AUPE3005 DESIGN OF VEHICLE COMPONENTS (3-0-0)

Course Objectives:

1. To provide a comprehensive understanding of the principles and procedures for designing automotive components.
2. To equip students with analytical and practical knowledge of designing vehicle powertrain, chassis, and safety components.
3. To integrate ergonomics and crashworthiness into vehicle design processes.

Module I: Design of Engine Components (08 Hours)

Design considerations for engine components: stress, thermal loading, fatigue. Cylinder and Liner: design for hoop stress, distortion, and cooling. Piston: crown thickness, ring groove design, expansion control, thermal analysis. Connecting Rod: buckling load, I- section, bearing cap design. Valves and Rocker Arm: design for lift, cam profile interaction, spring force. Camshaft: cam profile, pressure angle, follower motion, stress in cam nose. Flywheel: energy fluctuation in 4-stroke engines, rim stresses.

Module II: Transmission and Driveline Design (09 Hours)

Clutch: single plate clutch design – torque transmission, wear, lining material. Gearbox: design of constant mesh and synchromesh gearboxes – gear ratios, gear tooth strength (Lewis equation), module selection. Gear Design: spur and helical gears, contact ratio, wear and fatigue. Propeller Shaft: torsional strength, length and diameter optimization, universal joints. Rear Axle: semi-floating and fully-floating design, axle stress analysis, differential gears.

Module III: Design of Chassis and Suspension Systems (09 Hours)

Frame Design: ladder and monocoque structures, torsional and bending stiffness, material selection.
Suspension Components:
Leaf Spring: camber, number of leaves, stress distribution. Coil Spring: load vs deflection, fatigue life. Torsion Bar: stiffness and shear stress calculation.
Front Axle: load analysis under static and dynamic conditions. Steering Linkages: Ackermann mechanism, pitman arm, tie rod design.

Module IV: Design of Braking Systems (08 Hours)

Brake Design Requirements: thermal capacity, deceleration, fade resistance. Drum Brakes: self-energizing force, actuation mechanism, lining pressure distribution. Disc Brakes: disc material, caliper force, thermal stress, ventilation design. Hydraulic System Design: master and wheel cylinder sizing, line pressure, fluid selection. Brake balancing and anti-lock control design basics.

Module V: Ergonomics and Safety in Automotive Design (08 Hours)

Ergonomics in Interior Design: driver workspace, reach envelope, seating posture, visibility zones. Dashboard Layout: instrument cluster design, HMI principles, display positioning. Crash Safety Design: Crumple zones, load path distribution. Seat belt anchorage, airbag deployment zones. Side and frontal impact considerations. Safety Standards and Compliance: AIS-098, FMVSS, ECE regulations overview.

Course Outcomes (COs):

Upon completion of this course, students will be able to:
CO1:Design and analyze engine components based on strength, thermal, and fatigue considerations.
CO2:Design driveline elements like clutch, gearbox, propeller shaft, and rear axle.
CO3:Design structural and suspension components for strength and ride comfort.
CO4:Analyze braking systems and design brake components.
CO5:Apply ergonomic principles and safety standards to vehicle body and interior design.

Text Books:

1. Khurmi, R.S. & Gupta, J.K. – Machine Design, S. Chand
2. Sadhu Singh – Machine Design, Khanna Publishers
3. Srinivasan, S. – Automotive Mechanics, Tata McGraw Hill

Reference Books:

1. Heldt, P.M. – Automotive Chassis, Chilton
2. Gillespie, T.D. – Fundamentals of Vehicle Dynamics, SAE
3. N.K. Giri – Automobile Mechanics, Khanna Publishers
4. Bosch – Automotive Handbook, Bosch GmbH