DEPARTMENT OF MECHANICAL ENGINEERING

COURSE STRUCTURE

For

M.TECH

SPECIALIZATION

IN

MACHINE DESIGN AND ANALYSIS

(Effective from 2019-20)

VEER SURENDRA SAI UNIVESITY OF TECHNOLOGY

BURLA, SAMBALPUR

PIN-768018

Vision

To be recognised as a centre of excellence in education and research in the field of mechanical engineering by producing innovative, creative and ethical mechanical engineering professionals for socio-economic upliftment of society in order to meet the global challenges.

Mission

Mechanical Engineering Department of VSSUT Burla strives to impart quality education to the students with enhancement of their skills to make them globally competitive through:

M1: Maintaining state of the art research facilities to provide conducive environment to create, analyze, apply and disseminate knowledge.

M2: Fortifying collaboration with world class R&D organizations, educational institutions, industry and alumni for excellence in teaching, research and consultancy practices to fulfil 'Make In India' policy of the Government.

M3: Providing the students with academic environment of excellence, leadership, ethical guidelines and lifelong learning needed for a long productive career.

Programme Educational Objectives (PEO)

PEO1	To understand the facets of advanced technologies/materials/design and analysis necessary in solving the engineering problems in a scientific and systematic way.
PEO2	To be sensitive to professional and societal context and committed to ethical action
PEO3	To appreciate the significance of team work and collaborations in analyzing, designing, planning, and implementing solutions for practical problems and facilitate the networking with national research and academic organizations.

PEO-Mission Matrix

	M1	M2	M3
PEO1	3	3	3
PEO2	2	2	3
PEO3	3	3	3

Programme Outcomes (PO)

PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to machine design and analysis.
PO2	An ability to write and present a substantial technical report/document.
PO3	An ability to demonstrate a degree of mastery over machine design and analysis, a level higher than the requirements in the undergraduate program of mechanical engineering.
PO4	An ability to develop technical competence and comprehensive knowledge of analysis and design of machines to obtain optimal feasible solution considering safety, environment and other realistic constraints.
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex design engineering problems.
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.

Programme Specific Outcomes (PSO)

On completion of M. Tech in Machine Design and Analysis the students will be able to:

PSO1	Critically analyze, design and develop mechanical systems, components and processes using modern design tools, techniques and materials.
PSO2	Carry out innovative and independent research work to solve real world complex industrial problems pertaining to design engineering and to present coherently both in oral and written discourse.

Semester I

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-1	MMEMD101	Applied Elasticity and Plasticity	3	0	0	3
2	Core-2	MMEMD102	Mechanical Vibration Analysis	3	0	0	3
3	PE-1 (any one)	MMDPE101	Advanced Mechanics Of Solids	3	0	0	3
		MMDPE102	Automatic Control System	3	0	0	3

		MMDPE103	Robotics And Control	3	0	0	3
4	PE-2 (any one)	MMDPE104	Fatigue, creep and fracture	3	0	0	3
		MMDPE105	CAD and computer graphics	3	0	0	3
		MMDPE106	Theory of plates and Shells	3	0	0	3
5	Common	MMEMD103	Research Methodology & IPR	3	0	0	3
6	Lab-1	MMEMD104	Design Project of Mechanical System	0	0	3	2
7	Lab-2	MMEMD105	Analysis and Design Engineering Lab	0	0	3	2
8	Audit -1						
Total Credits							19

Semester II

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Core-3	MMEMD201	FEM in Engineering	3	0	0	3
2	Core-4	MMEMD202	Experimental Stress Analysis	3	0	0	3
3	PE-3 (any one)	MMDPE201	Composite Materials	3	0	0	3
		MMDPE202	Advance theory of Mechanisms and Machines	3	0	0	3
		MMDPE203	Mechatronics	3	0	0	3
4	PE-4 (any one)	MMDPE204	Tribology	3	0	0	3
		MMDPE205	Product Design	3	0	0	3
		MMDPE206	Engineering Design Optimization	3	0	0	3
5	Common	MMEMD203	Minor project & Seminar	0	0	4	2
6	Lab-3	MMEMD204	Engineering Software Lab	0	0	3	2
7	Lab-4	MMEMD205	Advanced Design Engineering Lab	0	0	3	2
8	Audit -2						
Total Credits							18

Semester III

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	PE-5 (any one)	MMDPE301	Applied FEM	3	0	0	3
		MMDPE302	Non-traditional Techniques in Design	3	0	0	3
		MMDPE303	Rotor Dynamics	3	0	0	3
2	OE-1 (any one)	MMDOE301	Computational Methods	3	0	0	3
		MMDOE302	Vibration Based Condition Monitoring	3	0	0	3
		MMDOE303	Advance Composites	3	0	0	3
3	Project	MMEMD301	Dissertation (Phase-I)	0	0	20	10
Total Credits							16

Semester IV

Sl. No.	Core/ Elective	Subject Code	Subject Name	L	T	P	Credits
1	Project	MMEMD401	Dissertation (Phase-II)	0	0	32	16
Total Credits							16

GRAND TOTAL CREDITS: 1**9+**1**8+16+16**= **69**

Audit course 1 & 2

Sl.No.	Course Code	Subject Name
1.	BCAC1001	English for Research Paper Writing
2.	BCAC1002	Disaster Management
3.	BCAC1003	Sanskrit for Technical Knowledge
4.	BCAC1004	Value Education
5.	BCAC2001	Constitution of India
6.	BCAC2002	Pedagogy Studies
7.	BCAC2003	Stress Management by Yoga

8.	BCAC2004	Personality Development through Life Enlightenment Skills.

1ST SEMESTER

APPLIED ELASTICITY AND PLASTICITY

Module I (12 Hours)

Introductions: Elasticity, Fundamental Assumptions in Elementary Elasticity, Stress, Strain, Hooke's Law Plane Stress and Plane Strain. Plane Stress and Plane Strain: Stress and Strain at a point, measurement of surface strains, equation of equilibrium and compatibility, boundary conditions, stress function.

Module II (8 Hours)

Two-dimensional problems in Rectangular Coordinates:Solutions by Polynomials, Determination of displacements, Bending of a Cantilever Loaded at the end, Bending of a Beam by Uniform Loading.

Module III (8 Hours)

Two-dimensional problems in Polar Coordinates:General Equations in Polar Coordinate, Stress Distributions Symmetrical about an Axis, Pure bending of Curved Bars, Strain Components in Polar Coordinates, Displacements for Symmetrical Stress Distributions, Rotating Disks.

Module IV (7 Hours)

Introduction to Plasticity: General Concept of Plasticity, Concept of Yielding and Elastic Failure, Yield Functions, Axioms and Postulates in Phenomenological Theory of Plasticity, Stress-Space Plasticity, Normality, Consistency conditions and Flow-rules, Associated and Non-Associated Plasticity, Perfect-Plasticity.

Module V (5 Hours)

Concept of hardening:Concept of hardening, Isotropic and Kinematic hardening, Constitutive relations for Elastoplasticity with hardening and perfect plasticity.

Text Book:

1. S. P. Timoshenko and J. N. Goodier – Theory of Elasticity (Mc.Graw Hills)
2. O. Hoffman and G. Sachs – Theory of Plasticity (Mc.Graw Hills)

References:

1. A. I. Lurie- Theory of Elasticity (Springer)

2. J. Chakrabarty-Theory of Plasticity (Elsevier)

Course outcomes

Upon completion of the course, the students will demonstrate the ability to:

CO1	Knowledge of Principal stresses and strains
CO2	Know about two-dimensional problems in rectangular Coordinates
CO3	Can solve the two-dimensional problems in polar Coordinates
CO4	Knowledge of engineering application of plasticity
CO5	Knowledge of hardening.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	1	1
CO2	2	1	3	3	1	1
CO3	2	1	3	3	1	1
CO4	2	1	3	3	1	1
CO5	2	1	3	3	1	1

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	2	1	3	3	1	1

Mechanical Vibration Analysis

Module I (4 Hours)

Review of free and forced vibrations with and without damping. Hamilton's Principle.

Module II (6 Hours)

Vibration Isolation: Theory of oscillation of single degree freedom system with application to Vibration isolation and vibration measurement. Vibration isolation and transmissibility; Un-damped vibration absorbers.

Module III (10 Hours)

Multi degree of freedom system:Generalized coordinates and coordinate coupling; Orthogonality of modes, Free and forced vibration of multi-degree of freedom systems with and without viscous damping; Lagrange's equation; Holzer's method. Solution of Eigen value problem, transfer matrix and modal analysis. Application of matrix to vibrational problems, principal frequencies and modes. Introduction of Rayleigh and Rayleigh-Ritz methods.

Module IV (10 Hours)

Continuous System:Transverse vibration of a string, Timoshenko Beam and Euler Beam, longitudinal vibration of a bar, transverse vibration of a beam for cantilever, simply supported, and fixed-fixed beam.

Module V (10 Hours)

Vibration of membranes and plates, Lap lace Transforms and operational Methods. Torsional vibration of shaft with rotor system.

Text Books:

1. Mechanical Vibrations by G.K. Groover
2. Mechanical Vibration by W.T. Thompson

Course outcomes:

At the end of the course, the student will be able to:

CO1	Analyze the mathematical model of a linear vibratory single degree of freedom system to determine its response
CO2	Explain about the working principle of vibration absorber and use of the Lagrange’s equation for linear vibratory systems.
CO3	Determine vibratory responses of MDOF systems to harmonic and periodic excitation.
CO4	Analyze and solve the problems related to continuous systems
CO5	Give general notion on frequency and time response of vibratory systems and understand the vibration of plates, shells and rotor systems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	2	1
CO2	3	1	3	2	2	1
CO3	3	1	3	2	2	1
CO4	3	1	3	2	2	1
CO5	3	1	3	2	2	1

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	1	3	2	2	1

PROFESSIONAL ELECTIVE-I

ADVANCED MECHANICS OF SOLIDS

Module – I (8 Hours)

Analysis of stress and Strain: 3-D dimensional stress and strain: Analysis of Stresses and Strains in rectangular and polar coordinates, Generalized Hooke's law, Relation between elastic constants, Cauchy's formula, Principal stresses and principal strains, 3D Mohr's Circle, Octahedral Stresses, Hydrostatic and deviatoric stress, Differential equations of equilibrium, Plane stress and plane strain, compatibility conditions, Theories of failure and factor of safety in design.

Module – II (8 Hours)

Unsymmetrical bending & Curved Beam Theory: Shear centres for sections with one axis of symmetry, shear centre for any unsymmetrical Section, stress and deflection of beams subjected to unsymmetrical bending. Winkler Bach formula for circumferential stress – Limitations – Correction factors – Radial stress in curved beams.

Module – III (8 Hours)

Torsion: Torsion of a cylindrical bar of Circular cross Section; Saint-Venant's semi-inverse methods; Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular cross Section; Hallow thin wall torsion members, Multiply connected Cross section, Thin wall torsion members with restrained ends.

Module – IV (8 Hours)

Axi-Symmetric Problems: Rotating Discs – Flat discs, Discs of uniform thickness, Discs of Uniform Strength, Rotating Cylinders.Buckling of columns: Beam column with single concentrated load, number of concentrated loads, continuous lateral Load, end couple, couples at both ends triangular loads.

Module – V (8 Hours)

Contact Stresses: Introduction, problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Methods of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact. Normal and Tangent to contact area.

Text Books:

1. Advanced strength and applied elasticity by R.C. Ugural, S.K. Fenster, Elsevier.
2. Advanced mechanics of solids by Hugh ford Longmans.

Reference Books:

1. Strength of material by S.Timoshenko affiliated East-West press pvt.Ltd, .N. Delhi
2. Advanced Mechanics of Solids By L.S Srinath

Course outcomes:

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

CO1	Understand the methods of three-dimensional stress and strain analysis and determine stress and strain invariants, principal stress and strains with their directions.
CO2	Solve general bending problems and determine the stresses resulting from bending of curved beams.
CO3	Analyze torsion of noncircular cross section members.
CO4	Calculate the stresses and strains associated with thick-wall cylindrical pressure vessels and rotating disks and analyze buckling of columns under different loading conditions
CO5	Determine the contact stresses, principal stresses and deflection of bodies in point contact and line contact.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	1	3
CO2	3	2	3	3	1	3
CO3	3	2	3	3	1	3
CO4	3	2	3	3	1	3
CO5	3	2	3	3	1	3

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	2	3	3	1	3

AUTOMATIC CONTROL SYSTEM

Module-I (5 Hours)

Closed loop & open loop systems; Linear & non-linear systems; Proportional, Derivative & integral controller; Laplace transform method; Transfer function & Block diagrams; Deriving transfer functions of physical systems.

Module-II (6 Hours)

Block diagram reduction; Signal flow graphs; Construction of signal flow graphs from block diagram; Mason's gain formula.

Module-III (5 Hours)

First order systems; Second order systems; Higher order systems; Steady-state error & error constants.

Module-IV (12 Hours)

Routh stability criterion; Bode plot; Gain margin & Phase margin; Root locus method; Nyquist criterion; Closed loop frequency response; M-circle & N-circle; Lag & lead compensation.

Module-V (12 Hours)

State space analysis- State variables; State-space representation; State equations; Relationship between state equations & transfer functions; Characteristics equation; Eigen values & Eigen vectors; State diagram; Solution of state equation; State transition matrix & its properties; Transfer matrix.

Text Books:

1. Modern Control Engineering, Katsuhiko Ogata, Prentice Hall, India.
2. Control Systems Engineering, L. J. Nagrath & M. Gopal, Fifth Edition, New Age International Publishers

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Evaluate and apply mathematical models of physical systems in forms suitable for use in the analysis and design of control system.
CO2	Evaluate the time and frequency-domain responses of first and second and higher order systems to different inputs.
CO3	Apply their knowledge on the stability of closed loop control systems in both time and frequency domain.
CO4	Apply root-locus technique to analyze and design control systems.
CO5	Develop and incorporate system equations in state variable forms (state space models)

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	3	1
CO3	3	3	3	3	3	1
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	1

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	3	3	3	2

ROBOTICS AND CONTROL

Module I (10 Hours)

Introduction:Definition, Structure, Classification and Specifications of Robots, Industrial Robots. Robot Elements and Control:Manipulators, Drives, Sensors, End Effectors, Configuration, Force/Torque Relationship, Trajectory Planning, Position Control, Feedback System.

Module II (10 Hours)

Modelling of Robots:Coordinate Frames, Mapping and Transformation; Direct Kinematic Model; Inverse Kinematics; Manipulator Differential Motion; Static Analysis; Jacobian.

Module III (10 Hours)

Manipulator Dynamics:Acceleration of a rigid body, mass distribution, Newtons equation, iterative Newton Euler dynamic formulation, Lagrangian formulation of manipulator dynamics, Trajectory Planning.

Module IV (6 Hours)

Linear and Non Linear Control of Manipulators: Control law partitioning, trajectory following control, Cartesian based control scheme.

Module V (4 Hours)

Force Control of manipulators:Position Control, Force Control strategies.

Text Books:

1. Craig John J., “Introduction to robotics: Mechanics & Control”, Addison- Wesley, 1986.

2. Niku Saeed B., Introduction to Robotics: Analysis, Systems, Applications, PHI, New Delhi, 2001.

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics.
CO2	Apply spatial transformation to obtain forward and inverse kinematics equation of robot manipulators.
CO3	Evaluate the Jacobian matrix and use it to identify singularities.
CO4	Generate joint trajectory for motion planning using Cartesian based control scheme.
CO5	Implement the position and force control strategies in different robotic manipulators.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	3	2
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	3	3	3	2

PROFESSIONAL ELECTIVE-II

FATIGUE, CREEP & FRACTURE

Module-I (10 Hours)

Fracture - Basic modes of fracture, Ductile & brittle fracture, Energy release rate, Grifth theory of brittle fracture, Crack resistance, Stable and unstable crack growth, Critical energy release rate, Irwin's theory of fracture in elastic-plastic materials, theories of linear elastic fracture mechanics, Anelastic deformation at crack tip, stress intensity function, Fracture toughness testing.

Module-II (10 Hours)

Fatigue - Fatigue and endurance limit, Fatigue under normal conditions, Relation between endurance limit & ultimate tensile strength, factor of safety in fatigue loading, stress concentration, controlling factors in fatigue design, design for fatigue fracture, Theories of strength and working stress.

Module-III (10 Hours)

Growth of fatigue crack, Sigmoidal curve, Paris-Erdogan law, Effect of overload, Basquin and Manson-Coffin relation, Damage accumulation and the wholler curve.

Module-IV (5 Hours)

Creep - Low temperature properties, High temperature properties, Temperature and Creep stress-strain properties, Creep-time curve, Creep-stress-time-temperature relation for simple tension.

Module-V (5 Hours)

Mechanics of creep - Creep in tension, Creep in bending, Creep in torsion, Creep buckling, Member subjected to creep and combined stresses.

Text Books:

1. Fracture Mechanics- T L Anderson (CRC press)
2. Mechanical Behavior of Engineering Material- J Marin (PHI)
3. Mechanical Metallurgy – George E. Dieter (Mc Graw-Hill)

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Understanding the principles of fracture mechanics.
CO2	Analysis of fatigue failure of machine components and ability to enhance product performance through fatigue design and analysis.
CO3	Understanding the fatigue failure mechanism.
CO4	Learning the mechanism of creep deformation and creep-failure in engineering materials.
CO5	Analysis the mechanics of creep.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	1	1
CO2	3	3	3	3	1	1
CO3	3	3	3	3	1	1
CO4	3	3	3	3	1	1
CO5	3	3	3	3	1	1

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	3	3	1	1

CAD & COMPUTER GRAPHICS

Module-I (10 Hours)

Fundamental of CAD: The design process, Application of computers for design. Creating the manufacturing database. The design workstation, Graphics terminal, operator input devices, Plotters and other output devices. The CPU, secondary storage.Geometric transformation of simple figures to different shapes by matrix method.

Module-II (5 Hours)

Computer Graphics Software: Configuration, Graphic packages, constructing the geometry, Transformation, Database structure and content.The benefits and cost of CAD: Principles of concurrent Engineering.

Module-III (5 Hours)

Soft and hard prototyping, Workflow in Concurrent Engineering. Key factors influencing the success of Concurrent Engineering.

Module-IV (10 Hours)

Graphic Workstation. Hardware of workstation, Advanced modelling techniques-Wire frame model, surface modelling, Solids modelling. Wire frame versus Solids modelling.Modelling facilities in solid modeller.

Module-V (10 Hours)

Automated Drafting, Menu based drafting, Use of software for drawing/colour processing, Optimum Design: Optimum Design for Normal Specification, Optimum design for Redundant specification.Simple Engineering Design Problems.

Text Books:

1. CAM: Computer Aided design & Manufacturing-MP Groover & E.W.Zimmer Jr. PHI. CAD.
2. CAD,CAM,CIM: P. Radhakrishana & S. Subramanyam – New Age International Publishers.
3. Optimization Theory & Applications: SS Rao, Wiely Eastern Ltd.

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Understanding the impact of CAD and computer graphics in engineering design and analysis.
CO2	Developing the ability to establish the CAD techniques appropriate for mechanical engineering applications.
CO3	Understanding the concurrent engineering and its application.
CO4	Analyzing the theory of modeling and the usage of models in different engineering applications.
CO5	Developing the knowledge of theoretical principles in optimization and artificial intelligence

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	3	1
CO2	3	3	3	3	3	1
CO3	3	3	3	3	3	1
CO4	3	3	3	3	3	1
CO5	3	3	3	3	3	1

Program Articulation Matrix row for this course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO	3	3	3	3	3	1

THEORY OF PLATES AND SHELLS

Module-I (8 Hours)

Plates, Bending of Circular Plates: Thin and Thick Plates, small and large deflection theory of thin plates - assumptions, moment-curvature relations, stress resultants, governing differential Equation for bending of plates, various boundary conditions. Bending of Circular Plates: Symmetrical loading.

Module-II (8 Hours)

Laterally Loaded Rectangular Plates: Differential equation of plates, Boundary conditions, Navier solution for simply supported plates subjected to uniformly distributed load and point load, Levy's method of solution for plates, Simply supported plates with moments distributed along the edges, Approximate Methods.

Module-III (8 Hours)

Effect of transverse shear deformation: plates of variable thickness, Anisotropic plates, thick plates, orthotropic plates and grids, Large Deflection theory.

Module-IV (8 Hours)

Deformation of Shells without Bending: Definitions and notation, shells in the form of a surface of revolution, displacements, membrane theory of cylindrical shells, the use of stress function in calculating membrane forces of shells.

Module-V (8 Hours)

General Theory of Cylindrical Shells: A circular cylindrical shell loaded symmetrically with respect to its axis, symmetrical deformation, pressure vessels, cylindrical tanks, general case of deformation, the use of a strain and stress function, stress analysis of cylindrical roof shells.

Text Books:

1. Theory of Plates and Shells by Stephen P. Timoshenko, SergiusWoinowsky-Krieger (McGraw- Hill)
2. Thin Plates and Shells: Theory: Analysis, and Applications by Eduard Ventsel, Theodor Krauthammer (CRC).

Reference Book:

1. Mechanics of Laminated Composite Plates and Shells: Theory and Analysis by J. N. Reddy (CRC)

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Demonstrate the behaviour of circular plates under different conditions
CO2	Analyze the rectangular plates under various loading and boundary conditions
CO3	Analyze the effects of transverse shear deformation on plates
CO4	Demonstrate the behaviour of shells under different conditions

CO5	Express the general theory of cylindrical shells

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	3	2	1
CO2	3	1	3	3	2	1
CO3	3	1	3	3	2	1
CO4	3	1	3	3	2	1
CO5	3	1	3	3	2	1

Program Articulation Matrix row for this course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO	3	1	3	3	2	1

SESSIONALS

DESIGN PROJECT OF MECHANICAL SYSTEM

List of Design Projects

1. Stress analysis on spur gear using ANSYS.
2. Automatic motor bike stand slider.
3. Regenerative braking system project.
4. Automated coconut scraping machine.
5. Mini conveyor belt mechanism.
6. Two wheel drive forklift for industry warehouses.
7. Unique hubless e-bike with suspension.
8. Pneumatic metal sheet bending machine.
9. Portable PPE kit sterilizer ozone + UV.
10. Pneumatic power steering system.
11. Pneumatic chapatti machine.
12. Magnetic braking system.
13. Low cost ant-lock braking system.
14. Composite parabolic leaf spring.
15. Pedaling dress washing machine.
16. Hydraulic disk brake.

17. Mini windmill power generation project
18. Automated rain operated wiper.
19. Gear based quick return mechanism.
20. Plant irrigation water sprinkler robot.

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Identify the needs of an arbitrary client and translate those into engineering specifications.
CO2	Utilize a variety of techniques to generate and select appropriate designs.
CO3	Justify design decisions with analysis, simulation, and/or physical testing and experimentation
CO4	Plan, organize, and schedule activities to meet team milestones and goals.
CO5	Solve a real engineering problem specified by someone else.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	2	1	1
CO2	3	3	3	2	1	1
CO3	3	3	3	2	1	1
CO4	3	3	3	2	1	1
CO5	3	3	3	2	1	1

Program Articulation Matrix row for this course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO	3	3	3	2	1	1

ANALYSIS AND DESGN ENGG LABORATORY

Content

1. Experiment of Universal Testing Machine.
2. Experiment on Fatigue machine
3. Experiment on NDT set up.
4. Determination of Mechanical properties using Resonant Frequency Damping Analyzer Basics (RFDA).
5. Experiment on torsional testing machine
6. Study of Journal bearing pressure profile

7. Experiment on vibration set up with modulated frequency of Excitation.
8. Measurement of acoustic properties of materials.

At the end of the syllabus students will be able to:

CO1	Evaluate the various mechanical properties of given specimen through tensile, compressive, bending and fatigue testing.
CO2	Evaluate various mechanical properties through non destructive testing in NDT and RFDA equipment.
CO3	Evaluate different torsional properties of the given specimen using torsional testing machine.
CO4	Express the tribological behavior of a journal bearing
CO5	Evaluate the vibration and acoustic properties of a given material through vibration and acoustic analysis.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	-
CO2	3	3	2	3	2	-
CO3	3	3	2	3	2	-
CO4	3	3	2	3	2	-
CO5	3	3	2	3	2	-

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	2	3	2	-

2ND SEMESTER

FINITE ELEMENT METHODS IN ENGINEERING

Module I (8 Hours)

Introduction: Role of the Computer, General Steps of the Finite Element Method, Applications of the Finite Element Method, Advantages of the Finite Element Method. Introduction to the Stiffness (Displacement) Method: Definition of the Stiffness Matrix, Derivation of the Stiffness Matrixfor a Spring Element, Example of a Spring Assemblage, Assembling the Total Stiffness Matrix by Superposition (Direct Stiffness Method),Boundary Conditions, Potential Energy Approach to Derive Spring Element Equations.

Module II (12 Hours)

Development of Truss Equations: Derivation of the Stiffness Matrix for a Bar Element in Local Coordinates, Selecting Approximation Functions for Displacements, Transformation of Vectors in Two Dimensions, Global Stiffness Matrix, Computation of Stress for a Bar in the x-y Plane, Solution of a Plane Truss, Potential Energy Approach to Derive Bar Element Equations, Comparison of Finite Element Solution to Exact Solution for Bar, Galerkin's Residual Method and Its Use to Derive the One-Dimensional Bar Element Equations, Other Residual Methods and Their Application to a One-Dimensional. Development of Beam Equations: Derivation of the Beam Stiffness matrices, Distributed Loading, Potential Energy Approach to Derive Beam Element Equations, Galerkin's Method for Deriving Beam Element Equations.

Module III (8 Hours)

Development of the Plane Stress and Plane Strain Stiffness Equations: Basic Concepts of Plane Stress and Plane Strain, Derivation of the Constant-Strain Triangular Element Stiffness Matrix and Equations, Treatment of Body and Surface Forces. Development of the Linear-Strain Triangle Equations: Derivation of the Linear-Strain Triangular Element Stiffness Matrix and Equations.

Module IV (6 Hours)

Axisymmetric Elements: Derivation of the Stiffness Matrix, Solution of an Axisymmetric Pressure Vessel, Applications of Axisymmetric Elements.

Module V (6 Hours)

Plate Bending Element: Basic Concepts of Plate Bending, Derivation of a Plate Bending Element Stiffness Matrix and Equations.

Text Books:

1. A First Course in the Finite Element Method- Daryl L. Logan, Thomson
2. Introduction to finite element method – Abel and Desal, EWP

Reference Book:

1. The Finite Element method in Engineering Science – O.C. Zienkiwiecs, TMH
2. Introduction to the finite element method-J. N. Reddy, Mc Graw Hill

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Analyze of finite element method and its importance

CO2	Evaluate bar and beam element problems
CO3	Evaluate different types of two dimensional problems
CO4	Evaluate the axis-symmetric Elements
CO5	Analyze plate element problem

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	2	3	3	3	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	1
CO4	3	2	3	3	3	1
CO5	3	2	3	3	3	1

Program Articulation Matrix row for this course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO	3	2	3	3	3	1

EXPERIMENTAL STRESS ANALYSIS

Module-I (14 Hours)

Electrical Wire Resistance Strain Gauges:Strain sensitivity, strain gauge construction, temperature effects in bonded strain gauges. Gauge factor and gauge sensitivities, Determination of actual strain. Measurement of stress by a strain gauge, stress gauge, strain gauge Rosette. Measuring Circuits:The potentiometer circuit, circuit sensitivity of potentiometer, Wheatstone bridge circuit, Null-balance bridge, strain gauge applications.

Module-II (6 Hours)

Moiré Fringe Method:Moiré method, geometry of moiré fringe, advantages and limitations of moiré method.

Module-III (6 Hours)

Photoelasticity:Introduction, basic principle, stress and strain optic law, plane polariscope, circular polariscope, white light illumination.

Module-IV (8 Hours)

Analysis Of Photoelastic Data:Materials and properties of material for photoelastic models, stress loci, fractional fringe orders, methods of compensation, calibration techniques, the frozen stress method, Reflection polariscope, separation of principal stresses.

Module-V (6 Hours)

Brittle Coating Method:Brittle coating, calibration of coating, application of failure theory to brittle coating, advantages and limitations.

Text Books:

1. J.W. Dally and W.F. Riley, “Experimental stress Analysis”, McGraw Hill, 1991.
2. Durelli, Augusto J., and William Franklin Riley. " Introduction to photomechanics. Prentice-Hall, 1965.

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Understand the Electrical Wire Resistance Strain Gauges and Measuring Circuits.
CO2	Analyze the mechanism of photo elasticity
CO3	Understanding of Moiré Fringe method for strain measurement.
CO4	Measurement of strain measurement using photo elasticity technique.
CO5	Strain measurement using brittle coating technique.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	1	1
CO2	3	3	3	3	1	1
CO3	3	3	3	3	1	1
CO4	3	3	3	3	1	1
CO5	3	3	3	3	1	1

Program Articulation Matrix row for this course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO	3	3	3	3	1	1

PROFESSIONAL ELECTIVE-III

COMPOSITE MATERIALS

Module-I (8 Hours)

Introduction – Definition & classification of composites; Reinforcing fibers-Types, Characteristics & Selection; Natural fibers, Boron; Carbon; Ceramic; Glass; Armids; Particulate fillers; Matrices-Polymer; Graphite; Ceramic & Metal matrices; Fiber surface treatments; Fillers & additives; Fiber content; Short & continuous fiber reinforced composites.

Module-II (8 Hours)

Processing – Pultrusion; Filament winding; Pre-page technology; Injection & compression moulding; Bag moulding; Resin transfer moulding; Other manufacturing processes; Processing of MMC- Diffusion bonding; Stir casting; Squeeze casting.

Module-III (6 Hours)

Mechanics – Rule of mixture; Volume & mass fractions; Density & void content; Stress-strain relations for anisotropic materials; Generallized Hook's law; Stiffenesses, Compliances & engineering constants for orthotropic materials

Module-IV (6 Hours)

Stress-strain relations for plane stress in orthotropic materials; Stress-strain relations for a lamina; Characteristics of fiber reinforced lamina.

Module-V (12 Hours)

Analysis-Classical lamination theory; Stress analysis of composite laminates; Failure predictions – Maximum stress theory; Maximum strain theory; Tsai-Hill theory; Modes of failure of composites; First ply failure; Partial ply failure; Total ply failure.

Text Books:

1. Mechanics of composite materials, R. M. Jones, Mc Graw Hill Book Co.
2. Mechanics of composite materials & structures, M Mukhopadhay, Universities Press.
3. Fiber-Reinforced composite materials, Manufacturing & Design, P. K. Mallick, Marcel Dekken, Inc. New York & Basel.

Course Outcomes

Upon completion of the course, the students will demonstrate the ability to:

CO1	Identify and explain the types of composite materials and their characteristic features.
CO2	Understand the differences in the strengthening mechanism of composite and its corresponding effect on performance and application.
CO3	Understand and explain the methods employed in composite fabrication.
CO4	Appreciate the theoretical basis of the experimental techniques utilized for failure mode of composites.
CO5	Develop expertise on the applicable engineering design of composite.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	1	1
CO2	3	1	3	3	1	1
CO3	3	1	3	3	1	1
CO4	3	1	3	3	1	1
CO5	3	1	3	3	1	1

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	1	3	3	1	1

ADVANCED THEORY OF MECHANISM & MACHINES

Module-I (7 Hours)

Review of determination of velocity & acceleration of points & links in mechanisms – Analytical & graphical methods; Synthesis of Mechanisms - Function generation; Overlay's method; Congnate linkages; Two position & three position synthesis of 4-bar linkages & slider crank mechanisms; Coupler curve synthesis; Intermittent rotary motion-Geneva mechanism.

Module-II (9 Hours)

Static & Dynamic Force Analysis – Forces, Couples, Conditions of equilibrium – Free body diagram; Analysis of 4-bar linkages & slider crank mechanisms; Spur, Helical & Bevel gear force analysis; Static force analysis with friction; Dynamic force analysis – Centroid & Centre of mass; Moment of inertia; D' Alembert's principle; Rotation about a fixed centre; Dynamic analysis of 4-bar mechanism.

Module-III (9 Hours)

Balancing – Primary balancing, Secondary balancing, Balancing of 2-cylinder & multi-cylinder engines, V-engines.

Module-IV (7 Hours)

Gyroscope – Motion of a rigid body in 3-dimensions; Rigid body in spheric motion; Euller's equation; Euller's modified equation; Simple precession of a symmetrical rotor.

Module-V (8 Hours)

Analysis of Cams – Basic curves; Cam size determination; Cam profile determination-Analytical & graphical methods; Advanced cam curves; Analytical cam design.

Cam Dynamics – Response of undamped cam mechanisms; Follower response-Phase plane method; Numerical method; Jump & Cross-over shock.

Text Books:

1. Theory of Machines & Mechanisms, J. E. Shigley, McGraw-Hill Publication.
2. Theory of Mechanisms & Machines, Ghose & Mallick, East-West Press.

Course Outcomes:

At the end of the course, the student will be able to:

CO1	Knowledge about velocity & acceleration of points & links in mechanisms
CO2	Study the static & dynamic force analysis of machines
CO3	Acquire the knowledge regarding balancing of machines.
CO4	Acquire the knowledge about the use of gyroscope
CO5	Understand the details of cams and its dynamic

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	3	2	2	1
CO2	3	1	3	2	2	1
CO3	3	1	3	2	2	1
CO4	3	1	3	2	2	1
CO5	3	1	3	2	2	1

Program Articulation Matrix row for this course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO	3	1	3	2	2	1

MECHATRONICS

Module I (10 Hours)

Introduction: Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach. Sensors and Transducers:Sensors and transducers, performance terminology, photoelectric transducers, flow transducers, optical sensors and transducers, semiconductor lasers, selection of sensors, mechanical / electrical switches, inputting data by switches.

Module II (10 Hours)

Actuators: Actuation systems, pneumatic and hydraulic systems, process control valves, rotary actuators, mechanical actuation systems, electrical actuation systems. Signal Conditioning:Signal conditioning, filtering digital signal, multiplexers, data acquisition, digital signal processing, pulse modulation, data presentation systems.

Module III (6 Hours)

Microprocessors and Microcontrollers: Microcomputer structure, microcontrollers, applications, programmable logic controllers.

Module IV (8 Hours)

Modeling and System Response: Mathematical models, mechanical, electrical, hydraulic and thermal systems, dynamic response of systems, transfer function and frequency response, closed loop controllers.

Module V (6 Hours)

Design and Mechatronics:Input/output systems, computer based modular design, system validation, remote monitoring and control, designing, possible design solutions, detailed case studies of mechatronic systems used in photocopier, automobile, robots.

Text Books:

1. Bolton, W., “Mechatronics”, Longman, 1999.
2. Bolton, W., “Mechatronics: A Multidisciplinary Approach”, 4th Ed., Prentice Hall, 2009.
3. Mahalik, N., “Principles, Concept and Applications: Mechatronics”, Tata McGraw, 2003.

Course outcomes

At the end of the course, the student will be able to:

CO1	Knowledge about the basics of different controller and and sensors and apply their knowledge to design and develop intelligent systems
CO2	Know about various actuation and signal conditioning systems and apply their knowledge in developing various control systems
CO3	Design and develop various micro-controllers useful for various purposes.
CO4	Model and build mechatronic systems and implement these systems.
CO5	Monitor and control various intelligent systems

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	-	2	-	1
CO2	3	3	-	2	-	-
CO3	3	3	-	2	-	-
CO4	3	3	-	1	-	-
CO5	3	3	-	1	-	-

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	-	2	-	1

PROFESSIONAL ELECTIVE-IV

TRIBOLOGY

Module-I (8 Hours)

Introduction: Defining Tribology, - Defining Tribology, Tribology in Design - Mechanical design of oil seals and gasket - Tribological design of oil seals and gasket, Defining Lubrication, Basic Modes of Lubrication, Properties of Lubricants, Lubricant Additives, Defining Bearing Terminology - Sliding contact bearings - Rolling contact bearings, Comparison between Sliding and Rolling Contact Bearings.

Friction and wear: Friction - Laws of friction - Friction classification - Causes of friction, Theories of Dry Friction, Friction Measurement, Stick-Slip Motion and Friction Instabilities, Wear - Wear classification - Wear between solids - Wear between solid and liquid - Factors affecting wear - Measurement of wear, Theories of Wear, Approaches to Friction Control and Wear Prevention, Bearing Materials and Bearing Construction.

Module-II (7 Hours)

Lubrication of bearings: Mechanics of Fluid Flow - Theory of hydrodynamic lubrication - Mechanism of pressure development in oil film, Two Dimensional Reynolds's Equation and its Limitations,Petroff's Solution, Idealized Bearings, Infinitely Long Plane Fixed Sliders, Infinitely Long Plane Pivoted Sliders, Infinitely Long Journal Bearings, Infinitely Short Journal Bearings, Designing Journal Bearing - Sommerfeld number - Raimondi and Boyd method -

Parameters of bearing design - Unit pressure - Temperature rise - Length to diameter ratio - Radial clearance - Minimum oil-film thickness.

Module-III (5 Hours)

Hydrodynamic thrust bearing: Introduction - Flat plate thrust bearing - Tilting pad thrust bearing, Pressure Equation - Flat plate thrust bearing - Tilting pad thrust bearing, Load - Flat plate thrust bearing - Tilting pad thrust bearing, Center of Pressure - Flat plate thrust bearing - Tilting pad thrust bearing, Friction - Flat plate thrust bearing - Tilting pad thrust bearing.

Module-IV (12 Hours)

Hydrostatic and squeeze film lubrication: Hydrostatic Lubrication - Basic concept - Advantages and limitations - Viscous flow through rectangular slot - Load carrying capacity and flow requirement - Energy losses - Optimum design, Squeeze Film Lubrication - Basic concept - Squeeze action between circular and rectangular plates - Squeeze action under variable and alternating loads, Application to journal bearings, Piston Pin Lubrications.

Elasto-hydrodynamic lubrication: Principles and Applications, Pressure viscosity term in Reynolds's equation, Hertz's Theory, Ertel-Grubin equation, Lubrication of spheres, Gear teeth bearings, Rolling element bearings.

Module-V (8 Hours)

Gas (air-) lubricated bearings: Introduction, Merits, Demerits and Applications, Tilting pad bearings, Magnetic recording discs with flying head, Hydrostatic bearings with air lubrication, Hydrodynamic bearings with air lubrication, Thrust bearings with air lubrication

Tribological aspects of rolling motion and gears:

Tribology of rolling bearings, Case studies on failure analysis of roller and ball bearings, Friction, Lubrication and wear in spur gears, surface failures, Case studies on online and off line condition monitoring of gears.

Text Books:

1. J Halling, Principles of Tribology, The Macmillan Press Ltd, London, 1975
2. Hamrock B J, Jacobson B O & Schmid S R, Fundamentals of Machine Elements, McGraw-Hill Inc., 1998.
3. Hamrock B J, Jacobson B O & Schmid S R Fundamentals of Fluid Film Lubrication, Mcgraw hills Inc,1998.

Reference Books:

1. A. Cameron, Principles of Lubrication,Longman Publishing Group, 1986
2. E.I.Radzimogky Lubrication of bearing, John Willey
3. W. L. Robertson Lubrication in Practice (CRC press
4. I.M. Hutchings Tribology Edward Arnold, 1992

Course Outcomes

At the end of the course, the student will be able to:

CO1	Demonstrate basic understanding of friction, lubrication, and wear processes.
CO2	Enhance students' awareness of tribological issues in the design of machine components, such as journal bearings, thrust bearings, hydrostatic bearing, gas bearing, seals, and gasket systems.
CO3	Design and conduct experiments, as well as analyze and interpret data.
CO4	Design a tribological system for optimal performance.
CO5	Develop skill for communicating research results and technical presentations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	-	-
CO2	-	2	3	3	2	1
CO3	1	1	2	-	3	1
CO4	-	3	3	2	2	1
CO5	1	2	1	1	3	-

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	1	2	2	2	3	1

PRODUCT DESIGN

Module-I (8 Hours)

The Product-scope, types of product Design requirements-functional, operating, portability, shipment, installation, use maintenance, appearance & cost.

Module-II (8 Hours)

Design factors-functions, attributes, circumstances, Resources, restraints, and uncertainly Design logic. Design method-stages, investigation product design, development test.

Module-III (8 Hours)

Design for function, Designing for use, design for appearance, Design for production. Standardization – Effects of standard, quality, reliability, Interchangeability, variety reduction.

Module-IV (8 Hours)

Value Engineering – Value analysis, Analysis of function.

Module-V (8 Hours)

Material selection, properties, cost manufacturing process in product design

Text Books

1. Engg. Product Design – W.D. Cain (Business Book Ltd.)
2. Value Engineering: Concepts, Techniques and Applications By Anil Kumar Mukhopadhyaya (SAGE)

Course Outcomes

At the end of the course, the student will be able to:

CO1	Understand and apply principles of creativity to develop original and useful ideas
CO2	Understand the principle of manufacturing processes and related materials required in product design.
CO3	Apply basic business practices of Industrial Design in diverse range of design projects.
CO4	Understand the relationship of business, technology, and human values in a global society.
CO5	Manage time and resources effectively both personally and organizationally through group dynamics and team work.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	3	2	3	1
CO2	1	2	3	2	3	1
CO3	1	2	3	2	3	1
CO4	1	2	3	2	3	2
CO5	1	2	3	2	3	3

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO	1	2	3	2	3	2

ENGINEERING DESIGN OPTIMIZATION

Module I (8 Hours)

Introduction: Introduction to design and specifically system design, Morphology of design with a flow chart, Very brief discussion on market analysis, profit, time value of money, an example of discounted cash flow technique, Concept of workable design, practical example on workable system and optimal design.

Module II (8 Hours)

System Simulation: Classification, Successive substitution method – examples, Newton Raphson method - one unknown – examples, Newton Raphson method - multiple unknowns – examples, Gauss Seidel method – examples, Rudiments of finite difference method for partial differential equations, with an example.

Module III (8 Hours)

Regression and Curve Fitting: Need for regression in simulation and optimization, Concept of best fit and exact fit, Exact fit - Lagrange interpolation, Newton's divided difference – examples, Least square regression - theory, examples from linear regression with one and more unknowns – examples, Power law forms – examples, Gauss Newton method for non-linear least squares regression - examples.

Module IV (8 Hours)

Optimization: Introduction, Formulation of optimization problems – examples, Calculus techniques – Lagrange multiplier method – proof, examples, Search methods – Concept of interval of uncertainty, reduction ratio, reduction ratios of simple search techniques like exhaustive search, dichotomous search.

Module V (8 Hours)

Fibonacci search and Golden section search – numerical examples, Method of steepest ascent/ steepest descent, conjugate gradient method – examples, Geometric programming – examples, Dynamic programming – examples, Linear programming – two variable problem – graphical solution, New generation optimization techniques – Genetic algorithm and simulated annealing – examples, Introduction to Bayesian framework for optimization-examples.

Text Books:

1. Optimization for engineering design - algorithms and examples, K. Deb, Prentice Hall
2. Introduction to optimum design, J. S. Arora, Mc Graw Hill

Course Outcomes

At the end of the course the students will be able to:

CO1	Explain the concept of the existence and uniqueness of an optimal solution.
CO2	Apply response surface methods to model complex engineering systems.
CO3	Apply design of experiments techniques to model a design space..
CO4	Solve numerical optimization problems of n-variables with constraints.
CO5	Use of a practical software package to solve typical engineering problems and project

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	1	
CO2		2	3	3	2	1
CO3	1	1	2	2	3	
CO4		3	3	2	2	
CO5	1	2	1	1	3	1

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	1	1	3	3	3	1

SESSIONALS

ENGINEERING SOFTWARE LABORATORY

Contents

Application of analytical methods in engineering using MATLAB and/or other standard programming languages and Modelling of Engineering Systems.

1. Writing solvers for systems of ordinary differential equations.
2. Writing solvers for systems partial differential equations.
3. Writing solvers for systems for finding roots of polynomials.
4. Writing solvers for systems for finding eigenvalues.
5. Writing solvers for systems of nonlinear algebraic equations.
6. Modelling and analysis of a given engineering system in ANSYS.
7. Modelling and Analysis of a given Engineering system in SOLID WORKS

8. Modelling and analysis of a given Engineering system using LS-DYNA

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Write system solving equations for engineering systems having ordinary differential equations, partial differential equations and finding roots for polynomial equations.
CO2	Write system solving equations for engineering systems for finding eigenvalues, and nonlinear algebraic equations.
CO3	Analyze engineering systems using ANSYS
CO4	Analyze engineering systems using SOLID WORKS
CO5	Analyze engineering systems using LS-DYNA

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	-
CO2	3	3	3	3	3	-
CO3	3	3	3	3	3	2
CO4	3	3	3	3	3	2
CO5	3	3	3	3	3	2

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	3	3	3	3	2

3rd SEMESTER

PROFESSIONAL ELECTIVE-V

APPLIED FEM

Module I (11 Hours)

Isoparametric Formulation:Isoparametric Formulation of the Bar Element Stiffness Matrix, Rectangular Plane Stress Element, Isoparametric Formulation of the Plane Element Stiffness Matrix, Gaussian and Newton-Cotes Quadrature, Evaluation of the Stiffness Matrix and Stress Matrix by Gaussian Quadrature,Higher-Order Shape Functions.

Module II (5 Hours)

Three-Dimensional Stress Analysis: Three-Dimensional Stress and Strain, Tetrahedral Element, Isoparametric Formulation.

Module III (9 Hours)

Heat Transfer:Derivation of the Basic Differential Equation, Heat Transfer with Convection,One-Dimensional Finite Element Formulation Usinga Variational Method, Two-Dimensional Finite Element Formulation, Line or Point Sources.

Module IV (6 Hours)

Thermal Stress: One-dimensional thermal strain and stress, Minimization of the thermal strain energy equation, thermal force matrix for the one dimensional bar element and the two-dimensional plane stress and plane strain elements.

Module V (9 Hours)

Structural Dynamics and Time-Dependent Heat Transfer: Dynamics of a Spring-Mass System, Direct Derivation of the Bar Element Equations, Numerical Integration in Time, Natural Frequencies of a One-Dimensional Bar, Time-Dependent One-Dimensional Bar Analysis.

Text Books:

1. A First Course in the Finite Element Method- Daryl L. Logan, Thomson
2. Introduction to finite element method – Abel and Desal, EWP

Reference Books:

1. The Finite Element method in Engineering Science – O.C. Zienkiwiecs, TMH
2. Introduction to the finite element method-J. N. Reddy, Mc Graw Hill

Course Outcomes

At the end of the syllabus students will be able to:

CO1	Define the use of isoparameteric formulation
CO2	Evaluate the three dimensional problems
CO3	Evalute the heat transfer problem
CO4	Evalute the thermal stresses problem

CO5	Analyze the real life Time-Dependent problem

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	1
CO4	3	2	3	3	3	1
CO5	3	2	3	3	3	1

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	2	3	3	3	1

NON-TRADITIONAL TECHNIQUES IN DESIGN

Module-I (4 Hours)

Introduction: Definition and importance of a nontraditional technique. Advantages over classical technique.

Module-II (10 Hours)

Genetic Algorithm (GA): Introduction; Chromosome representation and initialization- binary and real representation; GA operators – selection, crossover and mutation; Elite preserving mechanism; Schema theory; Constraints handling; GA for combinatorial problems – permutation representation and real coded representation; Multi-objective optimization – concept of dominance, non-dominated sorting,ranking and crowding distance.

Module-III (8 Hours)

Differential Evolution (DE): Introduction; Chromosome representation; Target, base and trail vectors; Mutation and crossover; DE for combinatorial problems; Differences between DE and other nontraditional techniques.

Module-IV (10 Hours)

Particle Swarm Optimization (PSO): Introduction; Chromosome representation; Global, population and local best solutions; Velocity and position of a solution; PSO for combinatorial problems.

Module-V (8 Hours)

Differences between PSO and other non traditional techniques. Introduction to other nontraditional techniques: Like simulated annealing, tabu search algorithm, artificial neural network, and ant colony optimization.

Text Books:

1. Optimization for Engineering Design-Algorithms and Examples – Kalyanmoy Deb; Prentice Hallof India Pvt. Ltd., New Delhi; 1995.
2. Multi-Objective Optimization using Evolutionary Algorithms – Kalyanmoy Deb; John Wiley &Sons Ltd, England; 2001.
3. Differential Evolution: A Practical Approach to Global Optimization – Kenneth V. Price, RainerM. Storn and Journi A. Lampinen; Natural Computing Series, Springer; 2005.
4. Particle Swarm Optimization – Maurice Clerc; ISTE Publishing Company; 2006.

Course Outcomes

After the successful completion of the course, the students will able to:

CO1	Have knowledge to formulate optimum design problems.
CO2	Solve the nonlinear optimum problems with evolutionary methods.
CO3	Identify nonlinear constrained and unconstrained optimum problems.
CO4	Solve discontinuous optimization problems using special methods.
CO5	Have knowledge of different non-traditional techniques for otimization.

Course Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	3	3	1
CO2	3	3	3	3	3	1
CO3	3	3	3	3	3	1
CO4	3	3	3	3	3	1
CO5	3	3	3	3	3	1

Program Articulation Matrix row for this course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO	3	3	3	3	3	1

ROTOR DYNAMICS

Module I (8 Hours)

Introduction to vibration and rotor dynamics:Co-ordinate systems, Steady state rotor motion, Elliptical motion, Single degree of freedom systems, Free and forced vibrations. The two degrees of freedom rotor system, Geared systems, Translational motion, Natural frequencies and Natural modes. Rudiments of Rotor Dynamics, Rotor Dynamic considerations in machinery design, critical speeds, the effect of flexible support and unbalance response.

Module – II (8 Hours)

Torsional Vibrations of Rotating Machinery:Modelling of rotating machinery shafting, Multi degree of freedom systems, Determination of natural frequencies and mode shapes, Branched systems.

Module – III (8 Hours)

Rigid Rotor Dynamics and Critical Speed:Rigid disk equation - Rigid rotor dynamics, Rigid rotor and flexible rotor, The gyroscopic effect on rotor dynamics, Whirling of an unbalanced simple elastic rotor, Unbalance response. Determination of bending critical speeds.

Module – IV (8 Hours)

Influence of Bearings on Rotor Vibrations:Stiffness and damping coefficients of journal bearings, Computation and measurements of journal bearing coefficients, Design configurations of stable journal bearings.

Module – V (8 Hours)

Balancing of Rotors: Single plane balancing, Multi-plane balancing, Balancing of rigid rotors, Balancing of flexible rotors, Influence coefficient and modal balancing techniques for flexible rotors.

Text Books

1. J. S. Rao, “Rotor Dynamics”, New Age International Publishers, New Delhi
2. M. J. Goodwin, Dynamics of Rotor-Bearing Systems, Unwin Hyman, Sydney, 1989.

Reference Books

1. W J Chen and J E Gunter, “Introduction to Dynamics of Rotor – Bearing Systems”, Trafford Publishing Ltd.
2. T. Yamamoto and Y. Ishida, “Linear and Nonlinear Rotor Dynamics: A Modern Treatment with Applications”, John Wiley.

Course outcomes

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

CO1	Understand the importance of vibrations and rotor dynamics in mechanical design of machine parts that operates in vibratory conditions.
CO2	Develop the modelling of rotating machineries for engineering problems in torsional vibrations.
CO3	Understand the gyroscopic effect on rotor dynamics and to determine the bending critical speeds.
CO4	Compute and measure the influence of bearings on rotor vibrations
CO5	Understand and analyze balancing of rotors

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	3	1
CO4	3	2	3	3	3	1
CO5	3	2	3	3	3	1

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	2	3	3	3	1

OTHER ELECTIVE-1

COMPUTATIONAL METHODS

Module I (8 Hours)

Significant figures, round-off, precision and accuracy, approximate and true error, truncation error and Taylor series, machine epsilon, data uncertainties, error propagation, importance of errors in computer programming.

Module – II (8 Hours)

Motivation, Bracketing methods: Bisection methods, Open methods: Newton Raphson method, Engineering applications.

Module – III (8 Hours)

Motivation, Cramer's rule, Gauss- Elimination Method, pivoting, scaling, engineeringapplications.

Module – IV (8 Hours)

Motivation, Newton's Cotes Integration Formulas: Trapezoidal Rule, Simpson's rule, engineering applications Numerical differentiation using Finite divide Difference method

Module – V (8 Hours)

Motivation, Least Square Regression: Linear Regression, Polynomial regression. Interpolation: Newton's Divide Difference interpolation, engineering applications. Solution to Ordinary Differentiation Equations: Motivation, Euler's and Modified Euler's Method, Heun's method, Runge– Kutta Method, engineering applications.

Computer Programming:Overview of programming language, Development of at least one computer program based on each unit.

Text Books

1. Steven C Chapra, Reymond P. Canale, "Numerical Methods for Engineers", Tata McGraw Hill Publications, 2010.
2. E. Balagurusamy, "Numerical Methods", Tata McGraw Hill Publications, 1999.

Reference Books

1. 1. V. Rajaraman, "Fundamental of Computers", Prentice Hall of India, New Delhi, 2003.
2. S. S. Sastri, "Introductory Methods of Numerical Methods", Prentice Hall of India, New Delhi, 3rd edition, 2003.
3. K. E. Atkinson, "An Introduction to Numerical Analysis", Wiley, 1978.
4. M.J. Maron, "Numerical Analysis: A Practical Approach", Macmillan, New York, 1982.

Course Outcomes

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

CO1	Analyze the concept of error
CO2	Define the concept of various Numerical Techniques
CO3	Evaluate the given Engineering problem using the suitable Numerical Technique
CO4	Apply curve fitting and interpolation method for solving various numerical problems
CO5	Develop the computer programming based on the Numerical Techniques

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	2	3	1
CO2	3	1	1	2	3	1
CO3	3	1	1	2	3	1
CO4	3	1	1	2	3	1
CO5	3	1	1	2	3	1

Program Articulation Matrix row for this course

	PO1	PO2	PO3	PO4	PO5	PO6
CO	3	1	1	2	3	1

VIBRATION BASED CONDITIONING MONITORING

Module-I (6 Hours)

Introduction:Basic concept, techniques -Vibration vibration monitoring, lubricant monitoring and noise monitoring, Benefits of Vibration Analysis, vibration transducersTorsional Vibration Transducers.

Module-II (6 Hours)

Vibration Signals from Rotatingand Reciprocating Machines: Signal Classification,Signals Generated by Rotating Machines,Unbalance, Misalignment, Bent Shaft,Vibrations from Gears, Rolling element bearing,oil whirl,Bladed Machines,Signals Generated by Reciprocating Machines.

Module-III (8 Hours)

Fundamentals of signal analysis – Basic signal processing techniques Probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, Digital filtering, Deterministic / random signal separation, Time-frequency analysis.

Module-IV (8 Hours)

Fault Detection: Rotating machines: Vibration Criteria, Use of Frequency Spectra, CPB Spectrum Comparison, Reciprocating Machines: vibration Criteria for Reciprocating Machines, Time–Frequency Diagrams, Torsional Vibration.

Module-V (12 Hours)

Gear Diagnostics: Cepstrum Analysis, Separation of Spalls and Cracks, Diagnostics of Gears with Varying Speed and Load, Rolling Element Bearing Diagnostics: Localized Faults and Extended Faults. Fault Trending and Prognostics: Trend Analysis, Trending of Simple Parameters, Trending of 'Impulsiveness', Introduction to Advanced Prognostics.

Text Books

1. Robert Bond Randall – Vibration-Based Condition Monitoring – Industrial, Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011
2. R.A.Collacot – Mechanical Fault Diagnosis – Chapman and Hall Ltd., 1977.

Reference Books

1. John S.Mitchell, Introduction to Machinery Analysis and Monitoring, PennWell Books,1993.
2. V. Wowk, Machinery vibration: Measurement and analysis,McGraw-Hill,New York,1991

Course Outcomes

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

CO1	Understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with vibration based condition monitoring techniques and its applications in the industries
CO2	Implement the basic signal processing techniques and Understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.
CO3	Understand the significance of mechanical fault diagnosis techniques in monitoring and maintenance.
CO4	Study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining
CO5	Develop skill for communicating research results and technical presentations.

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	1
CO2	3	3	1	2	2	1
CO3	3	3	3	2	2	1
CO4	3	3	2	2	3	1
CO5	2	2	3	3	3	

Program Articulation Matrix row for this course

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO	3	3	3	3	1	**1**

ADVANCE COMPOSITES

Module – I (8 Hours)

Basic concepts and characteristics: Geometric and Physical definitions, natural and man-made composites, Aerospace and structural applications, types and classification of composites. Reinforcements: Fibres – Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermo-sets, Metal matrix and ceramic composites.

Module – II (8 Hours)

Nano and Smart materials: Definition, Types, Properties and applications, Carbon nano tubes, Methods of production, Shape memory alloys, Piezoelectric materials, Electro active Polymers, Electro-rheological fluid, Functionally gradient material (FGM), biomaterials, micro-electro mechanical systems (MEMS).

Module – III (8 Hours)

Miscellaneous Advanced Materials: Magnetic materials, ceramics, composites and polymers, surface metal matrix composites, aerospace materials, and cryogenic materials, semi conducting and superconducting materials.

Module – IV (8 Hours)

Processing and Characterization of Advance Materials: Processing of Metal Matrix Composites, Polymer Matrix Composites, Ceramic Matrix Composites.

Module – V (8 Hours)

Properties and applications: Strength, stiffness, creep, fatigue and fracture; thermal, damping and tribological properties.

Text Books

1. Mechanics of composite materials, R. M. Jones, Mc Graw Hill Book Co.
2. Engineering Materials: Properties and applications of Metals and alloys, CP Sharma, PHI
3. Engineering Materials: Polymers, ceramics and composites, AK Bhargava, PHI
4. Nano Technology, AK Bandyopadhyay, New age international publishers

Reference Books

1. Gandhi, M.V., Thompson, B.S., Smart Materials and Structures, Chapman and Hall
2. Ray, A.K. (ed), Advanced Materials, Allied publishers.
3. Rama Rao, P. (ed), Advances in Materials and their applications, Wiley Eastern Ltd.
4. Bhushan, B., Nano Technology (ed), Springer, International Edition.
5. Engineering Materials and Applications, R. A. Flinn and P. K. Trojan

Course Outcomes:

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

CO1	Identify and explain the types of composite materials and their characteristic features.
CO2	Describe properties and applications of smart and Nano materials.
CO3	Explain the use of different Miscellaneous Advanced Materials
CO4	Understand and explain the processing and characterization of advance Materials.
CO5	Describe the properties and applications of advanced composite materials.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	1	2	-	2	-	-	-	-	-	-	-	-
CO2	2	3	3	-	-		-	-		1	-	1
CO3	2	-	-	3	-	-	1	2	-	-	-	-
CO4	3	2	-	-	1	-		-	1	-	-	-
CO5	1	-	-	2	-	-	-	-	2	-	2	3

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO	3	2	1	-	1	-	1	2	-	1	-	1

SESSIONALS

Major Project Dissertation (Ph-I)

4th SEMESTER

SESSIONALS

Major Project & Dissertation (Ph-II)