AUPE3009 AUTOMOTIVE EMISSIONS & CONTROL (3-0-0)

Course Objectives:

1. To understand the types, sources, and effects of automotive emissions.
2. To study emission regulations and control technologies in SI and CI engines.
3. To familiarize students with diagnostic systems and emission measurement techniques.

Module I: Combustion Emissions and Standards (08 Hours)

Types of emissions:
SI Engines: CO, HC, NOx, aldehydes. CI Engines: NOx, PM, soot, smoke, odor. Formation mechanisms: Rich/lean combustion, incomplete combustion, high-temperature reactions. Combustion chamber effects, injection parameters, ignition timing. Health and environmental effects: photochemical smog, respiratory impact, greenhouse gases. Emission Norms and Standards: Bharat Stage III to VI, Euro I to VI, US EPA Tier standards. Emission limits for 2W, 3W, LMV, HCV; fuel-specific standards (gasoline, diesel, CNG, LPG).

Module II: Emission Control Technologies (09 Hours)

Catalytic Converters: 2-way and 3-way catalyst, structure, function, washcoat materials. Light-off temperature, conversion efficiency.
Exhaust Gas Recirculation (EGR):
Types: external and internal EGR. Effect on NOx reduction, EGR rate, cooling techniques.
Selective Catalytic Reduction (SCR): Urea injection, NOx conversion, dosing strategies. Lean NOx Trap (LNT) and Diesel Oxidation Catalyst (DOC). Diesel Particulate Filters (DPF): regeneration techniques – passive and active. Effect of engine parameters on emission control system efficiency.

Module III: Evaporative and Crankcase Emissions Control (07 Hours)

Sources of evaporative emissions: fuel tank, carburetor, injectors. Control methods: Activated carbon canister, sealed fuel systems. Leak detection techniques and purge valve operation. Crankcase emissions: blow-by gases. Positive Crankcase Ventilation (PCV) system – closed loop and open loop. Integration of evaporative control with ECU and fuel system. Vapor pressure control and venting strategies.

Module IV: On-Board Diagnostics (OBD) (08 Hours)

OBD-I vs. OBD-II: evolution and architecture. EOBD and US OBD regulations overview. DTC (Diagnostic Trouble Codes): format, examples, interpretation. Emission-related system monitoring: Oxygen sensor, catalytic converter, misfire, EGR, fuel system. MIL (Malfunction Indicator Lamp) logic. Freeze-frame data and readiness codes. Communication protocols: CAN, ISO 9141, KWP2000. OBD tools and scanners: handheld, PC-based.

Module V: Emission Measurement and Testing (08 Hours)

Laboratory Emission Testing:
Engine test bed setup: transient and steady-state tests.
Emission analyzers: NDIR (CO/CO_2), FID (HC), CLD (NOx), opacity meter (smoke).
CVS (Constant Volume Sampler) system.
On-Road/Portable Emission Measurement Systems (PEMS). Smoke opacity and filter paper methods. Measurement of particulate mass and number.
Vehicle emission testing cycles: WMTC (World Motorcycle Test Cycle), WLTP, FTP-75. Indian certification agencies: ARAI, ICAT, VRDE, and test facility requirements.

Course Outcomes (COs):

After completion of this course, students will be able to:
CO1:Identify and explain the sources and formation mechanisms of emissions in IC engines.
CO2:Interpret emission standards and regulations applicable to various vehicle classes.
CO3:Apply knowledge of emission control technologies like EGR, SCR, and catalytic converters.
CO4:Analyze evaporative and crankcase emission control strategies.
CO5:Perform diagnostic and measurement techniques using OBD and lab/road testing methods.

Text Books:

1. B. B. Arora – Automobile Pollution and Control, Dhanpat Rai
2. Ganesan, V. – Internal Combustion Engines, Tata McGraw Hill
3. SAE Technical Papers on Emissions & OBD Systems

Reference Books:

1. Pundir, B.P. – Engine Emissions, Narosa Publishing
2. Heywood, J.B. – Internal Combustion Engine Fundamentals, McGraw Hill
3. Bosch – Automotive Handbook, Wiley