Course Outline and Detailed Syllabus for B. Tech. Mechanical Engineering (8th Semester)

Semester-VIII

S. No	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC450C	Operations Research	**3**	**0**	**0**	**3**	**3**
2.	MECXXXE	Elective-V (Discipline Centric)	**3**	**0**	**0**	**3**	**3**
3.	XXXXXXX	Elective-VI (Generic)	**X**	**0**	**0**	**-**	**X**
4.	MEC460C	Major Project	**0**	**0**	**18**	**270 (Total)**	**9**
5.	-	Open Elective	**-**	**-**	**-**	-	**-**
Total Credits							**15+X**

Electives (Discipline Centric)

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC450E	Gas Dynamics	**3**	**0**	**0**	**3**	**3**
2.	MEC451E	Automobile Engineering	**3**	**0**	**0**	**3**	**3**
3.	MEC452E	Internal Combustion Engines	**3**	**0**	**0**	**3**	**3**
4.	MEC453E	Computational Heat Transfer and Fluid Flow	**3**	**0**	**0**	**3**	**3**
5.	MEC454E	Surface Engineering	**3**	**0**	**0**	**3**	**3**

Note:

1. *Discipline Centric electives are offered to the students of the Department of Mechanical Engineering only.*
2. *The students of the Department of Mechanical Engineering have to choose Discipline Centric Electives from the above list.*

Electives (Generic)

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC450G	Fracture Mechanics	**3**	**0**	**0**	**3**	**3**
2.	MEC451G	Introduction to Robotics	**3**	**0**	**0**	**3**	**3**

Note:

1. *Generic electives are offered to the students of the School of Engineering and Technology including the students of the Department of Mechanical Engineering.*
2. *The students of the Department of Mechanical Engineering have to choose Generic Electives from the list of courses offered by all the Departments of School of Engineering and Technology.*

Open Electives

S. No.	Course Code	Course Title	Hours Per Week			Total Contact Hours	Credits
			L	T	P		
1.	MEC001	Optimization Techniques	**3**	**0**	**0**	**3**	**3**
2.	MEC002	Quality Management	**3**	**0**	**0**	**3**	**3**
3.	MEC003	Concurrent Engineering	**3**	**0**	**0**	**3**	**3**
4.	MEC004	Maintenance Engineering	**3**	**0**	**0**	**3**	**3**
5.	MEC005	Fundamentals of Manufacturing Processes	**3**	**0**	**0**	**3**	**3**
6.	MEC006	Solar Energy	**3**	**0**	**0**	**3**	**3**
7.	MEC007	Basic Automobile Engineering	**3**	**0**	**0**	**3**	**3**
9.	MEC008	Basic Mechanical Engineering	**3**	**0**	**0**	**3**	**3**

Note:

1. *Open electives are offered to the students of all Departments of the university other than the Department of Mechanical Engineering.*
2. *The students of the Department of Mechanical Engineering have to choose Open Electives offered by the departments other than the Department of Mechanical Engineering.*

MEC450C Operations Research 3-0-0

Operations Research, its Role in solving Industrial Problems, Mathematical Models, Decision Making Environments, Linear Programming, Graphical Method, Simplex Method, Duality, Transportation Problems, Assignment Problems, Goal Programming, Linear Goal Programming Problems.

Probabilistic Models, Uncertainties, Maxima and Minima, Decision Trees, Game Theory, Simple Two Person Zero-Sum Games, Simple Competitive Situations, Dynamic Programming, Deterministic and Probabilistic Dynamic Programming, Solution of Simple Problems.

Network Models, Shortest Route, Minimal Spanning Tree, Maximum Flow Models, CPM and PERT Networks, Critical Path Scheduling, Sequencing Models.

Inventory Models, Economic Order Quantity, Quantity Discount Models, Stochastic Inventory Models, Multi Product Models.

Queuing Theory, Queuing Systems, Parameters, Single Server And Multi Server Models, Poisson Input, Exponential Service, Constant Rate Service, Infinite Population, Simulation.

Text Books:

1. Taha H. A., Operations Research, *Prentice Hall India, New Delhi.*
2. Gupta P. K., Hira, D. S., Operations Research, *S. Chand & Co., New Delhi.*
3. Srinath L. S., PERT and CPM, Principles and Applications, *East-West Press, New Delhi.*

Reference Books:

1. Wagner H. M., Principles of Operations Research, *Prentice Hall India, New Delhi.*
2. Bazara M. J., Sherali J. H., Linear Programming and Network Flows, *John Wiley & Sons.*

MEC450E Gas Dynamics 3-0-0

Introduction to Compressible flow and its applications: Review of Basic Equation in Differential and Integral Form (Mass, Momentum and Energy) for a viscous compressible flow and equations of states. Review of concepts of speed of sound in a stationary compressible medium and the Mach. No Basic differential equations for an inviscid compressible flow Dynamic similarity parameters in a compressible viscous flow.

Steady One Dimensional Flow Model: Basic Equations, Normal Shock Waves (Stationary), Oblique Shock Waves, Reflection & Interaction of Oblique Shock Waves, Expansion Waves Adiabatic Flow in a Constant area passage with friction, frictionless flow in a constant area passage with heat addition/removal.

Quasi-ID Steady Flows: Adiabatic Flow in a variable area passage without friction, Convergent-divergent nozzles and their operating characteristics. Convergent-divergent, Supersonic Diffusers, Generalized Quasi-ID Flow Governing Equations.

Unsteady wave motion: Moving normal shocks, reflected shock waves, Physical aspects of wave propagation, Basic elements of acoustic theory. Finite (Non-Linear) waves, Shock-tube relations, Finite compression waves.

Text Books/Reference Books:

1. Oosthuizen P.H., Carscallen W.E., Compressible Fluid Flow, *McGraw Hill Education (India).*
2. Zucrow & Hoffman, Gas Dynamics, *John Wiley and Sons.*
3. Shapiro, Dynamics & Theordynamics-Vol-1, *Ronald Press New York.*
4. Anderson Jr J.D., Modern Compressible Flow with Historical Perspective, *McGraw Hill Education (India).*

MEC451E Automobile Engineering 3-0-0

Introduction To Automobiles: Classification and Requirements of Automobile Body; Vehicle Frames, Unitised Body, Car Body Styles, Bus Body & Commercial Vehicle Body Types; Front Engine Rear Drive & Front Engine Front Drive Vehicles, Four Wheel Drive Vehicles, Safety Considerations.

Power Transmission: Requirements of Transmission System; General Arrangement of Power Transmission System; Gear Box; Types of Gear Boxes, Freewheel Unit, Overdrive Units, Advantage of Overdrive, Transaxle, Transfer Cases, Drive Lines, Differential and Drive Axles, Driving Thrust and Torque Reactions; Hotchkiss Drive, Torque Tube Drive and Radius Rods; Propeller Shaft, , Slip Joint; Constant Velocity Universal Joints; Front Wheel Drive; Principle, Function, Construction & Operation of Differential; Rear Axles, Types of Load Coming on Rear Axles, Full Floating, Three Quarter Floating and Semi Floating Rear Axles.

Suspension and Steering Systems: Need of Suspension Systems, Types of Suspensions; Factors Influencing Ride Comfort, Suspension Spring; Constructional Details and Characteristics of Leaf Springs, Steering Systems, Front Wheel Geometry & Wheel Alignment; Different Types of Steering Gear Boxes; Steering Linkages and Layout; Power Steering, Rack & Pinion Power Steering Gear, Electronics Steering.

Automotive clutches and Brakes: Tyres & Wheels, Classification of Brakes; Principle and Constructional Details of Drum Brakes, Disc Brakes; Brake Actuating Systems; Mechanical, Hydraulic, Pneumatic Brakes, Power & Power Assisted Brakes; Tyres of Wheels; Types of Tyre & Their Constructional Details, Wheel Balancing, Tyre Rotation; Types of Tyre Wear & Their Causes, Requirement of Clutches, Friction Clutch, cone Clutch, Plate Clutch, Spring Clutch, Multi Plate Clutch, Centrifugal Clutches, Electromagnetic Clutch, Over Running Clutch; Clutch Linkages.

Emission Control System & Automotive Electrical Systems: Sources of Atmospheric Pollution from the Automobiles, Emission Control Systems – Construction and Operation of Positive Crank Case Ventilation, Evaporative Emission Control, Heated Air Intake System, Exhaust Gas Recirculation Systems, Air Injection System and Catalytic Converters; Purpose Construction & Operation of Lead Acid Battery, Capacity Rating & Maintenance of Batteries; Purpose and Operation of Charging Systems, Purpose and Operations of the Starting System; Vehicle Lighting System.

Text Books:

1. Crouse W. H., Anglin D. L., Automotive Mechanics, *McGraw Hill Education (India).*

Reference Books:

1. Srinivasan S., Automotive Mechanics, *McGraw Hill Education (India).*
2. Anthony E. Schwaller, Motor Automotive Technology, *Delmar Cengage Learning.*
3. Sethi H. M., Automotive Technology, *McGraw Hill Education (India).*
4. Kirpal Singh, Automobile Engineering, *Standard Publishers Distributors.*

MEC452E Internal Combustion Engines 3-0-0

Introduction to IC Engines: Classification and major applications, engine performance parameters, design and performance data, comparison of Otto, Diesel and Dual cycles, two-stroke engines-operation, advantages and disadvantages, scavenging-methods and parameters, engine emissions

Fuel-Air cycles: Fuel-air cycles and their significance, effects of specific heat variation, dissociation and number of moles, effect of operating variables, idealized intake and exhaust processes, actual cycles, various losses encountered in SI and CI engines

Fuel injection: Mixture requirement in SI engines for steady state end transient operation, carburetion, fuel injection in CI and SI engines, supercharging and turbocharging, types of combustion chambers in SI and CI engines

Combustion: Combustion in SI engines, effect of engine variables on detonation, combustion in CI engines, effect of engine variables on delay period, comparison of knock in SI and CI engines, conventional fuels for SI and CI engines-requirements and their knock rating, alternative fuels and fuel additives

Gas turbines cycles: Thermodynamic analysis of actual gas turbine cycles, gas turbine cycles with intercooling, regeneration and reheating, jet propulsion- turbojet, turboprop, turbofan, ramjet and scramjet engines.

Text Books:

1. Ganesan V., Internal Combustion Engines, *McGraw Hill Education (India).*

Reference Books:

1. Heywood J. B., Internal Combustion Engine Fundamentals, *McGraw Hill Education (India).*
2. Hoag K., Dondlinger B., Vehicular Engine Design, *Springer Publications.*

MEC453E Computational Heat Transfer and Fluid Flow 3-0-0

Introduction to mathematical modelling: mathematical modelling of physical phenomena, governing differential equations- mass, energy, momentum, nature of coordinates, choice of coordinates

Discretization methods: concept of discretization, deriving the discretization equations: Taylor series formulation, variational formulation, method of weighted residuals, control volume formulation.

Modelling heat conduction: Steady 1-D conduction: equations, grid spacing, source term linearization, boundary conditions, solution of the linear algebraic equations; Unsteady 1-D conduction: general discretization equation, explicit and fully implicit schemes, Crank-Nicholson method, fully implicit discretization; 2-D situations, solution of algebraic equations; Over and under-relaxation.

Modelling convection and diffusion: Steady 1-D convection and diffusion: preliminary derivation, upwind scheme, exponential scheme, hybrid scheme, power law scheme, discretization for 2-D, one-way space coordinate, false diffusion

Modelling the flow field: Calculation of flow field, vorticity based methods, representation of pressure-gradient, representation of the continuity equation, staggered grids, momentum equation, pressure and velocity corrections, SIMPLE algorithm, SIMPLER algorithm

Text Books / Reference Books:

1. Patankar S.V., Numerical Heat Transfer and Fluid Flow, *Hemisphere Series on Computational Methods in Mechanics and Thermal Science.*
2. Muralidhar K., Sundararajan T., Computational Fluid Flow and Heat Transfer, *Narosa Publications.*

MEC454E Surface Engineering 3-0-0

Introduction to surface and their nature: Surface structure and properties, Surface Integrity, Surface Texture and Surface Roughness. Introduction to Tribology, Friction, Wear and Lubrication: Friction in Metals, Plastics and Ceramics, Friction Measurement. Wear: Wear of Plastic and ceramics. Lubricants: Metal Working Fluids, Solid Lubricants, Lubricant selection.

Introduction: purpose and need of surface engineering in industries, surface and subsurface region, properties of enhanced life and performance of mechanical components, classification of surface modification techniques, scope of surface engineering, role of surface properties affecting wearand friction behavior. Surface damages: types of wear and mechanism, adhesive wear, abrasive wear, erosive wear, corrosion wear and diffusive wear, techniques to evaluate damage of wear surface.

Materials for controlling wear: material properties (hardness, ductility, toughness, stacking fault energy, fatigue resistance, fracture toughness), selection of materials for surface engineering: iron base alloy, cobalt base alloy, nickel base alloy, copper base alloy, Structure and wear of material: ferrous metals, carbon steel, alloy steel, stainless steel, hadfield steel, gray cast iron, white iron, chromium iron, non-ferrous metals, cobalt base alloys and composite, nickel base alloys, functionally graded materials (FGM).

Surface Engineering by Changing the Surface Metallurgy: transformation hardening methods (flame hardening, induction hardening and Laser beam hardening), plastic deformation based approach (shot peening, burnishing and contour rolling and friction stir processing)

Surface Engineering by changing the composites: Carburizing (solid, liquid and gas), Nitriding, Surface modification using diffusion based processes, (PVD, CVD) vacuum deposition, ion implantation, sputtering, ion plating, boronizing.

Text Books / Reference Books:

1. Dwivedi D. K., Surface Engineering: Enhancing Life of Tribological Components, *Springer Publications*.
2. Rickerby D. S., Matthews A., Advanced Surface Coatings: A Handbook on Surface Engineering, *Springer Publications*.

MEC450G Fracture Mechanics 3-0-0

Introduction to fracture mechanics: Historical development of fracture mechanics, basic concepts, stresses at crack tip, stress singularities, stress intensity factors, critical crack length, Griffith criterion, energy release rate, crack opening displacements, mechanisms of fracture and crack growth, brittle fracture, ductile fracture, fatigue crack growth, environment assisted cracking.

Linear elastic fracture mechanics: Crack deformation modes and basic concepts, crack tip stresses and deformation, Airy Stress Functions, Westergaard's stress function, Stress Intensity Factors, effect of finite size, crack tip plasticity, Irwin approach, Dugdale approach, shape of plastic zones, thickness effect.

Elastic-plastic fracture mechanics: The energy principles, the energy release rate, Crack resistance, R curves, compliance, the J integral, tearing modulus, Crack tip opening displacement, relationship between J integral and CTOD, use and limitations of J integral, two parameter fracture mechanics

Fatigue crack propagation: Introduction to fatigue failure, factors affecting fatigue crack growth, mechanism of fatigue crack growth, fatigue crack growth equations, crack closure, crack retardation models, effect of overloads, growth of short cracks.

Text Books:

1. Broek D., Elementary Engineering Fracture Mechanics, *Kluwer Academic Publishers, Netherlands*.
2. Anderson T. L., Fracture Mechanics; Fundamentals and Applications, *CRC Press, USA*.

Reference Books:

1. Gdoutos E. E., Fracture Mechanics; an Introduction, *Springer Publications, Netherlands*.
2. Schijve J., Fatigue of Structures and Materials, *Kluwer Academic Publishers, New York*.
3. Perez N., Fracture Mechanics, *Kluwer Academic Publishers, New York*.
4. Lee Y. Li, Pan J., Hathaway R., Barkey M., Fatigue Testing and Analysis, *Elsevier Publications, USA*.

MEC451G Introduction to Robotics 3-0-0

Introduction and classification: Definition, History of robots, Application of robots, Industrial applications, Classification of Robots, Actuators and Grippers.

Transformations: Kinematic constraints, Degrees of freedom and mobility, Pose of a rigid body, Coordinate Transformations, DH Parameters.

Kinematics: Forward position analyses, Inverse position analyses, Velocity analyses, Jacobian Matrix, Singularity, Forward and Inverse Velocity analyses, Acceleration analyses, Manipulator Design Requirements.

Dynamics and Control: Euler-Lagrange equations of motion for serial type manipulators; Inverse and Forward dynamic analyses, Linear control techniques, Transfer function and state space representation of dynamic system, A Robotic joint, PID control.

Text Books:

1. Saha S. K., Introduction to Robotics, *McGraw Hill Education (India).*
2. Craig J. J., Introduction to Robotics, Mechanics and Control, *Pearson Education*.

Reference Books:

1. Siciliano B., Khatib O., Springer Handbook of Robotics, *Springer Publications*.