JOGINPALLY B.R. ENGINEERING COLLEGE

Accredited by NAAC B++, Recognized by UGC 2(f) Act.1956
Approved by AICTE & Affiliated to JNTUH, Hyderabad

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE OUTCOMES (COs)

B.Tech. II Year I Sem R18 Syllabus Mechanical Engineering

Course Code	Course Title / Name	Course Outcomes
MA301BS	Probability and Statistics & Complex Variables	**At the end of this course, each student should be able to:** **CO1:** Formulate and solve problems involving random variables and apply statistical methods for analysing experimental data. **CO2:** Analyse the complex function with reference to their analyticity, integration using Cauchy's integral and residue theorems. **CO3:** Taylor's and Laurent's series expansions of complex function.
ME302PC	Mechanics of Solids	**At the end of this course, each student should be able to:** **CO1:** Analyze the behavior of the solid bodies subjected to various types of loading; **CO2:** Apply knowledge of materials and structural elements to the analysis of simple structures; **CO3:** Undertake problem identification, formulation and solution using a range of analytical methods; **CO4:** Analyze and interpret laboratory data relating to behavior of structures and the materials they are made of, and undertake associated laboratory work individually and in teams. **CO5:** Expectation and capacity to undertake lifelong learning

ME303PC	Material Science and Metallurgy	**At the end of this course, each student should be able to:** **CO1:** Analyze the Structure of materials at different levels, basic concepts of crystalline materials like unit cell, FCC, BCC, HCP, APF (Atomic Packing Factor), Co-ordination Number etc. **CO2:** Understand concept of mechanical behavior of materials and calculations of same using appropriate equations. **CO3:** Explain the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy. Construction and identification of phase diagrams and reactions **CO4:** Understand and suggest the heat treatment process & types. Significance of properties Vs microstructure. Surface hardening & its types. Introduce the concept of hardenability & demonstrate the test used to find hardenability of steels **CO5:** Explain features, classification, applications of newer class materials like smart materials, piezoelectric materials, biomaterials,composite materials etc
ME304PC	Production Technology	**At the end of this course, each student should be able to:** **CO1:** Understand the idea for selecting materials for patterns. **CO2:** Know Types and allowances of patterns used in casting and analyze the components of moulds. **CO3:** Design core, core print and gating system in metal casting processes **CO4:** Understand the arc, gas, solid state and resistance welding processes. **CO5:** Develop process-maps for metal forming processes using plasticity principles. **CO6:** Identify the effect of process variables to manufacture defect free products.

ME305PC	Thermodynamics	**At the end of this course, each student should be able to:** At the end of the course, the student should be able to Understand and differentiate between different thermodynamic systems and processes. Understand and apply the laws of Thermodynamics to different types of systems undergoing various processes and to perform thermodynamic analysis. Understand and analyze the Thermodynamic cycles and evaluate performance parameters.
ME306PC	Production Technology Lab	**At the end of this course, each student should be able to:** Understanding the properties of moulding sands and pattern making. Fabricate joints using gas welding and arc welding. Evaluate the quality of welded joints. Basic idea of press working tools and performs moulding studies on plastics.
ME307PC	Machine Drawing Practice	**At the end of this course, each student should be able to:** **CO1:** Preparation of engineering and working drawings with dimensions and bill of material during design and development. Developing assembly drawings using part drawings of machine components. **CO2:** Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs, ribs. **CO3:** Types of sections – selection of section planes and drawing of sections and auxiliary sectional views. Parts not usually sectioned. **CO4:** Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centers, curved and tapered features. **CO5:** Title boxes, their size, location and details - common abbreviations and their liberal usage **CO6:** Types of Drawings – working drawings for machine parts.

ME308PC	Material Science and Mechanics of Solids Lab	**At the end of this course, each student should be able to:** The Primary focus of the Metallurgy and Material science program is to provide undergraduates with a fundamental knowledge based associated materials properties, and their selection and application. Upon graduation, students would have acquired and developed the necessary background and skills for successful careers in the materials-related industries. Furthermore, after completing the program, the student should be well prepared for management positions in industry or continued education toward a graduate degree.
*MC309	Constitution of India	**At the end of this course, each student should be able to:** **CO1 :** Able to understand historical background of the constitutional making and its importance for building a democratic India, the structure of Indian government, the structure of state government, the local Administration. **CO2:** Able to apply the knowledge on directive principle of state policy, the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy. **CO3:** Able to analyze the History, features of Indian constitution, the role Governor and Chief Minister, role of state election commission, the decentralization of power between central, state and local self-government. **CO4:** Able to evaluate Preamble, Fundamental Rights and Duties, Zilla Panchayat, block level organization, various commissions of viz SC/ST/OBC and women.

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Course Code	Course Title / Name	Course Outcomes
EE401ES	Basic Electrical and Electronics Engineering	**At the end of this course, each student should be able to:** **CO1:** To analyze and solve electrical circuits using network laws and theorems. **CO2:** To understand and analyze basic Electric and Magnetic circuits **CO3:** To study the working principles of Electrical Machines **CO4:** To introduce components of Low Voltage Electrical Installations **CO5:** To identify and characterize diodes and various types of transistors.
ME402PC	Kinematics of Machinery	**At the end of this course, each student should be able to:** The main purpose is to give an idea about the relative motions obtained in all the above type of components used in mechanical Engineering.
ME403PC	Thermal Engineering - I	**At the end of this course, each student should be able to:** At the end of the course, the student should be able to evaluate the performance of IC engines and compressors under the given operating conditions. Apply the laws of Thermodynamics to evaluate the performance of Refrigeration and air-conditioning cycles. Understand the functionality of the major components of the IC Engines and effects of operating conditions on their performance
ME404PC	Fluid Mechanics and Hydraulic Machines	**At the end of this course, each student should be able to:** **CO1:** Able to explain the effect of fluid properties on a flow system. **CO2:** Able to identify type of fluid flow patterns and describe continuity equation. **CO3:** To analyze a variety of practical fluid flow and measuring devices and utilize Fluid Mechanics principles in design.

		CO4: To select and analyze an appropriate turbine with reference to given situation in power plants. **CO5:** To estimate performance parameters of a given Centrifugal and Reciprocating pump. **CO6:** Able to demonstrate boundary layer concepts.
ME405PC	Instrumentation and Control Systems	**At the end of this course, each student should be able to:** **CO1:** To identify various elements and their purpose in typical instruments, to identify various errors that would occur in instruments. **CO2:** Analysis of errors so as to determine correction factors for each instrument. **CO3:** To understand static and dynamic characteristics of instrument and should be able to determine loading response time. **CO4:** For given range of displacement should be able to specify transducer, it accurate and loading time of that transducer.
ME406PC	Basic Electrical and Electronics Engineering Lab	**At the end of this course, each student should be able to:** **CO1:** To analyze and solve electrical circuits using network laws and theorems. **CO2:** To understand and analyze basic Electric and Magnetic circuits **CO3:** To study the working principles of Electrical Machines **CO4:** To introduce components of Low Voltage Electrical Installations **CO5:** To identify and characterize diodes and various types of transistors.
ME407PC	Fluid Mechanics and Hydraulic Machines Lab	**At the end of this course, each student should be able to:** **CO1:** Able to explain the effect of fluid properties on a flow system. **CO2:** Able to identify type of fluid flow patterns and describe continuity equation. **CO3:** To analyze a variety of practical fluid flow and measuring devices and utilize fluid mechanics

		principles in design. **CO4:** To select and analyze an appropriate turbine with reference to given situation in power plants. **CO5:** To estimate performance parameters of a given Centrifugal and Reciprocating pump. **CO6:** Able to demonstrate boundary layer concepts
ME408PC	Instrumentation and Control Systems Lab	**At the end of this course, each student should be able to:** At the end of the course, the student will be able to Characterize and calibrate measuring devices. Identify and analyze errors in measurement. Analyze measured data using regression analysis. Calibration of Pressure Gauges, temperature, LVDT, capacitive transducer, rotameter.
*MC409	Gender Sensitization Lab	**At the end of this course, each student should be able to:** **At the end of this course, each student should be able to:** **CO1:** Students will have developed a better understanding of important issues related to gender in contemporary India. **CO2:** Students will be sensitized to basic dimensions of the biological, sociological, psychological and legal aspects of gender. This will be achieved through discussion of materials derived from research, facts, everyday life, literature and film. **CO3:** Students will attain a finer grasp of how gender discrimination works in our society and how to counter it. **CO4:** Students will acquire insight into the gendered division of labour and its relation to politics and economics. **CO5:** Men and women students and professionals will be better equipped to work and live together as equals. **CO6:** Students will develop a sense of appreciation of women in all walks of life.

		CO7: Through providing accounts of studies and movements as well as the new laws that provide protection and relief to women, the textbook will empower students to understand and respond to gender violence

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ME501PC	Dynamics of Machinery	**At the end of this course, each student should be able to:** The study of KOM & DOM are necessary to have an idea while designing the various machine members like shafts, bearings, gears, belts & chains and various I.C. Engine Components & Machine tool parts.
ME502PC	Design of Machine Members-I	**At the end of this course, each student should be able to:** **CO1:** The student acquires the knowledge about the principles of design, material selection, component behavior subjected to loads, and criteria of failure. **CO2:** Understands the concepts of principal stresses, stress concentration in machine members and fatigue loading. **CO3:** Design on the basis of strength and rigidity and analyze the stresses and strains induced in a machine element.
ME503PC	Metrology & Machine Tools	**At the end of this course, each student should be able to:** **CO1:** Identify techniques to minimize the errors in measurement. **CO2:** Identify methods and devices for measurement of length, angle, gear & thread parameters, surface roughness and geometric features of parts. **CO3:** Understand working of lathe, shaper, planer, drilling, milling and grinding machines. **CO4:** Comprehend speed and feed mechanisms of machine tools. **CO5:** Estimate machining times for machining operations on machine tools
SM504MS	Business Economics & Financial Analysis	**At the end of this course, each student should be able to:** The students will understand the various Forms of Business and the impact of economic variables on

		the Business. The Demand, Supply, Production, Cost, Market Structure, Pricing aspects are learnt. The Students can study the firm's financial position by analysing the Financial Statements of a Company.
ME505PC	Thermal Engineering-II	**At the end of this course, each student should be able to:** **CO1:** Develop state – space diagrams based on the schematic diagrams of process flow of steam and gas turbine plants **CO2:** Apply the laws of Thermodynamics to analyze thermodynamic cycles **CO3:** Differentiate between vapour power cycles and gas power cycles **CO4:** Infer from property charts and tables and to apply the data for the evaluation of performance parameters of the steam and gas turbine plants **CO5:** Understand the functionality of major components of steam and gas turbine plants and to do the analysis of these components
ME506PC	Operations Research	**At the end of this course, each student should be able to:** Understanding the problem, identifying variables & constants, Formulation of optimization model and applying appropriate optimization technique
ME507PC	Thermal Engineering Lab	**At the end of this course, each student should be able to:** **CO1:** Appreciate the practical ways to find calorific values of fuel. **CO2:** Understand the various components and mechanisms of I. C. Engines. Appreciate the Mechanism of ports /Valves functioning in 2-stroke petrol /Diesel engine. **CO3:** Evaluating the performance characteristics of single cylinder petrol engine at different loads and single cylinder diesel engine at different loads and draw the heat balance sheet. **CO4:** Understand the method of finding the indicated power of individual cylinders of an engine by

		using morse test. **CO5:** Understand the method of evaluating the co efficient of performance of refrigerator. **CO6:** Understand the method of finding the thermal conductivity of material.
ME508PC	Metrology & Machine Tools Lab	**At the end of this course, each student should be able to:** **CO1:** Perform plain turning, step turning and Grooving on a circular rod **CO2:** Perform the step turning and taper turning on a circular rod **CO3:** Perform thread cutting and knurling on a circular C.S rod and using the lathe machine **CO4:** Drill a hole and perform tapping once given work piece. **CO5:** Slotting operation on a given specimen **CO6:** Surface finish of given work piece **CO7:** Shaping of square block, V- groove **CO8:** Measure the length and diameter using vernier calipers **CO9:** Determine angle of given specimen
ME509PC	Kinematics & Dynamics Lab	**At the end of this course, each student should be able to:** **CO1:** Understand types of motion **CO2:** Analyze forces and torques of components in linkages **CO3:** Understand static and dynamic balance **CO4:** Understand forward and inverse kinematics of open-loop mechanisms
*MC510	Intellectual Property Rights	**At the end of this course, each student should be able to:** **CO1:** Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP. **CO2:** Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development.

		CO3: Identify activities and constitute IP infringements and the remedies available to the IP owner and describe the precautious steps to be taken to prevent infringement of proprietary rights in products and technology development. **CO4:** Be familiar with the processes of Intellectual Property Management (IPM) and various approaches for IPM and conducting IP and IPM auditing and explain how IP can be managed as a strategic resource and suggest IPM strategy. **CO5:** Be able to anticipate and subject to critical analysis arguments relating to the development and reform of intellectual property right institutions and their likely impact on creativity and innovation. **CO6:** Be able to demonstrate a capacity to identify, apply and assess ownership rights and marketing protection under intellectual property law as applicable to information, ideas, new products and product marketing;

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Course Code	Course Title / Name	Course Outcomes
ME601PC	Design of Machine Members-II	**At the end of this course, each student should be able to:** **CO1:** Knowledge about journal bearing design using different empirical relations. **CO2:** Estimation of life of rolling element bearings and their selection for given service conditions. **CO3:** Acquaintance with design of the components as per the standard, recommended procedures which is essential in design and development of machinery in industry.
ME602PC	**Heat Transfer**	**At the end of this course, each student should be able to:** **CO1:** Understand the basic modes of heat transfer **CO2:** Compute one dimensional steady state heat transfer with and without heat generation **CO3:** Understand and analyze heat transfer through extended surfaces **CO4:** Understand one dimensional transient conduction heat transfer **CO5:** Understand concepts of continuity, momentum and energy equations **CO6:** Interpret and analyze forced and free convective heat transfer **CO7:** Understand the principles of boiling, condensation and radiation heat transfer **CO8:** Design of heat exchangers using LMTD and NTU methods
ME603PC	CAD & CAM	**At the end of this course, each student should be able to:** Understand geometric transformation techniques in CAD. Develop mathematical models to represent curves and surfaces. Model engineering components using solid modeling techniques. Develop programs for CNC to manufacture industrial components. To understand the application of computers in various

		aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.
ME611PE	Professional Elective – I Unconventional Machining Processes	**At the end of this course, each student should be able to:** **CO1:** Understand the basic techniques of Unconventional Machining processes modeling **CO1:** Estimate the material removal rate and cutting force, in an industrially useful manner, for Unconventional Machining processes.
ME612PE	Professional Elective – I Machine Tool Design	**At the end of this course, each student should be able to:** At the end of the course, the student will be able to, understand basic motions involved in a machine tool, design machine tool structures, design and analyze systems for specified speeds and feeds, select subsystems for achieving high accuracy in machining, understand control strategies for machine tool operations and apply appropriate quality tests for quality assurance.
ME613PE	Professional Elective – I Production Planning & Control	**At the end of this course, each student should be able to:** At the end of the course, the student will be able to understand production systems and their characteristics. Evaluate MRP and JIT systems against traditional inventory control systems. Understand basics of variability and its role in the performance of a production system. Analyze aggregate planning strategies. Apply forecasting and scheduling techniques to production systems. Understand theory of constraints for effective management of production systems.
	Open Elective - I	
ME604PC	Finite Element Methods	**At the end of this course, each student should be able to:** At the end of the course, the student will be able to, Apply finite element method to solve problems in solid mechanics, fluid mechanics and heat transfer. Formulate and solve problems in one dimensional

		structures including trusses, beams and frames. Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, axisymmetric and plate bending problems. ANSYS, ABAQUS, NASTRAN, etc.
ME605PC	**Heat Transfer Lab**	**At the end of this course, each student should be able to:** **CO1:** Perform steady state conduction experiments to estimate thermal conductivity of different materials **CO2:** Perform transient heat conduction experiment **CO3:** Estimate heat transfer coefficients in forced convection, free convection, condensation and correlate with theoretical values **CO4:** Obtain variation of temperature along the length of the pin fin under forced and free convection **CO5:** Perform radiation experiments: Determine surface emissivity of a test plate and Stefan-Boltzmann's constant and compare with theoretical value
ME606PC	CAD & CAM Lab	**At the end of this course, each student should be able to:** To understand the analysis of various aspects in of manufacturing design
EN608HS	Advanced Communication Skills lab	**At the end of this course, each student should be able to:** **CO1:** To improve fluency in English through a well developed vocabulary and enable them to listen at normal conservational speed by educated English speakers and respond appropriately in different socio cultural and professional context **CO2:** Further, they would be required to communicate their ideas relevantly and coherently in writing **CO3:** To prepare all the students for their placements **CO4:** Learn to overcome stage fear and make

		presentations with ease **CO5:** Learn how to pronounce words using the rules they have been taught
*MC609	Environmental Science	**At the end of this course, each student should be able to:** Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

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Course Code	Course Title / Name	Course Outcomes
ME701PC	CAD/CAM	**At the end of this course, each student should be able to:** Understand geometric transformation techniques in CAD. Develop mathematical models to represent curves and surfaces .Model engineering components using solid modeling techniques. Develop programs for CNC to manufacture industrial components. To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.
ME702PC	Instrumentation and Control System	**At the end of this course, each student should be able to:** To identify various elements and their purpose in typical instruments, to identify various errors that would occur in instruments. Analysis of errors so as to determine correction factors for each an instrument. To understand static and dynamic characteristics of instrument and should be able to determine loading response time. For given range of displacement should be able to specify transducer, it accurate and loading time of that transducer.
ME721PE	**Professional Elective – II** Composite materials	**At the end of this course, each student should be able to:** The student will apply the concepts learnt during the course to design, and apply a composite material for a specific application.
ME722PE	**Professional Elective – II** Industrial Management	**At the end of this course, each student should be able to:** **CO1:** Choose, prepare, interpret and use cost estimates as a basis for the different situations in an industrial company. **CO2:** Interpret financial statements and other financial reports of industrial companies,

		including the income statement, the balance sheet, the cash flow statement and key measures. **CO3:** Explain how strategic planning, management, management control, entrepreneurship, organization, production and learning works in an industrial company. **CO4:** Explain how the industrial company markets and price it's products. **CO5:** Explain how the company deal with it's environment.
ME723PE	**Professional Elective – II** Power Plant Engineering	**At the end of this course, each student should be able to:** **CO1:** Understand the concept of Rankine cycle. **CO2:** Understand working of boilers including water tube,fire tube and high pressure boilers and determine efficiencies. **CO3:** Analyze the flow of steam through nozzles **CO4:** Evaluate the performance of condensers and steam turbines **CO5:** Evaluate the performance of gas turbines
ME724PE	**Professional Elective – II** Operations Research	**At the end of this course, each student should be able to:** Understanding the problem, identifying variables & constants, formulas of optimization model and applying appropriate optimization Technology.
ME731PE	**Professional Elective– III** Engineering Tribology	**At the end of this course, each student should be able to:** **CO1:** Understanding friction characteristics in journal bearings. **CO2:** Knowledge about different theories of lubrication to reduce friction and wear.
ME732PE	**Professional Elective– III** Computational Fluid Dynamics	**At the end of this course, each student should be able to:** **Outcome 1:** Provide the student with a significant level of experience in the use of modern CFD software for the analysis of complex fluid-flow systems.

		1.1 The student will demonstrate the ability to use modern CFD software tools to build flow geometries, generate an adequate mesh for an accurate solution, select appropriate solvers to obtain a flow solution, and visualize the resulting flow field. 1.2 The student will demonstrate the ability to analyze a flow field to determine various quantities of interest, such as flow rates, heat fluxes, pressure drops, losses, etc., using flow visualization and analysis tools. **Outcome 2:** Improve the student's understanding of the basic principles of fluid mechanics. 2.1 The student will demonstrate an ability to recognize the type of fluid flow that is occurring in a particular physical system and to use the appropriate model equations to investigate the flow. 2.2 The student will demonstrate an ability to describe various flow features in terms of appropriate fluid mechanical principles and force balances. **Outcome 3:** Improve the student's research and communication skills using a self-directed, detailed study of a complex fluid-flow problem and to communicate the results in written form. 3.1 The student will demonstrate the ability to simplify a real fluid-flow system into a simplified model problem, to select the proper governing equations for the physics involved in the system, to solve for the flow, to investigate the fluid-flow behavior, and to understand the results. 3.2 The student will demonstrate the ability to communicate the results of this detailed fluid-flow study in a written format.
ME733PE	**Professional Elective– III** Robotics	**At the end of this course, each student should be able to:** At the end of the course, the student will be able to understand the basic components of robots. Differentiate types of robots and robot grippers. Model forward and inverse kinematics of robot

		manipulators. Analyze forces in links and joints of a robot. Programme a robot to perform tasks in industrial applications. Design intelligent robots using sensors.
ME734PE	**Professional Elective– III** CNC Technology	**At the end of this course, each student should be able to:** At the end course, one should be able to select tooling method, control mechanism and do part programming for a given product.
ME741PE	**Professional Elective– IV** Mechanical Vibrations	**At the end of this course, each student should be able to:** At the end of the course, the student will be able to, Understand the causes and effects of vibration in mechanical systems. Develop schematic models for physical systems and formulate governing equations of motion. Understand the role of damping, stiffness and inertia in mechanical systems Analyze rotating and reciprocating systems and compute critical speeds. Analyze and design machine supporting structures, vibration isolators and absorbers.
ME742PE	**Professional Elective– IV** Turbo Machines	**At the end of this course, each student should be able to:** **CO1:** Ability to design and calculate different parameters for turbo machines **CO2:** Prerequisite to CFD and Industrial fluid power Courses. **CO3:** Ability to formulate design criteria **CO4:** Ability to understand thermodynamics and kinematics behind turbo machines
ME743PE	**Professional Elective– IV** MEMS	**At the end of this course, each student should be able to:** **CO1:** Students will be able to understand working principles of currently available micro sensors, actuators, and motors, valves, pumps, and fluidics used in Microsystems. **CO2:** Students will be able to apply scaling laws that are used extensively in the conceptual design of micro devices and systems.

		Students will be able to differentiate between the positive and negative consequences of scaling down certain physical quantities that are pertinent to Microsystems. **CO3:** Students will be able to use materials for common micro components and devices. **CO4:** Students will be able to choose a micromachining technique, such as bulk micromachining and surface micromachining for a specific MEMS fabrication process. **CO5:** Students will be able to understand the basic principles and applications of micro fabrication processes, such as photolithography , ion implantation, diffusion, oxidation, CVD, PVD, and etching. **CO6:** Students will be able to consider recent advancements in the field of MEMS and devices. **CO7:** Students will be able communicate their results and findings orally via formal presentations and in writing through reports.
ME744PE	**Professional Elective–IV** Additive Manufacturing Technology	**At the end of this course, each student should be able to:** **CO1:** Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation. **CO2:** Formulate and solve typical problems on reverse engineering for surface reconstruction from physical prototype models through digitizing and spline-based surface fitting. **CO3:** Formulate and solve typical problems on reverse engineering for surface reconstruction from digitized mesh models through topological modelling and subdivision surface fitting.

		CO4: Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems. **CO5:** Explain and summarize typical rapid tooling processes for quick batch production of plastic and metal parts.
ME703PC	CAD/CAM Lab	**At the end of this course, each student should be able to:** To be able to understand and handle design problems in a systematic manner. To be able to apply CAD in real life applications. To be understand the basic principles of different types of analysis.
ME704PC	Instrumentation and Control Systems Lab	**At the end of this course, each student should be able to:** At the end of the course, the student will be able to Characterize and calibrate measuring devices. Identify and analyze errors in measurement. Analyze measured data using regression analysis. Calibration of Pressure Gauges, temperature, LVDT, capacitive transducer, rotameter.
ME705PC	Industry Oriented Mini Project	**At the end of this course, each student should be able to:** **CO1:** Formulate a real world problem and develop its Requirements. **CO2:** Student will be exposed to industrial awareness **CO3:** Self learning technologies, methods and/or techniques that contribute to the software solution of the project.
ME706PC	Seminar	**At the end of this course, each student should be able to:** **CO1:** Ability to work in actual working environment. **CO2:** Ability to utilize technical resources **CO3:** Ability to write technical documents and give

		oral presentations related to the work completed.

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Course Code	Course Title / Name	Course Outcomes
	Open Elective – III	
ME851PE	**Professional Elective – V** Automation in Manufacturing	**At the end of this course, each student should be able to:** **CO1:** Illustrate the basic concepts of automation in machine tools. **CO2:** Analyze various automated flow lines, Explain assembly systems and line balancing methods. **CO3:** Describe the importance of automated material handling and storage systems. **CO4:** Interpret the importance of adaptive control systems, automated inspection systems.
ME852PE	**Professional Elective – V** Fluid Power System	**At the end of this course, each student should be able to:** **CO1:** Understand the Properties of fluids, Fluids for hydraulic systems. **CO2:** Governing laws. distribution of fluid power, Design and analysis of typical hydraulic circuits. **CO3:** Know accessories used in fluid power system,Filtration systems andmaintenance of system.
ME853PE	**Professional Elective – V** Renewable Energy Sources	**At the end of this course, each student should be able to:** **CO1:** Understanding of renewable energy sources **CO2:** Knowledge of working principle of various energy systems. **CO3:** Capability to carry out basic design of renewable energy systems.
ME854PE	**Professional Elective – V** Production Planning and Control	**At the end of this course, each student should be able to:** Understand production systems and their characteristics. Evaluate MRP and JIT systems against traditional inventory control systems. Understand basics of variability and its role in the

		performance of a production system. Analyze aggregate planning strategies. Apply forecasting and scheduling techniques to production systems. Understand theory of constraints for effective management of production systems.
ME861PE	**Professional Elective–VI** Automobile Engineering	**At the end of this course, each student should be able to:** **CO1:** Gain the knowledge on automobile and its types and basic knowledge about engine and its Lubrication to the practical problems. **CO2:** Analyze the Type of cooling and new technology processes of cooling and ignition systems and its trouble shooting of simple problems on fuel, ignition, cooling, lubrication and electrical systems . **CO3:** Develop an ability to analyze of suspension system and braking systems. **CO4:** Analyze new technical challenges and design of Power steering systems and new technical advancements in the automotive industry and braking systems. **CO5:** Gain the knowledge about the Alternative fuels used in automobile, performance and Emissions of automobile and its control of international standards.
ME862PE	**Professional Elective–VI** Advanced Mechanics of Solids	**At the end of this course, each student should be able to:** **CO1:** Determined the point of location of applied load to avoid twisting in thin sections used in aerospace applications. **CO2:** Understand the concept of distinguish between neutral and centroidal axes in curved beams. **CO3:** Understanding the analogy models developed for analyzing the non circular bars subjected to torsion, and also analyzing the stresses developed between rolling bodies and stress in three dimensional bodies.

ME863PE	**Professional Elective–VI** Unconventional Machining Processes	**At the end of this course, each student should be able to:** **CO1:** Understand the basic techniques of machining processes modeling **CO2:** Understand the mechanical aspects of orthogonal cutting mechanics **CO3:** Understand the thermal aspects of orthogonal cutting mechanics **CO4:** Ability to extend, through modeling Techniques , the single point, multiple point and abrasive machining processes **CO5:** Estimate the material removal rate and cutting force, in an industrially useful manner, for practical machining processes.
ME864PE	**Professional Elective–VI** Advanced Materials Technology	**At the end of this course, each student should be able to:** **CO1:** To select appropriate advanced materials processes for a given product or component recognizing material, size, precision, and surface quality requirements. **CO2:** To conduct theoretical and experimental analysis for advanced materials removal and laser processing technologies.
ME801PC	Major Project	**At the end of this course, each student should be able to:** **CO1:** Ability to implement and execute well defined Objective. **CO2:** Ability to work in team at component level and system level. **CO3:** Ability to troubleshoot.

Open Elective –I

(Common for EEE, ECE, CSE, IT, ME)

Course Code	Course Title / Name	Course Outcomes
CE600OE	**Open Elective –I** Disaster Preparedness & Planning Management	**At the end of this course, each student should be able to:** **CO1:** The application of Disaster Concepts to Management **CO2:** Analyzing Relationship between Development and Disasters. **CO3:** Ability to understand Categories of Disasters **CO4:** Realization of the responsibilities to society
CS600OE	**Open Elective –I** Entrepreneurship	**At the end of this course, each student should be able to:** It enables students to learn the basics of Entrepreneurship and entrepreneurial development which will help them to provide vision for their own Start-up.
CS601OE	**Open Elective –I** Fundamentals of Management for Engineers	**At the end of this course, each student should be able to:** The students understand the significance of Management in their Profession. The various Management Functions like Planning, Organizing, Staffing, Leading, Motivation and Control aspects are learnt in this course. The students can explore the Management Practices in their domain area.
CS602OE	**Open Elective –I** Cyber Law & Ethics	**At the end of this course, each student should be able to:** **CO1:** The students will understand the importance of professional practice, Law and Ethics in their personal lives and professional careers. **CO2:** The students will learn the rights and responsibilities as an employee, team member and a global citizen
EC600OE	**Open Elective –I** Fundamentals of Internet of Things	**At the end of this course, each student should be able to:** **CO1:** Known basic protocols in sensor networks. **CO2:** Program and configure Arduino boards for

		various designs. **CO3:** Python programming and interfacing for Raspberry Pi. **CO4:** Design IoT applications in different domains
EI600OE	**Open Elective –I** Basics Of Sensors Technology	**At the end of this course, each student should be able to:** **CO1: Identify** suitable sensors and transducers for real time applications. **CO2: Translate** theoretical concepts into working models. **CO3: Design** the experimental applications to engineering modules and practices. **CO4: Design** engineering solution to the Industry/Society needs and develop products.
EE600OE	**Open Elective –I** Reliability Engineering	**At the end of this course, each student should be able to:** **CO1:** Model various systems applying reliability networks **CO2:** Evaluate the reliability of simple and complex systems **CO3:** Estimate the limiting state probabilities of repairable systems **CO4:** Apply various mathematical models for evaluating reliability of irreparable systems
EE601OE	**Open Elective –I** Renewable Energy Sources	**At the end of this course, each student should be able to:** **CO1:** Understand the principles of wind power and solar photovoltaic power generation, fuel cells. **CO2:** Assess the cost of generation for conventional and renewable energy plants **CO3:** Design suitable power controller for wind and solar applications **CO4:** Analyze the issues involved in the integration of renewable energy sources to the grid
ME600OE	**Open Elective –I** Quantitative Analysis for Business Decisions	**At the end of this course, each student should be able to:** **CO1:** Familiar with issues that would crop up in business **CO2:** Able to formulate Mathematical Model to

		resolve the issue **CO3:** Able to select technique for solving the formulated Mathematical Model **CO4:** Able to analyze the results obtained through the selected technique for implementation.
MT600OE	**Open Elective –I** Industrial Management	**At the end of this course, each student should be able to:** **CO1:** Choose, prepare, interpret and use cost estimates as a basis for the different situations in an industrial company. **CO2:** Interpret financial statements and other financial reports of industrial companies, including the income statement, the balance sheet, the cash flow statement and key measures. **CO3:** Explain how strategic planning, management, management control, entrepreneurship, organization, production and learning works in an industrial company. **CO4:** Explain how the industrial company markets and price it's products. **CO5:** Explain how the company deal with it's environment.
MT601OE	**Open Elective –I** Non-Conventional Energy Sources	**At the end of this course, each student should be able to:** **CO1:** Demonstrate the generation of electricity from various Non-Conventional sources of energy, have a working knowledge on types of fuel cells. **CO2:** Estimate the solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation. **CO3**: Explore the concepts involved in wind energy conversion system by studying its components, types and performance. **CO4:** Illustrate ocean energy and explain the operational methods of their utilization. **CO5:** Acquire the knowledge on Geothermal energy.

PE600OE	**Open Elective –I** General Geology	**At the end of this course, each student should be able to:** The student would understand the basics of geology, viz: formation of earth, layers of earth, different types of rocks, formation of sedimentary basins and the micro fossils and their relationship to oil and gas.
MM600OE	**Open Elective –I** Testing of Materials	**At the end of this course, each student should be able to:** **CO1:** Classify mechanical testing of ferrous and non-ferrous metals and alloys. **CO2:** Recognize the importance of crystal defects including dislocations in plastic deformation. **CO3:** Identify the testing methods for obtaining strength and hardness. **CO4:** Examine the mechanisms of materials failure through fatigue and creep
MM601OE	**Open Elective –I** Alloy Steels	**At the end of this course, each student should be able to:** **CO1:** Ability to understand different types of alloys used in alloy steels. **CO2:** Ability to solve different metallurgical problems in alloy steels. **CO3:** It has a lot of scope in R&D and in automobile engineering.
MN600OE	**Open Elective –I** Introduction to Mining Technology	**At the end of this course, each student should be able to:** Upon completion of the course, the student shall be able to understand various stages in the life of the mine, drilling, blasting and shaft sinking**.**
MN601OE	**Open Elective –I** Coal Gasification, CBM & Shale Gas	**At the end of this course, each student should be able to:** Student can get specialized in the underground coal gasification concepts, application and future scope in various geomining conditions.

Open Elective –III

(Common for EEE, ECE, CSE, IT, ME)

Course Code	Course Title / Name	Course Outcomes
AE831OE	**Open Elective – III** Air Transportation Systems	**At the end of this course, each student should be able to:** **CO1:** Explain the air transport systems. **CO2:** Describe the aircraft characteristics, airlines and airport operation. **CO3:** Apply the Air Navigation System & Environmental Systems.
AE832OE	**Open Elective – III** Rockets and Missiles	**At the end of this course, each student should be able to:** **CO1:** Design a preliminary chemical rocket engine **CO2:** Compute various types of aerodynamic forces acting on the rocket and missile during the flight. **CO3:** Determine the various equations of motion used in rocket and missile technology **CO4:** Illustrate staging of rockets and its performance estimation. **CO5:** Judge the materials for rocket and missile components.
AM831OE	**Open Elective – III** Introduction to Mechatronics	**At the end of this course, each student should be able to:** At the end of the course, the student will be able to, Model, analyze and control engineering systems. Identify sensors, transducers and actuators to monitor and control the behavior of a process or product. Develop PLC programs for a given task. Evaluate the performance of mechatronic systems.
AM832OE	**Open Elective – III** Microprocessors and Microcontrollers	**At the end of this course, each student should be able to:** **CO1:** Understands the internal architecture and organization of 8086, 8051 and ARM processors / controllers.

		CO2: Understands the interfacing techniques to 8086 and 8051 and can develop assembly language programming to design microprocessor / micro controller based systems.
BM831OE	**Open Elective – III** Telemetry and Telecontrol	**At the end of this course, each student should be able to:** Upon completion of this course students will appreciate the application of different telemetry systems and control to any process.
BM832OE	**Open Elective – III** Electromagnetic Interference and Compatibility	**At the end of this course, each student should be able to:** **CO1:** Gain basic knowledge of problems associated with EMI and EMC from electronic circuits and systems. **CO2:** Analyze various sources of EMI and various possibilities to provide EMC. **CO3:** Understand and analyze possible EMI revention techniques such as grounding, shielding, filtering, and use of proper coupling mechanisms to improve compatibility of electronic circuits and systems in a given electromagnetic environment.
CE831OE	**Open Elective – III** Environmental Impact Assessment	**At the end of this course, each student should be able to:** **CO1:** Identify the environmental attributes to be considered for the EIA study. **CO2:** Formulate objectives of the EIA studies. **CO3:** Identify the suitable methodology and prepare Rapid EIA. **CO4:** Indentify and incorporate mitigation measures.
CE832OE	**Open Elective – III** Optimization Techniques in Engineering	**At the end of this course, each student should be able to:** **CO1:** Formulate optimization problem. **CO2:** Solve the problem by using a appropriate optimization techniques.
CE833OE	**Open Elective – III** Entrepreneurship and Small Business Enterprises	**At the end of this course, each student should be able to:** It enables students to learn the basics of Entrepreneurship and entrepreneurial development

		which will help them to provide vision for their own Start-up.
CN831OE	**Open Elective – III** Remote Sensing and GIS	**At the end of this course, each student should be able to:** **CO1:** Retrieve the information content of remotely sensed data. **CO2:** Analyze the energy interactions in the atmosphere and earth surface features. **CO3:** Interpret the images for preparation of thematic maps. **CO4:** Apply problem specific remote sensing data for engineering applications. **CO5:** Analyze spatial and attribute data for solving spatial problems. **CO6:** Create GIS and cartographic outputs for presentation.
CS831OE	**Open Elective – III** Linux Programming	**At the end of this course, each student should be able to:** **CO1:**Work confidently in Linux environment. **CO2:** Work with shell script to automate different tasks as Linux administration.
CS832OE	**Open Elective – III** R Programming	**At the end of this course, each student should be able to:** **CO1:** Be able to use and program in the Programming language R. **CO2:** Be able to use R to solve statistical problems. **CO3:** Be able to implement and describe Monte Carlo the technology. **CO4:** Be able to minimize and maximize functions using R.
CS833OE	**Open Elective – III** PHP Programming	**At the end of this course, each student should be able to:** **CO1:** Be able to develop a form containing several fields and be able to process the data provided on the form by a user in a PHP-based script. **CO2:** Understand basic PHP syntax for variable use and standard language constructs, such as conditionals and loops.

		CO3: Understand the syntax and use of PHP object-oriented classes. **CO4:** Understand the syntax and functions available to deal with file processing for files on the server as well as processing web URLs. **CO5:** Understand the paradigm for dealing with form-based data, both from the syntax of HTML forms, and how they are accessed inside a PHP-based script.
EC831OE	**Open Elective – III** Electronic Measuring Instruments	**At the end of this course, each student should be able to:** **CO1:** Identify the various electronic instruments based on their specifications for carrying out a particular task of measurement. **CO2:** Measure various physical parameters by appropriately selecting the transducers. **CO3:** Use various types of signal generators, signal analyzers for generating and analyzing various real-time signals.
EM831OE	**Open Elective – III** Data Analytics	**At the end of this course, each student should be able to:** **CO1:** Understand the impact of data analytics for business decisions and strategy. **CO2:** Carry out data analysis/statistical analysis **CO3:** To carry out standard data visualization and formal inference procedures. **CO4:** Design Data Architecture **CO5:** Understand various Data Sources.
EE831OE	**Open Elective – III** Entrepreneur Resource Planning	**At the end of this course, each student should be able to:** ERP System Implementation options, and functional modules of ERP. **CO1:** Introduction to ERP- Foundation for Understanding ERP systems-Business benefits of ERP-The challenges of implementing ERP system-ERP modules and Historical Development. Case: Response top RFP for ban ERP system (Mary Sumner).

		CO2: ERP system options & Selection methods- Measurement of project Inpact- information Technology Selection-ERP proposal evaluation-Project Evaluation Technique. Case: Atlantic Manufacturing (Mary Sumner). **CO3:** ERP system Installation Options- IS/IT Management results-Risk Identification analysis-System Projects- Demonstration of the system-Failure method-system Architecture & ERP (David L. Olson) Case: Data Solutions & Technology Knowledge (Mary Sumner). **CO4:** ERP - sales and Marketing- Management control process in sales and marketing – ERP customer relationship management - ERP systems- Accounting & Finance control processes. Financial modules in ERP systems. Case: Atlantic manufacturing (Mary Sumner). **CO5:** ERP – Production and Material Management- Control process on production and manufacturing - Production module in ERP- supply chain Management & e-market place- e-business & ERP-e supply chain & ERP- Future directions for ERP. Case: HR in Atlantic manufacturing. (Mary Sumner).
EE832OE	**Open Elective – III** Management Information Systems	**At the end of this course, each student should be able to:** **CO1:** Understand the usage of MIS in organizations and the constituents of the MIS. **CO2:** Understand the classifications of MIS, understanding of functional MIS and the different functionalities of these MIS. This would be followed by case study on Knowledge management. **CO3:** Assess the requirement and stage in which the organization is placed. Nolan model is expected to aid such decisions. **CO4:** Learn the functions and issues at each stage

		of system development. Further different ways in which systems can be developed are also learnt.
EE833OE	**Open Elective – III** Organizational Behaviour	**At the end of this course, each student should be able to:** **CO1:** Analyse the behaviour of individuals and groups in organizations in terms of the key factors that influence organizational behaviour. **CO2:** Assess the potential effects of organizational level factors (such as structure, culture and change) on organizational behaviour. **CO3:** Critically evaluate the potential effects of important developments in the external environment (such as globalization and advances in technology) on organizational behaviour. **CO4:** Analyse organizational behavioural issues in the context of organizational behaviour theories, models and concepts.
EI831OE	**Open Elective – III** Sensors and Transducers,	**At the end of this course, each student should be able to:** Upon completion of this course the student shall be able to understand the working of basic sensors and transducers used in any industries.
EI832OE	**Open Elective – III** PC Based Instrumentation	**At the end of this course, each student should be able to:** **CO1:** Understands measurement and analyzing techniques of digital computer power and performance . **CO2:** Understands the various types of interfacing systems and components. **CO3:** Develops the knowledge of real-time systems and case studies in instrumentation . **CO4:** Capability to analyze PC based data . **CO5:** Capable to develop instrumentation systems on various processes of industrial measurements.
ME831OE	**Open Elective – III** Total Quality Management	**At the end of this course, each student should be able to:** **CO1:** Evaluate the principles of quality

		management and to explain how these principles can be applied within quality management systems. **CO2:** Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality. **CO3:** Critically appraise the organisational, communication and teamwork requirements for effective quality management . **CO4:** Critically analyse the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans.
ME832OE	**Open Elective – III** Industrial Safety, Health, and Environmental Engineering	**At the end of this course, each student should be able to:** **CO1:** To list out important legislations related to Health , Safety and Environment **CO2:** To list out requirements mentioned in factories act for the prevention of accidents. To understand the health and welfare provisions given in factories act. **CO3:** To understand the statutory requirements for an Industry on registration, license and its renewal. **CO4:** To prepare onsite and offsite emergency plan.
ME833OE	**Open Elective – III** Basics of Thermodynamics	**At the end of this course, each student should be able to:** **CO1:** Understand and differentiate between different thermodynamic systems and processes. **CO2:** Understand and apply the laws of Thermodynamics to different types of system undergoing various processes. **CO3:** Understand and analyze the Thermodynamic Cycles.
ME834OE	**Open Elective – III** Reliability Engineering	**At the end of this course, each student should be able to:** **CO1:** Model various systems applying reliability networks.

		CO2: Evaluate the reliability of simple and complex systems. **CO3:** Estimate the limiting state probabilities of repairable systems. **CO4:** Apply various mathematical models for evaluating reliability of irrepairable systems.
NT831OE	**Open Elective – III** Concepts of Nano Science And Technology	**At the end of this course, each student should be able to:** The intended course covers the whole spectrum of nanomaterials ranging from introduction, classification, synthesis, properties, and characterization tools of nanophase materials to application including some new developments in various aspects.
NT832OE	**Open Elective – III** Synthesis of Nanomaterials	**At the end of this course, each student should be able to:** To provide abundant knowledge on various synthesis methods of nanomaterials.
NT833OE	**Open Elective – III** Characterization of Nanomaterials	**At the end of this course, each student should be able to:** **CO1:** The student will develop a fundamental knowledge of nanomaterials. . **CO2:** The student will demonstrate an understanding of the properties of materials with strong dependence on size. **CO3:** The student will demonstrate an understanding of approaches to nanomaterials characterization.
MT831OE	**Open Elective – III** Renewable Energy Sources	**At the end of this course, each student should be able to:** **CO1:** Understanding of renewable energy sources. **CO2:** Knowledge of working principle of various energy systems. **CO3:** Capability to carry out basic design of renewable energy systems.
MT832OE	**Open Elective – III** Production Planning and Control	**At the end of this course, each student should be able to:** At the end of the course, the student will be able to,

		Understand production systems and their characteristics. Evaluate MRP and JIT systems against traditional inventory control systems. Understand basics of variability and its role in the performance of a production system. Analyze aggregate planning strategies. Apply forecasting and scheduling techniques to production systems. Understand theory of constraints for effective management of production systems.
MT833OE	**Open Elective – III** Entrepreneurship and Small Business Enterprises	**At the end of this course, each student should be able to:** It enables students to learn the basics of Entrepreneurship and entrepreneurial development which will help them to provide vision for their own Start-up.
MM831OE	**Open Elective – III** Design and Selection of Engineering Materials	**At the end of this course, each student should be able to:** Understand the Relationship between materials selection, processing and applications.
MN831OE	**Open Elective – III** Solid Fuel Technology	**At the end of this course, each student should be able to:** Students can understand the fundamentals of Processes of formation of coal, properties and evaluation and coal preparation and washability characteristics of coal.
MN832OE	**Open Elective – III** Health & Safety in Mines	**At the end of this course, each student should be able to:** **CO1:** Gain insights of safety management system and risk management in Indian mining industries. **CO2:** Formulate safety audits and control in mining industries. **CO3:** Produce risk analysis using statistical methods and analysis of mine accidents.

PE831OE	**Open Elective – III** Disaster Management	**At the end of this course, each student should be able to:** **CO1:** Understanding Disasters, man-made Hazards and Vulnerabilities. **CO2:** Understanding disaster management mechanism. **CO3:** Understanding capacity building concepts and planning of disaster managements.
PE832OE	**Open Elective – III** Fundamentals of Liquefied Natural Gas	**At the end of this course, each student should be able to:** **CO1**: Have good knowledge on LNG process. **CO2:** Classify different liquefaction techniques. **CO3:** Understand different units in LNG processing and transportation. **CO4:** Have knowledge associated with safety aspects of LNG.
PE833OE	**Open Elective – III** Health, Safety and Environment in Petroleum Industry	**At the end of this course, each student should be able to:** **CO1:** The student can have the knowledge of various Acts related to safety, Health and environment in petroleum industry. **CO2:** The student can have the knowledge of various drilling fluids handling and safe disposal such toxic products. **CO3:** Knowledge of disaster management to fight any crisis. **CO4:** Knowledge of Hazard studies and occupational health hazards in the industry.