation hardening. Types and applications of ceramics. Fabrication and processing ofceramics, Mechanicalbehaviour of polymers. Mechanisms of deformation and strengthening ofpolymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis andprocessing, Particle reinforced composites. Fibre reinforced composites. Structural composites, Introduction to Functionally Graded materials

Module-V: Electrical, Thermal, Optical and Magnetic Properties and economic Considerations:Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionicceramics and in polymers. Dielectric behaviour. Ferroelectricity. PiezoelectricityHeat capacity. Thermal expansion. Thermal conductivity. Thermal stressesDiamagnetism and Para magnetism. Ferromagnetism, Antiferromagnetism and ferrimagnetism.Influence of temperature on magnetic behaviour. Domains and Hysteresis,Basic concepts. Optical properties of metals. Optical properties of non-metals. Application ofoptical phenomena.Economic, Environmental and Social Issues of Material Usage - Economic considerations.Environmental and societal considerations. Recycling issues. Life cycle analysis and its use indesign

References:

- William D. Callister, Jr, Materials Science and Engineering, John Wiley & sons
- Smallman R.E., Bishop R J, Butterworth Heinemann, Modern Physical Metallurgy and Material Engineering Science, Process, application, Sixth Ed., 1999

Subject:	**Design and Analysis of Experiments (MEPATP5)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Formulate objective(s) and identify key factors in designing experiments for a given problem

2 Develop appropriate experimental design to conduct experiments for a given problem

3 Analyze experimental data to derive valid conclusions

4 Optimize process conditions by developing empirical models using experimental data

5 Design robust products and processes using parameter design approach

Syllabus Contents:

Module-I: Fundamentals of Experimentation: Role of experimentation in rapid scientific progress, Historical perspective of experimental approaches, Steps in experimentation, Principles of experimentation; Error and Uncertainty Analysis

Module-II: Simple Comparative Experiments: Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA;

Module-III: Experimental Designs: Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data;

Module-IV: Response Surface Methodology: Concept, linear model, steepest ascent, second order model, regression;

Module-V: Taguchi's Parameter Design: Concept of robustness, noise factors, objective function & S/N ratios, inner-array and outer-array design, data analysis

References:

- Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008
- Ross PJ, Taguchi Techniques for Quality Engineering, McGraw-Hill Book Company, NY, 2008

Subject: **Design for Manufacturing and Assembly (MEPATP8)**

		Credits			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand the quality aspects of design for manufacture and assembly

2 Apply Boothroyd method of DFM for product design and assembly

3 Apply the concept of DFM for casting, welding, forming and assembly

4 Identify the design factors and processes as per customer specifications

5 Apply the DFM method for a given product

Syllabus Contents:

Module-I: Introduction to DFM, DFMA: Working of DFMA, Reasons for Not Implementing DFMA, Advantages of Applying DFMA during Product Design, Typical DFMA Case Studies, Overall Impact of DFMA on Industry.

Module-II: Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

Module-III: High speed Automatic Assembly & Robot Assembly: Design of Parts for High-Speed Feeding and Orienting, Additional Feeding Difficulties, High-Speed Automatic Insertion, General Rules for Product Design for Automation, Design of Parts for Feeding and Orienting, Product Design for Robot Assembly.

Module-IV: Design for Machining and Injection Molding: Cost Estimating for Machined Components, Injection Molding Materials, Estimation of the Optimum Number of Cavities, Design Guidelines. Design for Sheet Metal working & Die Casting: Turret Press working, Press Brake Operations, Design Rules, Design Principles.

Module-V: Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

References:

- Geoffrey Boothroyd, Assembly Automation and Product Design, Marcel Dekker Inc., NY, 3rd Edition,2010
- Geoffrey Boothroyd, Hand Book of Product Design, Marcel Dekker Inc., NY, 1992

Subject:	**Advanced Synthesis of Mechanisms (MEPATP9)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand basic mechanisms and machines and formulate the design problem

2 Develop analytical equations for relative position, velocity and acceleration of all moving links

3 Analyze Simple and Complex mechanisms

4 Apply the knowledge of Kinematic theories to practical problems of mechanism design and synthesis

5 Design higher pair kinematic linkages for a given application

Syllabus Contents:

Module-I: Introduction: review of kinematic chains, equivalent chains and their inversions.Position analysis: position and systems, co-ordinate transformation, rotation, translation and combined motion, algebraic position analysis, loop closure equations, position of any point on a linkage, transmission angles and toggle positions, position based synthesis of planar mechanisms.

Module-II: Kinematics of rigid bodies: plane motion of a rigid body, graphical velocity and acceleration analysis, instantaneous centers of velocity, centrodes, velocity of rub, analytical solutions for velocity analysis – velocity of any point on a linkage, acceleration of any point on a linkage, Coriolis acceleration, analytical solutions for velocity and acceleration analysis , case studies – four-bar pin joined linkage, four link slider-crank.

Module-III: Analytical linkage synthesis: types of kinematic synthesis – motion and path generation, number synthesis, dimensional synthesis, two position synthesis for rocker output, precision points, comparison of analytical and graphical two position synthesis, three position synthesis.

Module-IV: Graphical linkage synthesis: two position synthesis for rocker output, three position synthesis, position synthesis for more than three positions(four and six bar quick return), coupler curves, exact and approximate straight line mechanisms.

Module-V: Cam: terminology, types of follower, follower motions, cams, svaj diagrams, law of cam design, single and double dwell cam design using shm, cycloidal displacement, combined functions, critical path motion, practical design considerations.Gears and gear trains: law of gearing, involute tooth form, pressure angle, backlash, contact ratio, interference and method to avoid interference, gear train and its analysis.

References:

- A K Mallik, Amitabha Ghosh and Guntur, D Kinematics Analysis and Synthesis of Mechanisms, CRC Press, 2011
- Parviz E Nikravesh, Planar Multibody Dynamics, CRC Press, 2016
- Robert L Norton, Design of Machinery An Introduction to the Synthesis and Analysis of Mechanisms and Machines, 2nd Edition, McGraw Hill reprint 2011
- Sandor and Erdman, Advanced Mechanism Design: Analysis and Synthesis, vol II, PHI, New Delhi, 2010
- Shigley, Pennock and Uicker, Theory of Machines and Mechanisms, 4th Edition, Oxford University Press, 2011

Subject:	**Mechanical Vibrations (MEPATP3)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1. Exemplify and summarise the causes and effects of vibration in mechanical systems and identify discrete and continuous systems
2. Model the physical systems in to schematic models and formulate the governing equations of motion
3. Infer the role of damping, stiffness and inertia in vibratory systems
4. Analyze the Rotating/reciprocating systems and compute the critical speeds
5. Analyze and design machine supporting structures, Vibration Isolators, Vibration Absorbers

Syllabus Contents:

Module-I: Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models.SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert's method, Energy method; Free Vibration: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation.

Module-II: Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration

Module-III: Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion; Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial conditions, free vibration response case studies, Forced vibration response, undamped vibration absorbers, Case studies on undamped vibration absorbers.

Module-IV: Multi degree of freedom systems: Introduction , Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis.

Module-V: Continuous systems: Introduction to continuous systems, Exact and approximate solutions, free vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems Case studies, Approximate methods for continuous systems and introduction to Finite element method.

References:

- S.S.Rao, "Mechanical Vibrations ", 5th Edition, Prentice Hall, 2011.
- L.Meirovitch, "Elements of vibration Analysis", 2nd Edition, McGraw-Hill, New York, 1985
- W.T. Thompson, Theory of Vibration,. CBS Publishers
- Clarence W. de Silva , Vibration: Fundamentals and Practice, CRC Press LLC, 2000

Subject:	**Advanced Mechanical Design (MEPATP6)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Design mechanical components by selecting a suitable material and failure criteria

2 Evaluate fatigue life of mechanical components for ductile and brittle materials

3 Analyze and predict the fracture strength of mechanical components under different fracture modes

4 Design mechanical components involving contacts avoiding the surface failures

Syllabus Contents:

INTRODUCTION

Module-I: Material selection for design: Engineering Design process and the role of materials; materials classification and their properties; Materials Selection, Examples of material selection for typical applications, Elasticity, Plasticity, Bauschinger effect.

Module-II: Review of fundamental concepts: Overview of mechanical design, Free body diagram, Load analysis - 2D and 3D static load analysis, Case studies of static load analysis - Bicycle hand brake lever, Bicycle with pedal arm, Plier-wrench, Cyclic loading, Impact loading, Beam loading, Understanding of static failure for ductile and brittle materials, Comparison of experimental data with failure theories, Significance of the theories of failure, importance of factor of safety in design, Design case studies - Bracket, Bicycle hand brake lever, Bicycle with pedal arm, Plier-wrench.

Module-III: Fatigue Failure theories: Introduction to fatigue, Fatigue failure models, Fatigue life, Estimation of theoretical fatigue strength, Correction factors to the theoretical fatigue strength, stress concentration, Cumulative damage and life exhaustion, effect of mean stress, Designing for fully reversed uniaxial stresses, Designing for fluctuating uniaxial stresses, Designing for multi-axial stresses in fatigue.

Module-IV: Introduction to Fracture and Creep: Fundamentals of Fracture mechanics, Mechanism of fracture - Cleavage fracture, Ductile fracture and Inter-granular fracture, Linear Elastic Fracture Mechanics (LEFM) - Crack propagation with plasticity, hypothesis of LEFM, stress field in an isotropic material in the vicinity of crack tip, Elasto Plastic Fracture Mechanics (EPFM), Creep mechanisms, temperature dependence of creep

Module-V: Design for failure prevention: Fracture mechanics in Design, Design case studies - Bicycle with pedal arm, Plier-wrench. Surface failures - Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue wear, Contacts - Spherical contact, Cylindrical contact and General contact, Failure modes and effects analysis (FMEA).

References:

- Robert L Norton, Machine design an integrated approach, Pearson Education, Second edition, 2009
- Richard G. Budynas, J Keith Nisbett, Shigley’s Mechanical Engineering Design, Mc Graw Hill, Ninth edition, 2011
- Marc Meyers and Krishan Chawla, Mechanical Behavior of materials, Cambridge University Press, 2nd Edition, 2009
- Wolé Soboyejo, Mechanical properties of engineered materials, Marcel Dekker, Inc., 2002
- Prashant Kumar, Elements of Fracture Mechanics, McGraw Hill Education (India) Private Limited, 2014

Subject: **Numerical Simulation Lab (MEPAPT1)**

		Credits			
Type:	ProgrammeCore	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	1	0	2	2

Course outcomes: **At the end of the course, students will be able to**

1 Understand numerical techniques using MATLAB/SCILAB

2 Formulate and solve problems using numerical methods

3 Build 2D and 3D representation of objects using CAD software

4 Design surfaces and solids as per geometrical requirements

Syllabus Contents:

- To know the history and features of MATLAB & the local environment of MATLAB
- Write a program to find the roots of an equation using Bi-section method, Regula-falsi method and Newton Raphson method
- Find the addition, subtraction, multiplication, transpose and inverse of matrices
- Find the area enclosed between the curves in MATLAB/SCILAB
- Find the derivative of an equation in MATLAB/SCILAB
- Find the roots of equations, find the values at different points and plot the graph
- Plot the surface for an equation
- Introduction to CAD software and working with features like Extrude & Revolve in sketch mode
- 3D modeling of different components using CAD software
- Assembly modelling in CAD software: Generating, editing and modifying drawings
- Surface modeling of different mechanical components in CAD software
- Presenting different orthographic/isometric views of 3D models in CAD software

References:

- Lab Instruction Manual

Subject:	**Research Methodology & IPR (IPPATC1)**	**Credits**			
Type:	MANDATORY COURSE	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	1	0	2	2

Course outcomes: **At the end of the course, students will be able to**

1. Understand research problem formulation
2. Analyze research related information
3. Follow research ethics
4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property
5. Right to be promoted among students in general & engineering in particular

Syllabus Contents:

Module-1: Introduction and Design of research: Meaning, objectives and significance of research, types and parameters of research, research process, identification and definition of the research problem, definition of construct and variables, pure and applied research design, exploratory and descriptive design methodology, qualitative vs. quantitative research methodology, field studies, field experiments vs. laboratory experiments, research design in social and physical sciences.

Module-II: Data and Methods of Data Collection: Survey, assessment and analysis: data collection, primary and secondary sources of data, Collection of primary data through questionnaire and schedules. Collection of secondary data, processing and analysis of data. Sample survey, simple random sampling, stratified random sampling, systematic sampling, cluster sampling, area sampling and multistage sampling. Pilot survey, scaling techniques, validity & reliability.

Module-III: Data Analysis: Procedure for testing of hypothesis, the null hypothesis, determining levels of significance, type i and ii errors, grouped data distribution, measures of central tendency, measures of spread/dispersion, normal distribution, analysis of variance: one way, two way, chi square test and its application, students 'T' distribution, non-parametric statistical techniques, binomial test. Correlation and regression analysis – discriminate analysis – factor analysis – cluster analysis, measures of relationship

Module-IV: Research report preparation and presentation: Review of literature: historical survey and its necessity, layout of research plan, meaning, techniques and precautions of interpretation, types of report: technical report, popular report, report writing – layout of research report, mechanics of writing a research report. Writing bibliography and references.

Module-V: Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development.International Scenario: International cooperation on Intellectual Property. Procedure for grantsof patents, Patenting under PCT

References:

- Research in education, By J W Best and J V Kahn, Pearson/ Allyn and Bacon
- Research Methodology – Methods and Techniques, C K Kothari, New Age International
- Design and Analysis of Experiments, D C Montgomery, Wiley
- Applied Statistics & Probability for Engineers, D C Montgomery & G C Runger, Wiley
- Management Research Methodology: Integration of Principles, Methods and Techniques, K N Krishnaswamy, A I Sivakumar and M Mathiranjan, Pearson Education

SCHOOL OF STUDIES OF ENGINEERING & TECHNOLOGY
GURU GHASIDAS VISHWAVIDYALAYA(A CENTRAL UNIVERSITY)
CBCS-NEW, STUDY & EVALUATION SCHEME
PROPOSED W.E.F. SESSION 2021-2022
M.Tech. I Year (SEMESTER II)

SN	Course No.	SUBJECT	PERIODS			EVALUATION SCHEME			CREDITS
			L	T	P	IA	ESE	SUB-TOTAL	
1.	**MEPBTT1**	Advanced Engineering Design	3	-	-	40	60	100	3
2.	**MEPBTT2**	Finite Elements in Design	3	-	-	40	60	100	3
3.		Professional Elective-4	3	-	-	40	60	100	3
4.		Professional Elective-5	3	-	-	40	60	100	3
5.		Open Elective	3	-	-	40	60	100	3
6.		Audit Course	2	-	-	40	60	100	2
		Total	**17**	**-**	**-**	**240**	**360**	**600**	**17**
PRACTICALS									
1.	**MEPBPT1**	Design Lab	1	-	2	30	20	50	2
2.	**MEPBPT2**	Modeling and Analysis Lab	1	-	2	30	20	50	2
		Total	**2**	**-**	**4**	**60**	**40**	**100**	**4**
GRAND TOTAL			**19**	**-**	**4**	**300**	**400**	**700**	**21**

Total Credits : **21**
Total Contact Hour : **23**
Total Marks : **700**

*INTERNAL ASSESSMENT- Two Class Test of 15 Marks and Assignments, Attendance etc. of 10 Marks.
L-LECTURE,T-TUTORIAL,P-PRACTICAL, ESE –END SEMESTER EXAMINATION

Professional Elective-4	**Professional Elective-4**	**Open Elective**
MEPBTP1-Fracture Mechanics	MEPBTP2-Optimization Techniques in Engineering Design	Business Analytics
MEPBTP3-Theory of Plates and Shells	MEPBTP4-Rotor Dynamics	Operations Research
MEPBTP5-Noise, Vibrations and Harshness	MEPBTP6-Computational Fluid Dynamics	Industrial Safety
MEPBTP7-Product Design and Development	MEPBTP8-Smart Materials & Structures	Composite Materials
		Waste to Energy
		Internet of Things
		Cost Management of Engineering Projects
		MOOCs

Subject:	**Advanced Engineering Design (MEPBTT1)**	**Credits**			
Type:	Programme Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand the design process and design models

2 Analyze different theories of failures

3 Evaluate economic factors involved in design process

4 Apply strategies for product design of various applications

Syllabus Contents:

Module-I: Design philosophy: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity, Creative techniques, Material selections, Notches and stress concentration, design for safety and Reliability

Module-II: Economic factors influencing design: Economic analysis, Break-even analysis, Human engineering considerations, Ergonomics, Design of controls, Design of displays. Value engineering, Material and process selection in value engineering, Modern approaches in design. Importance of Fits and Tolerance influencing design:

Module-III: Team work and Ethics in engineering design: Team formation, functioning, discharge, team dynamics, Ethical issues considered during engineering design process

Module-IV: Product Design: Product strategies, Product value, Product planning, product specifications, concept generation, concept selection, concept testing.

Module-V: Design for manufacturing: Forging design, Casting design, Design process for non metallic parts, Plastics, Rubber, Ceramic, Wood, Glass parts. Material selection in machine design

References:

- Machine Design An Integrated Approach by Robert L. Norton, Prentice-Hall New Jersey,USA
- Mechanical Engineering Design by J.E. Shigley and L.D. Mitchell published by McGraw-Hill International Book Company, New Delhi
- Fundamentals of machine elements by Hamrock, Schmid and Jacobian, 2nd edition,McGraw- Hill International edition
- Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, Prentice Hall
- Engineering Design / George E Dieter / McGraw Hill /2008

Subject:	**Finite Elements in Design (MEPBTT2)**	**Credits**			
Type:	Programme Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1. Make use of the concept of finite element method for solving machine design problems
2. Solve problems in 1-D structural systems involving bars, trusses, beams and frames
3. Develop 2-D and 3-D FE formulations involving triangular, quadrilateral elements and higher order elements
4. Apply the knowledge of FEM for stress analysis, model analysis, heat transfer analysis and flow analysis
5. Develop algorithms and FE code for solving design problems and adapt commercial packages for complex problems

Syllabus Contents:

Module-I: Introduction: Historical Perspective of FEM and applicability to mechanical engineering design problems.

Mathematical Models and Approximations: Review of elasticity. Mathematical models for structural problems: Equilibrium of continuum-Differential formulation, Energy Approach- Integral formulation: Principle of Virtual work - Variational formulation. Overview of approximate methods for the solution of the mathematical models, Residual methods and weighted residual methods, Ritz, Rayleigh-Ritz and Gelarkin's methods. Philosophy of solving continuum problems using Finite Element Method.

Finite Element Formulation: Generalized FE formulation based on weighted residual method and through minimization of potential, displacement based formulation, Concept of discretization, Interpolation, Formulation of Finite element characteristic matrices and vectors, Compatibility conditions, Assembly and boundary considerations.

Module-II: Finite Element Analysis for One Dimensional Structural problems: Structural problems with one dimensional geometry. Bar element: formulation of stiffness matrix, consistent and lumped load vectors. Boundary conditions and their incorporation: Elimination method, Penalty Method, Introduction to higher order elements and their advantages and disadvantages. Formulation for Truss elements, Case studies involving hand calculations with an emphasis on Assembly, boundary conditions, contact conditions and multipoint constraints.

Beams and Frames: Review of bending of beams, higher order continuity (C0 and C1 Continuity), interpolation for beam elements and formulation of FE characteristics, Plane and space frames and examples problems involving hand calculations. Algorithmic approach for developing computer codes involving 1-D elements.

Module-III: Two dimensional Problems: Interpolation in two dimensions, natural coordinates, Isoparametric representation, Concept of Jacobian. Finite element formulation for plane stress plane strain and axi-symmetric problems; Triangular and Quadrilateral elements, higher order elements, sub-parametric, Isoparametric and superparametric elements. Formulation of plate bending elements using linear and higher order bending theories, Shell elements, General considerations in finite element analysis of design problems, Choosing an appropriate element and the solution strategies. Introduction to pre and post processing of the results and analysis.

Module-IV: FEM in Heat Transfer and Fluid Mechanics problems: Finite element solution for one dimensional heat conduction with convective boundaries. Formulation of element characteristics and simple numerical problems. Formulation for 2-D and 3-D heat conduction problems with convective boundaries. Introduction to thermo-elastic contact problems. Finite element applications in potential flows; Formulation based on Potential function and stream function. Case studies.

Module-V: Dynamic Analysis: FE formulation in dynamic problems in structures using Lagrangian Method, Consistent and lumped mass models, Formulation of dynamic equations of motion, Modelling of structural damping and formulation of damping

matrices, Model analysis, Mode superposition methods and reduction techniques.

Three Dimensional Problems: Finite element formulation for 3-D problems, mesh preparation, tetrahedral and hexahedral elements, case studies.Algorithmic Approach for problem solving: Algorithmic approach for Finite element formulation of element characteristics, Assembly and incorporation of boundary conditions. Guidelines for code development. Introduction to commercial Finite Element software packages like ANSYS.

References:

- Singiresu S.Rao, Finite element Method in Engineering, 5ed, Elsevier, 2012
- Seshu P, Textbook of Finite Element Analysis, PHI. 2004
- Reddy, J.N., Finite Element Method in Engineering, Tata McGraw Hill, 2017
- Zeincowicz, The Finite Element Method 4 Vol set, 4th Edition, Elsevier 2007

Subject:	**Product Design and Development (MEPBTP7)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Develop conceptual product models using creativity and product design techniques

2 Apply embodiment principles in product development process

3 Develop products by considering the social, environmental and ethical concerns

4 Experience by developing CAD/ physical models using the concepts of product design theory

Syllabus Contents:

Module-I: Introduction: Design versus Scientific method, Considerations of a Good Design, Product Development process cycles, Organizations for Product Design, Technological Innovation and Business Strategies, Modern Product development and design theories, Reverse engineering and redesign methodology.

Module-II: Problem Definition: Identifying Customer needs, Kano Diagram, Establishing Engineering Characteristics, Quality Function Deployment (QFD), Product Design Specification (PDS); Gathering Information: Design information and sources, Professional societies and Trade associations, Codes and Standards, Patents and Intellectual Property

Module-III: oncept Generation: Freud's model, Brain dominance theory, Creative thinking techniques and barriers, Systematic methods: Tear down and experimentation, Function structure, Morphological methods, Theory of Inventive Problem solving (TRIZ), Axiomatic Design (AD)

Module-IV: Concept evaluation and decision-making: Decision Theory, Evaluation methods, Comparison based on absolute criteria, Pugh's concept, Measurement scales, Weighted decision Matrix, Analytic Hierarchy process (AHP).Embodiment Design: Product Portfolios and Architecture, Configuration and Parametric design, detailed design, Ergonomics and Design for Environment, Modelling and Simulation, Material selection for Design, Quality assessment and Robust Design.

Module-V: Team behavior and Tools: Team Roles and Dynamics, Effective Team meeting, Robert rules and Parliamentary procedures, Problem solving tools, planning and scheduling, Time management.Legal and Ethical Issues in Engineering: Origin of laws, Contracts, Product Liability, Tort Law, Codes of Ethics, and solving ethical conflicts.

References:

- Engineering Design 3rd Ed., George E Dieter, McGraw Hill2001
- Engineering Design 3rd Ed. Pahl, W Beitz J Feldhusun, K G Grote Springer2007
- Engineering Design Principles, Ken Hurst, Elsevier,1999

Subject:	**Fracture Mechanics (MEPBTP1)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand the characteristics of mechanical failures of materials

2 Apply the fundamental theories of fracture

3 Derive fracture mechanics theories and evaluate the results

4 Perform fracture mechanics calculations and solve problems of engineering interest

Syllabus Contents:

Module-I: Introduction: Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behaviour. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, The ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature.

Module-II: Griffiths analysis: Concept of energy release rate, G, and fracture energy, R.Modification for ductile materials, loading conditions. Concept of R curves.Linear Elastic Fracture Mechanics, (LEFM). Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness.

Module-III: Elastic-Plastic Fracture Mechanics; (EPFM).The definition of alternativefailure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use.

Module-IV: Fatigue: definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodmans rule and Miners rule. Micromechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction.

Module-V: Creep deformation: the evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters.Creep-fatigue interactions.Examples.

References:

- T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
- B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993
- J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)
- J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials

Subject: **Theory of Plates and Shells (MEPBTP3)**

		Credits			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Formulate the Constitutive Relations and Equilibrium conditions applicable to plates

2 Analyze the forces and bending moments in plates and shells

3 Analyse Natural Frequencies and Modes in plates and shells under free vibrations

4 Solve problems of Plates and Shells on Elastic Foundations

Syllabus Contents:

Module-I: Introduction: Fundamental Relations – Equilibrium– Kinematic Relations – Constitutive Relations.

Module-II: Plate Theories: Reissner-Mindlin– Differential Equation, Variational Formulation-- Kirchhoff-- Differential Equation, stresses, Variational Formulation, Analytical Solutions.

Module-III: Deep Shell Equations: Shell Coordinates and Infinitesimal Distances in Shell Layers, Stress–Strain Relationships, Membrane Forces and Bending Moments, EnergyExpressions, Boundary Conditions, Hamilton's Principle, Other Deep Shell Theories.

Module-IV: Natural Frequencies and Modes: General Approach, Rectangular Plates that are simply supported Along Two Opposing Edges, Circular Plates Vibrating Transversely, In-Plane Vibrations of Rectangular Plates.

Module-V: Vibration of Shells and Membranes under the Influence of Initial Stresses: Strain- Displacement Relationships, Equations of Motion, Pure Membranes, Equations of Motion for Shells on Elastic Foundations, Plates on Elastic Foundations.

References:

- Werner .S Vibration of Shells and Plates, Marcel Publishing House, 2004
- Arthur. W. L, Vibration of Plates, 1970.Timoshenko, Theory of Plates and Shells, Mc Graw Hill.
- Saouma .V.E, Finite Element II Solid Mechanics, Springer- 2001

Subject:	**Noise, Vibration & Harshness (MEPBTP5)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Identify sources of noise and vibration

2 Measure sound intensity and human sensitivity

3 Model statistical energy analysis and simulators

4 Evaluate active control techniques

5 Identify and evaluate the signal processing techniques

Syllabus Contents:

Module-I: NVH in the Automotive Industry :Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.

Module-II: Sound and Vibration Theory :Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.

Module-III: Test Facilities and Instrumentation :Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings., Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis.

Module-IV: Signal Processing: Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.

Module-V: NVH Control Strategies & Comfort: Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimization of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.

References:

- Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,2001
- Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 2002
- Baxa, Noise Control of Internal Combustion Engine, John Wiley, 2000
- Ewins D. J., Model Testing : Theory and Practice, John Wiley,1995
- Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993
- McConnell K, “Vibration Testing Theory and Practice”, John Wiley, 1995

Subject:	**Computational Fluid Dynamics (MEPBTP6)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Develop the governing equations and understand the behavior of the equations

2 Understand the stepwise procedure to completely solve a fluid dynamics problem using computational methods

3 Analyse the consistency, stability and convergence of discretization schemes for parabolic, elliptic and hyperbolic partial differential equations

4 Analyse variations of SIMPLE schemes for incompressible flows and variations of Flux Splitting algorithms for compressible flows

5 Evaluate methods of grid generation techniques and application of finite difference and finite volume methods to thermal problems

Syllabus Contents:

Module-I: Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods; Governing equations of fluid dynamics: Models of the flow, the substantial derivative, Physical meaning of the divergence of velocity, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, Time marching and space marching.

Module-II: Mathematicalbehavior of partial differential equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations.Basic aspects of discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points.

Module-III: Parabolic partial differential equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization.Stability analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, Artificial dissipation and dispersion.

Module-IV: Elliptic equations: Finite difference formulation, solution algorithms: Jacobi- iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, alternative direction implicit methods.Hyperbolic equations: Explicit and implicit finite difference formulations, Scalar representation of Navier-Stokes equations: Equations of fluid motion, numerical algorithms: ftcs explicit, ftbcs explicit, Dufort-Frankel explicit, Maccormack explicit and implicit, btcs and btbcs implicit algorithms, applications.

Module-V: Grids with appropriate transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids.GRID GENERATION: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation.Finite volume method for unstructured grids: Advantages, Cell Centered and Nodal point Approaches, Solution of Generic Equation with tetra hedral Elements, 2-D Heat conduction with Triangular Elements.

References:

- Anderson, J.D.(Jr), Computational Fluid Dynamics, McGraw-Hill Book Company, 1995
- Hoffman, K.A., and Chiang, S.T., Computational Fluid Dynamics, Vol. I, II and III, Engineering Education System, Kansas, USA, 2000
- Chung, T.J., Computational Fluid Dynamics, Cambridge University Press, 2003

- Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, McGraw Hill Book Company, 2002
- Versteeg, H.K. and Malalasekara, W., AnIntroduction to Computational Fluid Dynamics, Pearson Education, 2010

Subject:	**Smart Materials and Structures (MEPBTP8)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Identify Smart Materials and their applications in Engineering

2 Develop constitutive equations and mathematical models for the smart and functionally graded materials

3 Develop sensing devices and structures using smart materials

4 Evaluate the methods of energy harvesting using ambient vibrations

5 Adapt smart materials in damage detection and structural health monitoring

Syllabus Contents:

Module-I: Introduction: Smart material age, Classification, Magnetostrictive materials, Shape memory alloys, Elastomers, Piezoelectric materials, Ferro fluids.

Module-II: High Bandwidth Low Strain (HBLS) materials:Villari and Matteuci effect, Galfenol and Metglas materials, Magneto mechanical coupling coefficients of magnetostrictive materials, constitutive relationships, HBLS smart actuators, Magnetostrictive mini actuators, discretely distributed actuation, magnetostrictive composites, modelling and applications

Module-III: Piezoelectric actuators - Constitutive equations and properties of piezoelectric materials, Variation of coupling coefficients for hard and soft materials, Piezoelectric smart structures, Piezo composite beam, Numerical analysis, Rectangular and Circular shape distributed piezoelectric actuators, Electro mechanical performance, Active fiber composites, Piezoelectric energy harvesting, mathematical modelling of an energy harvester, experimental methods

Module-IV: Low Bandwidth High Strain (LBHS) materials: Classification of shape memory alloys, methods of fabrication, Control design for shape memory alloys and polymers, Electro active polymers and their applications in engineering

Module-V: Smart structures: Smart sensing devices- piezoelectric, magnetostrictive, EAP, SMA based sensors, fiber optic sensors, Structural Health Monitoring using smart sensors and devices, monitoring structural integrity using fiber optic and piezoelectric sensors

References:

- Smart Materials and Structures, Thompson and Gandhi, Chapman and Hall, 1992
- Smart Structures and Materials, Bryan Culshaw, Artech House, 1996
- Piezoelectric energyharvesting,AlperErturk and Daniel J Inmann, Wiley Publications, 2011
- Structural Health monitoring with Piezoelectric Wafer Active sensors, by Victor GIuriutiu, Academic Press, 2008

Subject:	**Optimization Methods for Engineering Design (MEPBTP2)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Formulate a design task as an optimization problem

2 Identify constrained and unconstrained optimization problems and solve using corresponding methods

3 Solve discontinuous optimization problems using special methods

4 Solve nonlinear optimization problems with evolutionary methods

Syllabus Contents:

Module-I: Introduction to Optimization in Design: Problem formulation, Optimization problems in Mechanical Engineering, Classification of methods for optimization; Single-variable Optimization: Optimal criteria, Derivative-free methods (bracketing, region elimination), Derivative based methods, root-finding methods.

Module-II: Multiple-variable Optimization: Optimal criteria, Direct search methods (Box's, Simplex, Hooke-Jeeves, Conjugate methods), Gradient-based methods (Steepest Descent, Newton's, Marquardt's, DFP method). Formulation and Case studies.Constrained Optimization: KKT conditions, Penalty method, Sensitivity analysis, Direct search methods for constrained optimization, quadratic programming, GRG method, Formulation and Case studies.

Module-III: Specialized algorithms: Integer programming (Penalty function and branch-and-bound method), Geometric programming.Evolutionary Optimization algorithm: Genetic algorithms, simulated annealing, Anti-colony optimization, Particle swarm optimization.

Module-IV: Multi-objective Optimization: Terminology and concepts, the concepts of Pareto optimality and Pareto optimal set, formulation of multi-objective optimization problem, NSGA.

Module-V: Case studies and Computer Implementation: Representative case studies for important methods and development of computer code for the same to solve problems.

References:

- Jasbir Arora, Introduction to Optimum Design, Academic Press, 2004
- KalyanmoyDeb, Optimization For Engineering Design: Algorithms And Examples, PHI, 2004
- Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, Wiley, 2001

Subject:	**Rotor Dynamics (MEPBTP4)**	**Credits**			
Type:	Programme Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Model the Rotor bearing systems and formulate the governing equations

2 Understand the role of damping, gyroscopic, centrifugal, stiffness and inertial effects on rotors

3 Compute the critical speeds and stability limits for rotors under axial, transverse and torsional modes

4 Analyse the rotor bearing systems using transfer matrix method and Finite Element Method

5 Compute the transient response of rotors

Syllabus Contents:

Module-I: Introduction: Introduction to rotor dynamics, Rotating and reciprocating unbalances, Classification of Discrete and continuous systems, Review of free and forced vibrations of single and multi-degree of freedom systems.

Module-II: Linear Rotor Dynamics : Equation of motion, Rotating systems, Complex coordinate representation, Undamped Jeffcott Rotor – Free whirling, Unbalance response, Shaft Bow Jeffcott Rotor with viscous damping – Free whirling, Unbalance response, Shaft Bow With structural damping – Free whirling, Unbalance response, frequency dependent loss factors with non-synchronous damping, Effect of Bearing Compliance, Stability in supercritical region.

Module-III: Modelling with Four Degrees of Freedom: Generalised coordinates and equations of motion in real and complex coordinates, Static and couple unbalance and their effects, uncoupled gyroscopic systems, Free whirling of coupled undamped systems, Unbalance response and Shaft bow. Model uncoupling of gyroscopic systems, Configuration and state space approaches;

Module-IV: Discrete multi-degree of freedom: Introduction, Transfer matrix approach for undamped systems, Damped systems, The finite element method for rotors, Beam elements, spring elements, Mass elements, Assembly and constraints, Damping matrices, Choice of coordinates: fixed Vs Rotating and Real Vs Complex coordinates, Computation of critical speeds, Computation of unbalance response. Campbell and root locus diagrams, Reduction of DOF: Nodal reduction, model reduction and component mode synthesis.

Module-V: Transmission Shafts: Modelling of rotors as continuous systems, Euler-Bernoulli and Timoshenko beam models, Dynamic stiffness, Analytical and approximate solutions.Anisotropy of rotors and supports: Isotropic rotors on Anisotropic supports – Influence of damping, non-isotropic rotors on isotropic supports.Torsional and Axial Dynamics: Free and forced Torsional vibrations and critical speeds, Axial Vibration of rotors; Rotor-Bearing Interaction

References:

- Giancarlo Genta, Dynamics of Rotating Systems, Springer, 2009
- Rao, J.S., Rotor Dynamics, 3 Ed. New Age International, 2003
- Rotating Machinery Vibrations, Marcel Dekker, Inc., New York, 2001
- Chong-Won Lee, Vibration Analysis of Rotors, Kluwer Academic Publishers, London, 1995
- Muszynska A, Rotor dynamics, Taylor & Francis, New York, 2005

Subject: **Design Lab (MEPBPT1)**

		Credits			
Type:	Programme Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	1	0	2	2

Course outcomes: **At the end of the course, students will be able to**

1 Understand advanced features of MATLAB

2 Analyze single degree of freedom free and forced vibrations

3 Evaluate free and forced single and multi-degree of freedom vibration

4 Design suitable MATLAB code for engineering problems on vibrations

Syllabus Contents:

- To know the history and features of MATLAB & the local environment of MATLAB
- Free Vibration of Single Degree of Freedom Systems
- Forced Vibration of Single Degree of Freedom Systems
- Response Under a Periodic Force of Irregular Form
- Response Under a General Periodic Force
- Two Degree of Freedom Systems - Free Vibration analysis
- Multi-degree of freedom systems - Natural frequencies and mode shapes
- Free vibration of damped system
- Modal analysis for undamped systems
- Harmonic excitations

References:

- Lab Instruction Manual

Subject: **Modeling and Analysis Lab (MEPBPT2)**

		Credits			
Type:	Programme Core	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	1	0	2	2

Course outcomes: **At the end of the course, students will be able to**

1 Develop programs for modeling the synthetic curves and surfaces

2 Develop finite element code to solve problems involving Trusses, Beams and Frames

3 Solve structural problems using finite element software

4 Execute mini project involving both modeling and analysis

Syllabus Contents:

- Develop Programs for Transformations and Synthetic curves in CAD
- Model solids with features like Hole, Round, Chamfer and Rib
- Model solids with features like Pattern, Copy, Rotate, Move and Mirror
- Advanced modeling tools (Sweep, Blend, Variable section Sweep etc)
- Introduction to developing program for finite element analysis in MATLAB
- Solution of Trusses problems using the developed code
- Solution of Beams and Frames using the developed code
- Solution of problems involving triangular element using the developed code
- Introduction to FEA software, ANSYS
- Solution of problems of Trusses using ANSYS
- Solution of problems of Beams and Frames using ANSYS
- Solution of problems involving triangular element etc. using ANSYS
- Solution of 3D analysis problems using ANSYS

References:

- Lab Instruction Manual

M.Tech. III-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	MEPCPT1	Dissertation Stage–I	0	0	28	100	100	200	14
Total			0	0	28	100	100	200	14

M.Tech. IV-Semester

Sl.	Course Type/ Code	Subjects	Periods/Week			Evaluation			Credits
			L	T	P	IA	ESE	Total	
1.	MEPDPT1	Dissertation Stage–II	0	0	32	200	100	300	16
Total			0	0	32	200	100	300	16

Total Credits for the Program = 19 + 21 +14 +16 = 70

Detailed Syllabi of Open Electives

Subject:	**Business Analytics (MSPBTO1)**	**Credits**			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Students will demonstrate knowledge of data analytics

2 Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.

3 Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.

4 Students will demonstrate the ability to translate data into clear, actionable insights.

Syllabus Contents:

- Unit1: Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.
- Unit 2: Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.
- Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.
- Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.
- Unit 5:Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making.
- Unit 6:Recent Trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

References:

- Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
- Business Analytics by James Evans, persons Education..

Subject: **Industrial Safety (IPPBTO2)**

		Credits			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Apply the knowledge of Safety Measures

2 Plan for Engineering maintenance.

3 Determine the wear &Corrosion and apply methods for their prevention.

4 Trace the Fault of machine tools and equipment

5 Plan and implement the periodic and preventive maintenance for machines/equipment.

Syllabus Contents:

- Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.
- Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.
- Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.
- Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.
- Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

References:

- Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
- Maintenance Engineering, H. P. Garg, S. Chand and Company.
- Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
- Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Subject:	**Operations Research (IPPBTO3)**	**Credits**			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.

2 Students should able to apply the concept of non-linear programming

3 Students should able to carry out sensitivity analysis

4 Student should able to model the real world problem and simulate it.

Syllabus Contents:

- Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models
- Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming
- Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT
- Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.
- Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

References:

- H.A. Taha, Operations Research, An Introduction, PHI, 2008
- H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
- J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
- Hitler Libermann Operations Research: McGraw Hill Pub. 2009
- Pannerselvam, Operations Research: Prentice Hall of India 2010
- Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Subject: **Cost Management of Engineering Projects (CEPBTO4)**

		Credits			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Discuss the cost concepts in the cost management process.

2 Able to handle the projects by the application of project cost control methods.

3 Determine all types of costing and carryout the analysis of pricings for profitability.

4 Application of PERT/CPM for cost management.

Syllabus Contents:

- Introduction and Overview of the Strategic Cost Management Process
- Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.
- Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process
- Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.
- Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

References:

- Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
- Charles T. Horngren and George Foster, Advanced Management Accounting
- Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
- Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
- N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Subject:	**Composite Materials (MEPBTO5)**	**Credits**			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Explain and also implement the composite materials for the required performance based on the characteristics.

2 Adopt the composite materials as reinforcements.

3 Implement the methods of manufacturing of metal matrix composites

4 Adopt the methods of manufacturing of polymer matrix composites

5 Evaluate the strength of laminates.

Syllabus Contents:

- INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.
- REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.
- Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.
- Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.
- Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations

References:

- Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
- Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.
- Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
- Hand Book of Composite Materials-ed-Lubin.
- Composite Materials – K.K.Chawla.
- Composite Materials Science and Applications – Deborah D.L. Chung.
- Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Subject:	**Waste to Energy (CHPBTO6)**	**Credits**			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Classify the waste for fuel and identify the devices for conversion of waste to energy.

2 Implement the Biomass Pyrolysis

3 Evaluate the methods of Biomass Gasification and implement their applications.

4 To design, construct and operation the Biomass Combustion devices.

5 Classify biomass, apply the bio energy systems design and construction.

Syllabus Contents:

- Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors
- Biomass Pyrolysis: Pyrolysis – Types, slow, fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.
- Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.
- Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.
- Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

References:

- Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
- Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
- Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
- Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Subject:	**Internet of Things (IoT) (ECPBTO7)**	**Credits**			
Type:	Open Elective	L	T	P	Total
Teaching Scheme:	Lectures: 3 hours/week	3	0	0	3

Course outcomes: **At the end of the course, students will be able to**

1 Understand the concepts of Internet of Things.

2 Analyze basic protocols in wireless sensor network.

3 Design IoT applications in different domain and be able to analyze their performance

4 Elaborate the need for Data Analytics and Security in IoT.

5 Understand the concepts of Internet of Things.

Syllabus Contents:

Review of computer communication concepts (OSI layers, components, packet communication, Networks, TCP-IP, subnetting, IPV4 addressing and challenges). IPV6 addressing. IoT architecture reference layer. Characteristics IoT sensor nodes, Edge computer, cloud and peripheral cloud, single board computers, open source hardware, Examples of IoT infrastructure.

IoT and M2M

Software defined networks, network function virtualization, difference between SDN and NFV for IoT, Basics of IoT System Management with NETCOZF, YANG- NETCONF, YANG, SNMP NETOPEER.

IOT protocols and Communication Technologies

MQTT, UDP, MQTT brokers, publish subscribe modes, HTTP, COAP,XMPP and gateway protocols, IoT Communication Pattern, IoT Protocol Architecture, Selection of Wireless technologies (6LoWPAN, Zigbee, WIFI, BT, BLE,SIG,NFC, LORA, Lifi, Widi).

Data and Analytics for IoT

An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics, Securing IoT, A Brief History of IOT Security, Common Challenges in IOT Security, How IT and OT Security Practices and Systems Vary, Formal Risk Analysis Structures: OCTAVE and FAIR, The Phased Application of Security in an Operational Environment.

IoT Physical Devices and Endpoints: Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Programming – Python program with Raspberry PI with focus on interfacing external gadgets, controlling output, reading input from pins.

IoT Physical Servers and Cloud Offerings: Introduction to Cloud Storage models and communication APIs WebServer: Web server for IoT, Cloud for IoT, Python web application framework Designing a RESTful web API.

IoT application and its Variants: Case studies: IoT for smart cities, smart grid, health care, agriculture, smart meters.M2M, Web of things, Cellular IoT, Industrial IoT, Industry 4.0,IoT standards.

References:

- “Internet of Things - A Hands-on Approach”, ArshdeepBahga and Vijay Madisetti, Universities Press, 2015, ISBN: 9788173719547
- “Internet of Things”,Srinivasa K G, CENGAGE Leaning India, 2017.
- ” IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry1stEdition, Pearson Education (Cisco Press Indian Reprint). (ISBN: 978-9386873743)
- “Getting Started with Raspberry Pi”, Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014, ISBN: 9789350239759.
- “From Machine to Machine to Internet of Things”, Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, Elsevier Publications, 2014.

Subject:	**English For Research Paper Writing (ELPBTX1)**	**Credits**			
Type:	Audit Course/Value Added Course	L	T	P	Total
Teaching Scheme:	Lectures: 2 hours/week	2	0	0	2

Course outcomes: **At the end of the course, students will be able to**

1 Understand that how to improve your writing skills and level of readability.

2 Learn about what to write in each section

3 Understand the skills needed when writing a Title

4 Ensure the good quality of paper at very first-time submission

Syllabus Contents:

- Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness
- Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction
- Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check
- Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Ruseful phrases, how to ensure paper is as good as it could possibly be the first- time submissioneview of the Literature.
- skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions
- useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

References:

- Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
- Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
- Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
- Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Subject:	**Stress Management by Yoga (PEPBTX2)**	**Credits**			
Type:	Audit Course/Value Added Course	L	T	P	Total
Teaching Scheme:	Lectures: 2 hours/week	2	0	0	2

Course outcomes: **At the end of the course, students will be able to**

1 Develop healthy mind in a healthy body thus improving social health also.

2 Improve efficiency

Syllabus Contents:

- Definitions of Eight parts of yog. (Ashtanga).
- Yam and Niyam, Do`s and Don't's in life, i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.
- Asan and Pranayam, i) Various yog poses and their benefits for mind & body, ii) Regularization of breathing techniques and its effects-Types of pranayam.

References:

- 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
- "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata.

Subject:	**Disaster Management (CEPBTX3)**	**Credits**			
Type:	Audit Course/Value Added Course	L	T	P	Total
Teaching Scheme:	Lectures: 2 hours/week	2	0	0	2

Course outcomes: **At the end of the course, students will be able to**

1 Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.

2 Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives

3 Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations

4 Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Syllabus Contents:

- Introduction Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.
- Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.
- Disaster Prone Areas in India, Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with special reference to Tsunami; Post-Disaster Diseases and Epidemics.
- Disaster Preparedness and Management: Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other agencies, Media Reports: Governmental and Community Preparedness.
- Risk Assessment: Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.
- Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

References:

- R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company.
- Sahni, Pardeep Et. al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi.
- Goel S. L. , Disaster Administration and Management Text and Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Subject:	**Constitution of India (LAPBTX4)**	**Credits**			
Type:	Audit Course/Value Added Course	L	T	P	Total
Teaching Scheme:	Lectures: 2 hours/week	2	0	0	2

Course outcomes: **At the end of the course, students will be able to**

1 Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.

2 Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.

3 Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

4 Discuss the passage of the Hindu Code Bill of 1956.

Syllabus Contents:

- History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working).
- Philosophy of the Indian Constitution: Preamble, Salient Features
- Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.
- Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, appointment and Transfer of Judges, Qualifications, Powers and Functions.
- Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.
- Election Commission: Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

- The Constitution of India, 1950 (Bare Act), Government Publication.
- Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
- M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.