JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

Kakinada-533003, Andhra Pradesh, India

B.Tech in Mechanical Engineering

Vision

To nurture the excellence in modeling and designing of modern mechanical engineering systems by imparting timeless core values to the learners and to mould the Department into a centre of academic excellence catering to the industrial needs through advanced research.

Mission

To offer high quality graduate and post graduate programs in Mechanical Engineering in order to make the learners globally competitive technologists who are professionally capable and socially responsible. The department enables the learners inculcate and imbibe theoretical and practical knowledge for exploration and deep insight for advanced technological innovations and inventions.

PROGRAM EDUCATIONAL OBJECTIVES

PEO 1 To impart the fundamentals of the basic sciences and engineering to develop modeling and analytical skills required for professional practice of Mechanical Engineering and other allied fields.
PEO 2 To provide the core knowledge in the fields of manufacturing, design and thermal engineering to model, design, analyze and innovate the effective and efficient Mechanical Engineering systems.
PEO 3 To equip the learners demonstrate successful careers in industry with sound technical skills in design, production, execution and optimization of Mechanical systems.
PEO 4 To produce ethical and socially responsible graduates with commitment to lifelong learning and exhibit competency in their work culture.

PROGRAM OUTCOMES: At the end of the program the student will be able to:

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance : Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

P012: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES:

PSO 1 To be able to apply the sound fundamental knowledge of basic sciences and engineering for solving complex mechanical problems catering to the needs of the industry.

PSO 2 To prepare for higher education and research in mechanical engineering and multi-disciplinary fields.

PSO 3 Able to possess the knowledge and skill to design and develop products related to mechanical engineering and other allied fields, for sustainable development of the society.

COURSE OUTCOMES

Course Code	**Mathematics-I**
R19BS1101	

CO1. Utilize mean value theorems to real life problems (L3)
CO2. Solve the differential equations related to various engineering fields (L3)
CO3. Familiarize with functions of several variables which is useful in optimization (L3)
CO4. Apply double integration techniques in evaluating areas bounded by region (L3)
CO5. Students will also learn important tools in calculus in higher dimensions. Students will become familiar with 2- dimensional and 3-dimensional coordinate systems (L5)
CO6. Conclude the use of special function in multiple integrals (L4)

Course Code	**Engineering Physics**
R19HS1101	

CO1. explain the concept of dielectric constant and polarization in dielectric materials.
CO2. summarize various types of polarization of dielectrics.
CO3. Interpret Lorentz field and Claussius Mosotti relation in dielectrics.
CO4. classify the magnetic materials based on susceptibility and their temperature dependence.
CO5. explain the applications of dielectric and magnetic materials.
CO6. Apply the concept of magnetism to magnetic devices.

Course Code	**Engineering Mechanics**
R19PC1102	

CO1. To Learn the principles (Axioms) of statics, able to find resultant & resolution of system of forces and resultant force.
CO2. Explore the concepts of constraints, free body diagram and action-reaction.
CO3. Estimate the geometric parameters like centroid, center of gravity and moment of inertia and identify their application.
CO4. Learn the analysis of frames and trusses and know the importance of friction.
CO5. Able to determine solution to dynamic problems through D'Alembert equilibrium equations, Impulse-Momentum and work- energy method.

Course Code	**Problem Solving and Programming using C**
R19ES1101	

CO1. Student will be able to develop efficient algorithm for solving a problem.
CO2. Use various constructs of C programming language efficiently.
CO3. Student will be able to develop programs using modular approach.

CO4. Such as functions. And also able to develop programs to perform matrix and mathematical applications.
C05. Student will be able to understand dynamic memory management and problems using pointers and solving the problems.
CO6 Student will be able to develop programs for real life applications using structures and also learn about handling the files for storing the data permanently.

Course Code	**Engineering Graphics and Drafting**
R19ES1103	

CO1. To make the students to draw the attributes and its importance in the fields of design and manufacturing.
CO2. To make the student familiar with the techniques used for drawing various geometric elements used in engineering practice.
CO3. Making them to understand orthographic projections of points, lines, planes and solids in various
Positions with respect to different reference planes.
CO4. Ability to use the concepts of isometric projections to analyze 3D objects by viewing their
2D projections and vice versa.

Course code	**Mathematics-II**
R19BS1201	

After completion of course, students would be ableto:
CO1. develop the use of matrix algebra techniques that is needed by engineers for practical applications (L6)
CO2. solve system of linear algebraic equations using Gauss elimination, Gauss Jordan, Gauss Seidel (L3)
CO3. evaluate approximating the roots of polynomial and transcendental equations by different algorithms (L5)
CO4. apply Newton's forward & backward interpolation and Lagrange's formulae for equal and unequal intervals (L3)
CO5. apply different algorithms for approximating the solutions of ordinary differential equations to its analytical computations (L3)

Course code	

R19ES1201	**Basic Electrical & Electronics Engineering**

CO1. Analyse various electrical networks.
CO2. Understand operation of DC generators, 3-point starter and DC machine testing by Swinburne's Test.
CO3. Analyse performance of single-phase transformer.
CO4. Explain operation of 3-phase alternator and 3-phase induction motors.
CO5. Analyse operation of half wave, full wave bridge rectifiers and OP-AMPs and Explain single stage CE amplifier and concept of feedback amplifier.

Course Code	
R19ME2102	**MECHANICS OF SOLIDS**

CO1: Model & Analyze the behavior of basic structural members subjected to various loading and support conditions based on principles of equilibrium.
CO2: Understand the apply the concept of stress and strain to analyze and design structural members and machine parts under axial, shear and bending loads, moment and torsional moment.
CO3: Students will learn all the methods to analyze beams, columns, frames for normal, shear, and torsion stresses and to solve deflection problems in preparation for the design of such structural components. Students are able to analyse beams and draw correct and complete shear and bending moment diagrams for beams.
CO4: Students attain a deeper understanding of the loads, stresses, and strains acting on a structure and their relations in the elastic behavior
CO5: Design and analysis of Industrial components like pressure vessels.

Course Code	
R19ME2103	**MATERIALS SCIENCE & ENGINEERING**

CO1: Understand the crystalline structure of different metals and study the stability of phases in different alloy systems.
CO2: Study the behavior of ferrous and non ferrous metals and alloys and their application in different domains
CO3: Able to understand the effect of heat treatment, addition of alloying elements on properties of ferrous metals.
CO4: Grasp the methods of making of metal powders and applications of powder metallurgy
CO5: Comprehend the properties and applications of ceramic, composites and other advanced methods.

Course Code	PRODUCTION TECHNOLOGY
R19ME2104	

After completion of course, students would be able to:
CO1: Able to design the patterns and core boxes for metal casting processes
CO2: Able to design the gating system for different metallic components
CO3: Know the different types of manufacturing processes
CO4: Be able to use forging, extrusion processes
CO5: Learn about the different types of welding processes used for special fabrication.

Course Code	THERMODYNAMICS
R19ME2105	

After completion of course, students would be able to:
CO1: Basic concepts of thermodynamics
CO2: Laws of thermodynamics
CO3: Concept of entropy
CO4: Property evaluation of vapors and their depiction in tables and charts
CO5: Evaluation of properties of perfect gas mixtures.

Course Code	MACHINE DRAWING
R19ME2106	

After completion of course, students would be able to:
CO1. Draw and represent standard dimensions of different mechanical fasteners and joints and Couplings.
CO2. Draw different types of bearings showing different components.
CO3. Assemble components of a machine part and draw the sectional assembly drawing showing the dimensions of all the components of the assembly as per bill of materials
CO4. Select and represent fits and geometrical form of different mating parts in assembly drawings.
CO5: To prepare manufacturing drawings indicating fits, tolerances, surface finish and surface treatment requirements.

Course Code	KINEMATICS OF MACHINERY
R19ME2202	

After completion of course, students would be able to:
CO1: Contrive a mechanism for a given plane motion with single degree of freedom.
CO2: Suggest and analyze a mechanism for a given straight line motion and automobile steering motion.

CO3: Analyze the motion (velocity and acceleration) of a plane mechanism.
CO4: Suggest and analyze mechanisms for a prescribed intermittent motion like opening and closing of IC engine valves etc.
CO5: Select a power transmission system for a given application and analyze motion of different transmission systems

Course Code	APPLIED THERMODYNAMICS - I
R19ME2203	

After completion of course, students would be able to:
CO1**:** Expected to learn the working of steam power cycles and also should be able to analyze and evaluate the performance of individual components
CO2: Student is able to learn the principles of combustion , stochiometry and flue gas analysis
CO3: Students will be able to design the components and calculate the losses and efficiency of the boilers, nozzles and impulse turbines**.**
CO4: Students will be able to design the components and calculate the losses and efficiency of reactions turbines and condensers.
CO5: Student is able to learn various types of compressors, principles of working and their performance evaluation.

Course Code	FLUID MECHANICS & HYDRAULIC MACHINES
R19ME2204	

After completion of course, students would be able to:
From this course the student is expected to learn
CO1: The basic concepts of fluid properties.
CO2: The mechanics of fluids in static and dynamic conditions.
CO3: Boundary layer theory, flow separation and dimensional analysis.
CO4: Hydrodynamic forces of jet on vanes in different positions.
CO5: Working Principles and performance evaluation of hydraulic pump and turbines.

Course Code	METAL CUTTING & MACHINE TOOLS
R19ME2205	

CO1: Learned the fundamental knowledge and principals in material removal process.
CO2: Acquire the knowledge on operations in conventional, automatic, Capstan and turret lathes
CO3: capable of understanding the working principles and operations of shaping, slotting, planning , drilling and boring machines.
CO4: able to make gear and keyway in milling machines and understand the indexing mechanisms
CO5: Understand the different types of unconventional machining methods and principles of

finishing processes.

Course Code	DESIGN OF MACHINE MEMBERS – I
R19ME2206	

After completion of course, students would be able to:
CO 1. Calculate different stresses in the machine components subjected to various static loads, failures and suitability of a material for an engineering application.
CO 2. Calculate dynamic stresses in the machine components subjected to variable loads.
CO 3. Design riveted, welded, bolted joints, keys, cotters and knuckle joints subjected to static loads and their failure modes
CO 4. Design the machine shafts and suggest suitable coupling for a given application.
CO 5. Calculate stresses in different types of springs subjected to static loads and dynamic loads.

Course Code	DYNAMICS OF MACHINERY
R19ME3101	

CO1: Compute frictional losses, torque transmission of mechanical systems
CO2: Analyze dynamic force analysis of slider crank mechanism and design of flywheel
CO3: understand the principle of working of different types of governors and Analyze stabilization of sea vehicles, aircrafts and automobile vehicles
CO4: Understand balancing of reciprocating and rotary masses.
CO5: Develop understanding of vibrations and its significance on engineering design.

Course Code	DESIGN OF MACHINE MEMBERS– II
R19ME3102	

CO1: Understand to select the suitable bearing based on the application of the loads and predict the life of the bearing
CO2: apply the design procedures of engine parts such as connecting rod, crank and crank shaft, piston, cylinder and cylinder liners
CO3: Design of curved beams with various cross sections and crane hooks
CO4: Design power transmission elements such as belts, chains, ropes and power screws.
CO5: Design the spur and helical gear drives

Course Code	MECHANICAL MEASUREMENTS & METROLOGY
R19ME4101	

CO1: Describe the construction and working principles of measuring instruments for measurement of displacement and speed and select appropriate instrument for a given application.
CO2: Describe the construction and working principles of measuring instruments for strain, force, Torque, power, acceleration and Vibration and select appropriate instrument for a given

application.
CO3: Explain shaft basis system and hole basis systems for fits and represent tolerances for a given fit as per the shaft basis system and hole basis system and design limit gauges based on the tolerances for quality check in mass production.
CO4: Explain methods for linear, angle and flatness measurements and select a suitable method and its relevant instrument for a given application.
CO5: To measure the threads, gear tooth profiles, surface roughness and flatness using appropriate instruments and analyze the data.

Course Code	**INDUSTRIAL ROBOTICS (PROGRAM ELECTIVE-1)**
R19ME3105C	

CO1: Understand different types of robots, classification of coordinate system and control systems and challenges of end effectors of robot.
CO2: Comprehend numerous Sensors and Actuators appropriate to robots and the applications of robots in different industrial and other areas.
CO3: Conclude kinematic analysis with D-H notation, forward and inverse kinematics
CO4: Solve dynamic analysis with Lagrange – Euler and Newton – Euler formulations
CO5: Model trajectory planning for a manipulator by avoiding obstacles

Course Code	**IC ENGINES & GAS TURBINES**

CO1: Derive the actual cycle from fuel-air cycle and air- standard cycle for all practical applications.
CO2: Explain working principle and various components of IC engine
CO3: Explain combustion phenomenon of CI and SI engines and their impact on engine variables.
CO4: Analyze the performance of an IC engine based on the performance parameters.
CO5: Explain the cycles and systems of a gas turbine and determine the efficiency of gas turbine.
CO6: Explain the applications and working principle of rockets and jet propulsion.

Course Code	**OPERATIONS RESEARCH**
R19ME3201	

CO1: Formulate the resource management problems and identify appropriate methods to solve them
CO2: Apply LPP, transportation and assignment models to optimize the industrial resources
CO3: Solve decision theory problems through the application of game theory
CO4: Apply the replacement and queuing models to increase the efficiency of the system
CO5: Model the project management problems through CPM and PERT

Course Code	HEAT TRANSFER (DATABOOK IS ALLOWED)
R19ME3202	

CO1: Compute rate of heat transfer for 1D, steady state composite systems without heat generation.
CO2: Analyze the system with heat generation, variable thermal conductivity, fins and 1D transient conduction heat transfer problems.
CO3: Develop the empirical equations for forced convection problems by using Buckingham's pi theorem.
CO4: Compute the rate of heat transfer for natural convection systems and design and analysis of heat exchangers.
CO5: Solve the heat transfer systems with phase change and radiation.

Course Code	FINITE ELEMENT METHODS
R19ME3203	

CO1: Understand the concepts behind variation methods and weighted residual methods in FEM
CO2: Develop element characteristic equation procedure and generation of global stiffness equation will be applied
CO3: Identify the application and characteristics of FEA elements such as bars, beams, trusses and isoperimetric elements.
CO4: Apply suitable boundary conditions for 2D stress analysis, formulation of axi-symmetric problems and higher order isoperimetric elements.
CO5: Evaluate the concepts of steady state heat transfer analysis and dynamic analysis

Course Code	CAD/CAM
R19ME3208	

1. Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix
2. Describe the use of GT and CAPP for the product development

3. Identify the various elements and their activities in the Computer Integrated Manufacturing Systems.

Course Code	COMPOSITE MATERIALS (PEC-1)
R19MD 2034D	

. Explain various composite materials with their constituents, advantages, limitations and applications
2. Enumerate different reinforcements with their application.
3. Describe various manufacturing methods of polymer and metal matrix composites materials.
4. Describe various manufacturing methods of metal matrix composites materials and their applications.
5. Explain the synthesis and characterization procedures of nano composites.

Course Code	REFRIGERATION AND AIR CONDITIONING (PEC-1)
R19ME3105B	

- Differentiate between different types of refrigeration systems with respect to engineering applications
- Thermodynamically analyse refrigeration and air conditioning systems and evaluate performance parameters
- Apply the principles of Psychrometrics to design the air conditioning loads for the industrial applications
- perform cooling load calculations and select the appropriate process and equipment for the required comfort and industrial air-conditioning.

Course Code	MECHANICAL VIBRATIONS (PROGRAM ELECTIVE-3)
R19CA 1033C	

CO1: Understand various methods to determine the vibration characteristics of free and forced vibrations of a single degree of freedom system

CO2: Understand Forced Vibrations and measurement of vibration parameters

CO3: Model two degree of freedom systems and explain working principle of vibration absorber

CO4: Compute the national frequencies of multi-degree of freedom systems and explain model analysis for free and forced vibrations.

CO5: Model and analyze vibrations of continuous systems

Course Code	UNCONVENTIONAL MACHINING PROCESSES (PEC-1)
R19ME3105A	

- Understand the characteristics and importance of different types of unconventional machining processes
- Identify the appropriate unconventional machining process for the implementation in a typical industrial scenario based on the applications
- Understand the significance of tools and resources used for machining the components in unconventional machining
- Machine the components through ECM / EDM and other machining processes
- Perform experiments in the advanced unconventional machining processes such as laser beam machining and electron beam machining

Course Code	ADVANCED MECHANICS OF SOLIDS (PROGRAM ELECTIVE-3)
R19MD101	

CO1: Understand the basic concepts related to stress and strains of deformable bodies.
CO2: Able to identify the failure modes of different structural members and applying various energy methods for statically determinate and indeterminate structures.
CO3: Gets acquainted with solving problems with unsymmetrical loading
CO4: Analyze the problems associated with curved beams
CO5: Able to apply the soap film analogy concept for torsional problems with non circular cross-section

Course Code	MATERIAL CHARACTERIZATION (PEC-2)

choose and appropriate electron microscopy techniques to investigate microstructure of materials at high resolution
2. Determine crystal structure of specimen and estimate its crystallite size
3. Use appropriate spectroscopic technique to measure vibrational / electronic transitions to estimate parameters like energy band gap, elemental concentration, etc.
4. Apply thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen.

Course Code	MECHATRONICS
R19ME4104B	

CO1. Shall be able to use the various mechatronics systems devices and components in the design of electro mechanical systems.
At the end of the course, the student will be able to
CO1: Explain mechatronics design process and outline appropriate sensors and actuators for engineering applications
CO2: Develop a simulation model for simple physical systems
CO3: Write simple microcontroller programs
CO4: Explain linearization of nonlinear systems and elements of data acquisition
CO5: Explain various applications of design of mechatronic systems

Course Code	INDUSTRIAL MANAGEMENT

CO 1. Design and conduct experiments, analyse, interpret data and synthesize valid conclusions
CO 2. Design a system, component, or process, and synthesize solutions to achieve desired needs
CO 3. Use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints
CO 4. Function effectively within multi-disciplinary teams and understand the fundamental precepts of effective project management

Course Code	FINITE ELEMENT METHODS
R19ME3203	

CO 1. Understand the concepts behind variational methods and weighted residual methods in FEM
CO 2. Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element .
CO 3. Develop element characteristic equation procedure and generate global equations.
CO 4. Able to apply Suitable boundary conditions to global equations, and reduce it to a solvable form.
Able to apply the FE procedure to field problems like heat transfer

Course Code	MECHANICAL VIBRATIONS (PEC-3)
R19ME3206A	

CO 1. To Analyze the various 1-D periodic and periodic responses of an vibrating system with and without damping

CO 2. Able to derive equations of motion and solutions for two and multi degree freedom systems by the application of analytical methods

CO 3. Able to understand the numerical methods for quick estimation of 1st natural frequency of multi degree freedom systems.

CO 4. Apply the knowledge of the various physical vibration measuring instruments and their applications in real life vibration data acquisition.

Course Code	**RENEWABLE ENERGY SOURCES (PEC-3)**
R19ME4202C	

CO 1. To understand the principles and working of solar, wind, biomass, geo thermal, ocean energies.
CO 2. To understand the principles and working and green energy systems and appreciate their significance in view of their importance in the current scenario and their potential future applications.

Course Code	**PRODUCTION PLANNING & CONTROL (PEC-3)**
R19ME3206C	

CO1. Apply the systems concept for the design of production and service systems.
CO2. Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.
CO3. Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources.
CO4. Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances.

Course Code	**MACHINE TOOL DESIGN (PEC-3)**

CO 1.Understand the basic working principles of different machine tools with kinematic mechanisms.

CO 2.Distinguish the functional and operational requirements of different machine tools

CO 3. Design speed and feed gear boxes for a particular configuration.

CO 4. Design machine tool structures for strength and rigidity

CO 5. Understand various controls used in machine tools

Course Code	**INDUSTRIAL AUTOMATION AND ROBOTICS (PEC-4)**

CO 1. Identify various robot configuration and components,
CO 2. Select appropriate actuators and sensors for a robot based on specific application
CO 3. Carry out kinematic and dynamic analysis for simple serial kinematic chains
CO 4. Perform trajectory planning for a manipulator by avoiding obstacles.
CO 5. Use knowledge of robotics for automation in manufacturing applications.

Course Code	**MICRO AND NANO MANUFACTURING (PEC-4)**

CO 1. get awareness of different techniques used in micro and nano manufacturing.
CO 2. get in-depth idea of thin films and nano composites
CO 3. get awareness on Characterization Techniques
CO 4. find different materials for Micro and Nano mechanical systems and their applications in mechanical engineering.
CO 5. Explain different MEMS & Nano fabrication Techniques.

Course Code	**POWER PLANT ENGINEERING (PEC-4)**
R19ME4103B	

CO 1. Understand various conventional methods of power generation
CO 2. To understand the principle of operation and performance of respective prime movers along with their economics and their impact on environment.
CO 3. To understand the power plant instrumentation and control

Course Code	**OPTIMIZATION TECHNIQUES (PEC-4)**
R19CA 3022B	

CO 1. Explain various composite materials with their constituents, advantages, limitations and applications
CO 2. Enumerate different reinforcements with their application.
CO 3.Describe various manufacturing methods of polymer and metal matrix composites materials.
CO 4. Describe various manufacturing methods of metal matrix composites materials and their applications.

CO 5. Explain the synthesis and characterization procedures of nano composites.

Course Code	**OPTIMIZATION METHODS (OPEN ELECTIVE-1)**

CO 1. Students at the end of the course learn advanced optimization techniques to solve real-life problems
CO 2. Students can able to formulate and solve various practical optimization problems in manufacturing and service organizations

Course Code	**OPTIMIZATION MANAGEMENT (OPEN ELECTIVE-1)**

CO 1. Identify the elements of operations management and various transformation processes to enhance productivity and competitiveness
CO 2. Analyze plant and process layout
CO 3. Develop aggregate capacity plans and MPS in operation environments.

Course Code	**NANO TECHNOLOGY (OPEN ELECTIVE-1)**
R19OE3204D	

Course Code	**FINITE ELEMENT ANALYSIS (OPEN ELECTIVE-1)**
R19ME3203	

CO 1. Understand the concepts behind variational methods and weighted residual methods in FEM
CO 2. Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element .
CO 3. Develop element characteristic equation procedure and generate global equations.
CO 4. Able to apply Suitable boundary conditions to global equations, and reduce it to a solvable form.
CO 5. Able to apply the FE procedure to field problems like heat transfer.

Course Code	**ADDITIVE MANUFACTURING (PEC-5)**
R19ME3205A	

COURSEOUTCOMES

After completion of course, students would be able to:

Course Code	GAS DYNAMICS AND JET PROPULSION (PEC-5)
R19ME4201B	

CO1: Illustrate fluid flow systems
CO2: Analyze the isotropic flow of an ideal gas and its parameter
CO3: Study simple frictional flow with heat transfer problems
CO4: Analyze the impact of heat transfer on flow parameters.
CO5: Performance evaluation of different propulsion systems

Course Code	PRODUCT DESIGN AND DEVELOPMENT (PEC-5)
R19ME4202E	

CO 1. Apply the principles of generic development process; conduct customer need analysis; and set
product specification for new product design and development.
CO 2. Generate, select, screen, and test concepts for new product design and development.
CO 3. Apply the principles of product architecture and industrial design to design and develop new
products.
CO 4. Apply the principles of DFMA and Prototyping to design and develop new product.
CO 5. Apply the concepts of economics principles sustainable product development and life cycle
assessment.

Course Code	RELIABILITY ENGINEERING (PEC-5)
R19ME4202D	

CO1: Explain the basic concepts of Reliability Engineering and its Understand measures.
CO 2. Predict the Reliability at system level using various models.
CO 3. Design the test plan to meet the reliability Requirements.
CO 4. Predict and estimate the reliability from failure data.
CO 5. Develop and implement a successful Reliability programme

Course Code	CONDITION MONITORING

R19ME4103D	**(PEC-6)**

CO 1. Understand the types of maintenance used and its significance, role of condition based maintenance in industries, familiarize with different condition monitoring techniques and its advantages in industries.
CO 2. Implement the basic signal processing techniques.
CO 3. Understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.
CO 4. Understand the significance of mechanical fault diagnosis and non-destructive testing techniques in monitoring and maintenance.
CO 5. Study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining.

Course Code	**COMPUTATIONAL FLUID DYNAMICS (PEC-6)**
R19ME4104C	

Course Code	**NON - DESTRUCTIVE EVALUATION (PEC-6)**
R19CA 3011A	

CO 1. Comprehensive, theory based understanding of the techniques and methods of non destructive testing
CO 2. Apply methods knowledge of non destructive testing to evaluate products of railways, automobiles, aircrafts, chemical industries etc.

Course Code	**CONTROL SYSTEMS (PEC-6)**
R19ME3205C	

CO 1 Derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.
CO 2. Determine time response specifications of second order systems and to determine error constants.
CO 3. Analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.
CO 4. Analyze the stability of LTI systems using frequency response methods.
CO 5. Represent physical systems as state models and determine the response. Understanding

the concepts of controllability and observability.

Course Code	ENTREPRENEURSHIP DEVELOPMENT (PEC-6)

CO 1. Gain the competency of preparing business plans
CO 2. Get the awareness on industrial policies
CO 3. Study the impact of launching small business
CO 4. Understand the recourse planning and market selection for start ups.

Course Code	HYDROGEN & FUEL CELLS (OPEN ELECTIVE-II)

Course Code	ROBOTICS (OPEN ELECTIVE-II)
R19OE4105A	

CO 1. Understand the basic components of robots.
CO 2. Differentiate types of robots and robot grippers.
CO 3 . Model forward and inverse kinematics of robot manipulators.
CO 4. Analyze forces in links and joints of a robot.
CO 5. Programme a robot to perform tasks in industrial applications.
CO 5. Design intelligent robots using sensors.

Course Code	ENERGY MANAGEMENT (OPEN ELECTIVE-II)

CO 1. Explain the fundamentals of energy management and its influence on environment
CO 2. Describe methods of energy production for improved utilization.
CO 3. Apply the principles of thermal engineering and energy management to improve the performance of thermal systems. Analyze the methods of energy conservation and energy efficiency for buildings, airconditioning, heat recovery and thermal energy storage systems.
CO 4. Assess energy projects on the basis of economic and financial criteria.

Course Code	3D PRINTING TECHNOLOGIES (OPEN ELECTIVE-II)
R19ME4203A	

CO 1. Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation.
CO 2. Formulate and solve typical problems on reverse engineering for surface reconstruction from physical prototype models through digitizing and spline-based surface fitting.
CO 3. Formulate and solve typical problems on reverse engineering for surface reconstruction from digitized mesh models through topological modelling and subdivision surface fitting.
CO 4. Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.
CO 5. Explain and summarize typical rapid tooling processes for quick batch production of plastic and metal parts

Course Code	MECHATRONICS (OPEN ELECTIVE-II)
R19MD 2043C	

Course Code	TOTAL QUALITY MANAGEMENT (OPEN ELECTIVE-III)

CO1. To realize the importance of significance of quality
CO2. Manage quality improvement teams
CO3. Identify requirements of quality improvement programs

Course Code	SUPPLY CHAIN MANAGEMENT (OPEN ELECTIVE-III)

CO1. To realize the importance of Supply chain management frame work in business management
CO2. Understand basic concepts of forecasting and risk management
CO3. Explain and implement the concept of aggregate planning and inventory.

Course Code	PRODUCT DESIGN AND DEVELOPMENT

R19CA 2033C	**(OPEN ELECTIVE-III)**

CO 1. Apply the principles of generic development process; conduct customer need analysis; and set
product specification for new product design and development.
CO 2. Generate, select, screen, and test concepts for new product design and development.
CO 3. Apply the principles of product architecture and industrial design to design and develop new
products.
CO 4. Apply the principles of DFMA and Prototyping to design and develop new product.
CO 5. Apply the concepts of economics principles sustainable product development and life cycle
assessment.

Course Code	**ENTREPRENEURSHIP (OPEN ELECTIVE-III)**

CO 1. Up on completing this course, students are able to
CO 2. Gain the competency of preparing business plans
CO 3. Get the awareness on industrial policies
CO 4. Study the impact of launching small business
CO 5. Understand the recourse planning and market selection for start ups.

Course Code	**ADVANCED MATERIALS (OPEN ELECTIVE-III)**

CO 1. Explain various composite materials with their constituents, advantages, limitations and applications
CO 2. Describe various manufacturing methods of polymer matrix composites materials.
CO 3. Derive stress strain relationships for orthotropic materials and analyze orthotropic lamina.
CO 4. Explain various functionally graded materials with their properties, preparation and applications
CO 5. Explain different smart materials with their application.