**Second/Third/Final Year Mechanical Engineering: Course Outcomes**

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| **MED 202: Strength of Materials** |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 202.1 | Define the concept of mechanical stress-strain, bending and deflection of beam, thin shells, principal stresses, torsion and strain energy.  |
| CO 2 | MED 202.2 | Illustrate stress-strain relationship and elastic constants, pure bending, Mohr’s theorem, shear force and bending moment diagram, circumferential and longitudinal stresses, direct and bending stress, torsion equation, Castigliano’s theorem and strain energy due to various loads.  |
| CO 3 | MED 202.3 | Solve problems of stress in simple and compound bars, shear force and bending moment diagram, stress in thin shells, stress in an oblique plane and combined stresses, stress due to torsion and strain energy due to various loading. |
| CO 4 | MED 202.4 | Analyze the volumetric stresses in bars, slope and deflection of beam, core of section, eccentric loading on chimney, torsion moment diagram and principle of virtual work. |
| CO 5 | MED 202.5 | Determine the temperature stresses and strains, slope and deflection of beam using various methods, shear stresses in beams, volumetric strains in thin shells and stresses in shaft due to combined effect of torsion and bending. |
| CO 6 | MED 202.6 | Discuss the concept of surface stresses, bending of beam with composite cross section, effect of internal fluid pressure on thin shells, Mohr’s circle for three dimensional stresses, effect of end thrust on shaft and applications of Castigliano’s theorem |

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| **MED 203: Fluid Mechanics** |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 203.1 | Define basic principles of fluid mechanics and properties of fluid. |
| CO 2 | MED 203.2 | Summarize concepts and governing equations in context with fluid statics, kinematics and dynamics. |
| CO 3 | MED 203.3 | Apply principles and techniques to resolve various fluid mechanics problems. |
| CO 4 | MED 203.4 | Examine principles of fluid mechanics practically. |
| CO 5 | MED 203.5 | Interpret the analysis of fluid mechanics problems with advanced techniques. |
| CO 6 | MED 203.6 | Formulate the solution for the problems on the basis of principles of fluid mechanics. |

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| **MED 204: Manufacturing Processes – I** |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 204.1 | Outline the concept, need and scope of solidification, metal forming and joining processes. |
| CO 2 | MED 204.2 | Explain classification, advantages, disadvantages and applications of various manufacturing processes. |
| CO 3 | MED 204.3 | Understand the working principle, process variables and their importance in manufacturing processes. |
| CO 4 | MED 204.4 | Identify process variables in various manufacturing processes. |
| CO 5 | MED 204.5 | Choose an appropriate manufacturing process for a given component. |
| CO 6 | MED 204.6 | Analyze the process defects for various manufacturing processes. |

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| **MED 205: Metrology and Quality Control** |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 205.1 | Recall the principles of engineering metrology measurement standard and instruments. |
| CO 2 | MED 205.2 | Explain quality control techniques and its applications in engineering industries. |
| CO 3 | MED 205.3 | Apply knowledge of various tools and techniques used to determine geometry and dimensions of components in engineering applications and use quality tools to produce quality products. |
| CO 4 | MED 205.4 | Analyze the data of measurement for understanding the concept of quality and SQC. |
| CO 5 | MED 205.5 | Examine the deviation and surface finish of the measured parts with measuring tools. |
| CO 6 | MED 205.6 | Discuss the principles of SQC, quality tools and acceptance sampling. |

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| **MED 206: Engineering Thermodynamics** |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 206.1 | Recall the concepts of physics and thermodynamics. |
| CO 2 | MED 206.2 | Illustrate concepts of thermodynamics to various engineering applications.  |
| CO 3 | MED 206.3 | Identify energy interactions in various gas processes. |
| CO 4 | MED 206.4 | Apply law of thermodynamics to study behavior of working substances in different thermodynamic system. |
| CO 5 | MED 206.5 | Analyze different flow processes |
| CO 6 | MED 206.6 | Assess the state of working substance with the help of different thermodynamic relations. |

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| **MED 252: Machine Drawing** |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 252.1 | Recall the first angle projection method to represent any given three dimensional object into two dimensional views |
| CO 2 | MED 252.2 | Demonstrate the knowledge of drafting skills by using drawing instruments or any software |
| CO 3 | MED 252.3 | Identify various machine components and their shape like fasteners, threads, pulleys, tolerances, levels of surface finish, gear tooth profile and various materials according to standard conventions |
| CO 4 | MED 252.4 | Classify various machine parts and their joints using standard conventions  |
| CO 5 | MED 252.5 | Interpret the true shape of arrangement of any geometric solids like prisms, pyramids, cone, cylinder and any other standard machine component  |
| CO 6 | MED 252.6 | Develop an assembly drawing using parts drawing of machine components |

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| **MED 253: Manufacturing Processes – II** |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 253.1 | Explain the principle of metal cutting and different conventional and unconventional machining processes. |
| CO 2 | MED 253.2 | Describe construction, operations and specifications of different machine tools. |
| CO 3 | MED 253.3 | Select the appropriate metal cutting processes and machine tools for producing given component. |
| CO 4 | MED 253.4 | Identify tool type, tool materials and cutting parameters for different machining processes. |
| CO 5 | MED 253.5 | Calculate cutting forces, power required and machining time for producing given component. |
| CO 6 | MED 253.6 | Evaluate tool life for a range of different operations and work piece materials.  |

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| **MED 254: Applied Thermodynamics** |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 254.1 | Recall the basic concepts of thermodynamics applicable to different thermal systems. |
| CO 2 | MED 254.2 | Summarize governing equations and principle of thermodynamics applicable for various thermal systems. |
| CO 3 | MED 254.3 | Apply thermodynamics laws to analyze boiler, steam nozzle, condenser, steam power cycles, air standard cycles and reciprocating air compressor. |
| CO 4 | MED 254.4 | Analysis of various thermodynamic power cycles. |
| CO 5 | MED 254.5 | Evaluate the performance analysis of various thermal systems. |
| CO 6 | MED 254.6 | Discuss the energy performance assessment for various equipment and utility systems. |

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| **MED 301: Design of Machine Elements – I**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 301.1 | Define the fundamentals of machine elements, mechanical joints and its components |
| CO 2 | MED 301.2 | Explain the theory of mechanical joints and its components, power screw, spring, failures and fluctuating loads |
| CO 3 | MED 301.3 | Select the appropriate material for mechanical joints and its components, power screws, spring against the static and fluctuating loads |
| CO 4 | MED 301.4 | Analyze the design of mechanical joints and its components, power screws, spring against the static and fluctuating loads |
| CO 5 | MED 301.5 | Estimate the design procedure for mechanical joints and its components, power screws and spring against the static and fluctuating loads |
| CO 6 | MED 301.6 | Design of mechanical joints and its components, power screws and spring against the static and fluctuating loads |

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| **MED 302: Production Management**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 302.1 | Apply the functions of PPC and principles of production management.  |
| CO 2 | MED 302.2 | Outline the most appropriate materials management methods. |
| CO 3 | MED 302.3 | Describe the basic concepts of maintenance.  |
| CO 4 | MED 302.4 | Comprehend the concept of job evaluation, merit rating, work and motion study. |
| CO 5 | MED 302.5 | Apply break even analysis and forecasting methods. |
| CO 6 | MED 302.6 | Select the plant layout, type of product design and material handling equipment. |

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| **MED 303: Heat Transfer**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 303.1 | Explain the basic concepts, laws of heat transfer, various modes of heat transfer and fundamentals of heat Exchangers. |
| CO 2 | MED 303.2 | Develop solution for one dimensional steady state heat conduction and unsteady state heat conduction problem. |
| CO 3 | MED 303.3 | Analyze fundamental relationship between thermo-physical properties and modes of heat transfer. |
| CO 4 | MED 303.4 | Choose empirical correlations for forced, free convection and phase change process to determine values for the convection heat transfer coefficient. |
| CO 5 | MED 303.5 | Formulate numerical solutions for radiation heat transfer problems. |
| CO 6 | MED 303.6 | Evaluate the temperature profiles and performance of fins and heat exchangers.  |

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| **MED 304: CAD/CAM/CAE**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 304.1 | Describe the CAD, CAM, CAE and its technologies like CFD, CIM, PLM, & ERP. |
| CO 2 | MED 304.2 | Express the geometric modelling techniques and the technique of transformation of geometric entities using transformation matrix. |
| CO 3 | MED 304.3 | Produce simple geometric model of engineering parts using basic modelling operations and implement a computer program of moderate complexity for CAD/CAM/CAE tasks. |
| CO 4 | MED 304.4 | Checking visualization ability of machine components and assemblies before their actual fabrication through finite element modelling, animation, shading, rendering, lighting and colouring, etc. |
| CO 5 | MED 304.5 | Organize CAD and CAM system for modelling design information and converting the CAD model into a CAM model for modelling the manufacturing information. |
| CO 6 | MED 304.6 | Understanding the concept of advances in the field of CAD CAM CAE like 3D printing, FMS and supply chain management etc. |

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| **MED 305: Theory of Machines**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 305.1 | Understand the principles of kinematic pairs, chains and their classification, degree of freedom, inversions and other mechanisms. |
| CO 2 | MED 305.2 | Analyse the planar mechanisms for the position, velocity and acceleration. |
| CO 3 | MED 305.3 | Synthesize planar four bar and slider crank mechanisms for specified kinematic conditions. |
| CO 4 | MED 305.4 | Design cams and followers for specified motion profiles. |
| CO 5 | MED 305.5 | Understand the working principle of Flywheel, Governor, Brakes and Dynamometer. |
| CO 6 | MED 305.6 | Determine the unbalanced forces in various types of rotating and reciprocating masses and engines. |

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| **MED 342: Mechatronics (Elective – II)**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 342.1 | Demonstrate the basics of mechatronics systems |
| CO 2 | MED 342.2 | Outline the working of various types of sensors and actuators. |
| CO 3 | MED 342.3 | Illustrate data acquisition system and pin configuration used in microprocessor and microcontroller. |
| CO 4 | MED 342.4 | Examine the structure of PLC and its working. |
| CO 5 | MED 342.5 | Determine the selection criteria of sensors, actuators and PLCs for mechatronic systems. |
| CO 6 | MED 342.6 | Interpret the usage of various components in mechatronic systems.  |

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| **MED 351: Design of Machine Elements – II**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 351.1 | Define the basics of mechanical power transmission drive & its components, advancement in design of machine elements |
| CO 2 | MED 351.2 | Explain the theory of mechanical power transmission drive & its components, advancement in design of machine elements  |
| CO 3 | MED 351.3 | Select the appropriate material for mechanical power transmission drive & its components |
| CO 4 | MED 351.4 | Analyze the design of mechanical power transmission drive & its components, advancement in design of machine elements |
| CO 5 | MED 351.5 | Estimate the design procedure for mechanical power transmission drive & its components |
| CO 6 | MED 351.6 | Design of mechanical power transmission drive & its component |

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| **MED 352: Materials and Metallurgy**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 352.1 | Measure various mechanical properties of metals |
| CO 2 | MED 352.2 | Classify the phases of steel and their crystal structures in various phase diagrams. |
| CO 3 | MED 352.3 | Illustrate various types of heat treatments and their effects on metal properties. |
| CO 4 | MED 352.4 | Distinguish various steel alloys, their properties & applications. |
| CO 5 | MED 352.5 | Classify various nonferrous alloys and cast irons according to their properties & applications. |
| CO 6 | MED 352.6 | Illustrate various smart materials and composites according to their properties & applications. |

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| **MED 353: Internal Combustion Engines**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 353.1 | Recall IC engine terminology and different systems of IC engines |
| CO 2 | MED 353.2 | Understand the various losses, stages of combustion and performance parameter in IC engines. |
| CO 3 | MED 353.3 | Apply knowledge of fundamentals of thermodynamics and physics to measure performance parameters and characteristics of IC engines |
| CO 4 | MED 353.4 | Compare different technologies to enhance IC engine performance |
| CO 5 | MED 353.5 | Evaluation of engine emission and their effect on environment |
| CO 6 | MED 353.6 | Discuss alternative solutions for current problems in IC engines. |

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| **MED 354: Industrial Management (All)**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 354.1 | Define and understand the terms related to industrial management |
| CO 2 | MED 354.2 | Explain all concepts related to industrial management |
| CO 3 | MED 354.3 | Apply the theories techniques in industrial management |
| CO 4 | MED 354.4 | Perform the functions related to managerial aspects |
| CO 5 | MED 354.5 | Select appropriate managerial technique for the situation under consideration |
| CO 6 | MED 354.6 | Explain six sigma and relevant information |

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| **MED 355: Computational Techniques** |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 355.1 | Interpret the errors in numerical methods |
| CO 2 | MED 355.2 | Recognize the theoretical and practical aspects of the use of numerical methods  |
| CO 3 | MED 355.3 | Recall the knowledge of ordinary differential equations  |
| CO 4 | MED 355.4 | Recognize the numerical integration and differentiation |
| CO 5 | MED 355.5 | Compare the numerical methods in modern scientific computing,  |
| CO 6 | MED 355.6 | Implement the different numerical methods for a variety of multidisciplinary applications with languages like C and C ++ |

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| **MED 401: Tool Design**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 401.1 | Find different tool materials, their properties, different tools, their geometry and necessary aspects related to tool. |
| CO 2 | MED 401.2 | Explain fits, gauges, terms related to fits, locating & clamping devices, element of dies and drawing dies. |
| CO 3 | MED 401.3 | Select appropriate type of tool for machining process by calculating various parameters. |
| CO 4 | MED 401.4 | Classify all type of cutting tools used in machining and metal cutting. |
| CO 5 | MED 401.5 | Analyze various types of cutting tools, jigs and fixtures. |
| CO 6 | MED 401.6 | Design the gauges, jigs, fixtures, dies and drawing dies for given component. |

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| **MED 402: Automatic Control Systems**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 402.1 | Explain mathematical model of a system. |
| CO 2 | MED 402.2 | Differentiate the use of different controllers in control systems  |
| CO 3 | MED 402.3 | Demonstrate working of different components of control systems |
| CO 4 | MED 402.4 | Analyse control system with the help of Block Diagram Analysis. |
| CO 5 | MED 402.5 | Interpret the response of different order systems for test signals |
| CO 6 | MED 402.6 | Justify stability of the system |

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| **MED 403: Refrigeration and Cryogenics**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 403.1 | State the basic refrigeration and liquification principles with respect to current low cooling technology. |
| CO 2 | MED 403.2 | Explain thermodynamics property, processes carried out during refrigeration and cryogenics. |
| CO 3 | MED 403.3 | Apply the knowledge for selection of refrigerant and cryogenic fluids for various refrigeration and cryogenics systems. |
| CO 4 | MED 403.4 | Analyze various components of refrigeration and cryogenics systems. |
| CO 5 | MED 403.5 | Evaluate the performance of refrigeration and cryogenics systems. |
| CO 6 | MED 403.6 | Design the various components of refrigeration systems. |

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| **MED 431: Operation Research (Elective – II)**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 431.1 | Outline the characteristics of different types of decision-making environments and the appropriate decision-making approaches. |
| CO 2 | MED 431.2 | Build operational research models from the verbal description of the real system. |
| CO 3 | MED 431.3 | Solve Transportation Models, Assignment Models and sequencing problems for its optimal solutions. |
| CO 4 | MED 431.4 | Apply mathematical optimization functions to various applications. |
| CO 5 | MED 431.5 | Design new simple models, like CPM, PERT to improve decision-making. |
| CO 6 | MED 431.6 | Implement practical cases, by using TORA/LINDO/LINGO software. |

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| **MED 424: Hydraulic Machines (Lab)**  |
| **CO No.** | **Code** | **Statement** |
| CO 1 | MED 424.1 | Explain the working of hydraulic machines. |
| CO 2 | MED 424.2 | Compare working of turbo machines. |
| CO 3 | MED 424.3 | Evaluate the performance characteristic of hydraulic turbine and pumps.  |