25MMET402	IC ENGINES AND EMISSION CONTROL	Category	L	T	P	R	Credit	Year of Introduction
		VAC	4	0	0	0	4	2025

Preamble: This course introduces the fundamental concepts of internal combustion engines and the formation and control of engine emissions. It covers engine operating cycles, performance characteristics, modern engine technologies, and emission control techniques in spark ignition and compression ignition engines. The course also highlights environmental impacts and emission standards, providing students with knowledge of cleaner and more efficient engine technologies.

Prerequisite: 25MMET302 Fundamentals of Automobile Engineering

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Explain IC engine cycles, performance and emission standards.	K2 Understand
CO2	Apply modern IC engine technologies and fuel injection systems.	K3 Apply
CO3	Explain pollutant formation in spark ignition engines and its control.	K3 Apply
CO4	Apply emission control techniques in compression ignition engines.	K4 Analyse

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	1	-	-	-	-	-	2	-
CO2	2	2	2	-	-	1	-	-	-	-	-	3	2
CO3	2	3	-	-	-	2	-	-	-	-	-	2	-
CO4	2	3	1	-	-	2	-	-	-	-	-	2	1
Avg	2.25	2.5	1.5	-	-	1.5	-	-	-	-	-	2.25	1.5

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

CO	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*	_	_	*	_
CO2	*	*	*	*	*	*	*	*	_
CO3	*	*	*	*	*	*	_	*	_
CO4	*	*	*	*	*	*	*	*	_

WKs Mapped with the Course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*	*	*	*	_

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	**40**	**60**	**2.5 hrs**

Continuous Internal Evaluation Pattern:
Attendance : 5 marks
Continuous Assessment Test : 20 marks
Continuous Assessment Assignment : 15 marks

SYLLABUS

Module 1 (12 hrs)
Engine types – otto, diesel, dual operating cycles – Fuel air cycle and actual cycles – Engine design and operating parameters - Two and four stroke engines - Typical performance curves for automobile engines - performance and pollution aspects. Emission effects on health and environment. Emission inventory, ambient air quality monitoring. Bharat Standard up to BS – VI and procedures for confirmation on production, vehicle tests.

Module 2 (14 hrs)
Lean Burn engine – Different approaches to lean burn – LHR engine – Surface ignition concept – catalytic ignition – homogenous charge compression ignition – variable valve timing – Multi Port Injection System - Gasoline Direct Injection – Common Rail Direct Injection – Recent Trends (Case Studies)

Module 3 (14 hrs)
Emission formation in S.I. engines - Hydrocarbons, Carbon monoxide, Oxides of Nitrogen, Polyneclear Aromatic Hydrocarbon. Effects of design and operating variables on emission formation in Spark Ignition engines Controlling of pollutant formation in engines Exhaust after treatment, Charcoal Canister Control for Evaporative Emission Control, emissions and drivability, Positive crank case ventilation system for UBHC emission reduction.

Module 4 (16 hrs)

Chemical delay – Intermediate compound formation – Pollutant formation during incomplete combustion – Formation of particulate matter and NOx in CI engines – Effect of design and operating variables on pollutant formation. Control of emissions in CI engines – Exhaust Gas Recirculation (EGR) – Diesel oxidation catalyst (DOC) – Diesel particulate filter (DPF) – Selective catalytic reduction (SCR) – Exhaust after-treatment technologies – Emissions and drivability – Emission reduction through alternative fuels and advanced combustion techniques.
Text Books:

1. Ganesan, V., *Internal Combustion Engines,* 4th Edition, Tata McGraw-Hill Education, New Delhi, 2012.
2. Rajput, R.K., *Thermal Engineering*, Laxmi Publications, New Delhi, 2019.
3. Mathur, M.L. & Sharma, R.P., *Internal Combustion Engines*, 2nd Edition, Dhanpat Rai & Sons, New Delhi, 2010.
4. Pulkrabek, W.W., *Engineering Fundamentals of the Internal Combustion Engine,* 2nd Edition, Pearson Education, 2015.
5. Heywood, J.B., *Internal Combustion Engine Fundamentals*, 2nd Edition, McGraw-Hill Education, 2018.

Reference Books:

1. Rudramoorthy, R., *Thermal Engineering*, 3rd Edition, Tata McGraw-Hill Education, 2014.
2. Yadav, R.S., *Thermodynamics and Heat Engines*, 9th Edition, Central Book Depot, Allahabad, 2015.
3. Khurmi, R.S. & Gupta, J.K., *Thermal Engineering*, 14th Edition, S. Chand Publications, New Delhi, 2016.
4. Stone, R., *Introduction to Internal Combustion Engines*, 4th Edition, SAE International / Palgrave Macmillan, 2012.
5. Gupta, H.N., *Fundamentals of Internal Combustion Engines*, 2nd Edition, PHI Learning, 2014.
6. Ferguson, C.R. & Kirkpatrick, A.T., *Internal Combustion Engines: Applied Thermosciences,* 3rd Edition, Wiley, 2016.

END SEMESTER EXAMINATION - MODEL QUESTION PAPER

Course Code	**25MMET402**
Course Name	**IC ENGINES AND EMISSION CONTROL**
Max. Marks: 60	**Duration: 2.5 Hours**

Part A
(Answer all questions. Each question carries 3 marks)

Qn No.	Question	Marks	CO	BL
1	Explain the assumptions of air-standard and fuel-air cycles used in IC engine analysis.	3	1	L2
2	Explain Bharat Stage emission standards up to BS-VI and their relevance to engine pollution control.	3	1	L2
3	Use the concept of lean burn combustion to identify its effect on fuel economy and NOx formation.	3	2	L3
4	Select a suitable fuel injection system among MPFI, GDI and CRDI for a given engine application and justify the choice.	3	2	L3
5	Use operating variables to identify the causes of HC, CO and NOx formation in spark ignition engines.	3	3	L3

6	Demonstrate the role of positive crankcase ventilation and charcoal canister systems in reducing UBHC emissions.	3	3	L3
7	Analyze the effect of EGR on NOx control and engine performance in compression ignition engines.	3	4	L4
8	Analyze the suitability of DOC, DPF and SCR systems for controlling diesel engine emissions.	3	4	L4
Part B (Answer any one full question from each Module. Each carry 9 marks)				
Module I				
Qn No.	**Question**	**Marks**	**CO**	**BL**
9	Explain the working of Otto, Diesel and Dual cycles with suitable P-V and T-S diagrams. Also describe the differences between fuel-air cycle and actual cycle.	9	1	L2
OR				
10	Describe engine performance parameters and typical performance curves of automobile engines. Explain the influence of engine operating parameters on performance and pollution.	9	1	L2
Module II				
Qn No.	**Question**	**Marks**	**CO**	**BL**
11	A modern passenger car engine is required to achieve better fuel economy with reduced emissions. Apply lean burn, variable valve timing, MPFI/GDI and HCCI concepts to suggest suitable engine technologies for this requirement.	9	2	L3
OR				
12	Apply modern fuel injection concepts to compare MPFI, GDI and CRDI systems with respect to injection location, pressure, mixture preparation, combustion control and emission behaviour.	9	2	L3
Module III				
Qn No.	**Question**	**Marks**	**CO**	**BL**
13.a	Use design and operating variables to identify the major reasons for hydrocarbon, carbon monoxide and oxides of nitrogen formation in SI engines.	5	3	L3
13.b	Demonstrate the use of evaporative emission control and positive crankcase ventilation systems for UBHC reduction.	4	3	L3

OR				
14.a	Apply exhaust after-treatment concepts to select suitable methods for controlling HC, CO and NOx emissions from SI engines.	5	3	L3
14.b	Use the relationship between emissions and drivability to recommend suitable emission control measures for a spark ignition engine.	4	3	L3
Module IV				
Qn No.	**Question**	**Marks**	**CO**	**BL**
15.a	Analyze particulate matter and NOx formation in CI engines by relating chemical delay, incomplete combustion and operating variables.	5	4	L4
15.b	Analyze the role of EGR and SCR systems in NOx reduction and their influence on diesel engine drivability.	4	4	L4
OR				
16.a	Analyze DOC, DPF and SCR after-treatment technologies for controlling diesel engine emissions and identify the pollutant mainly controlled by each system.	5	4	L4
16.b	Analyze the role of alternative fuels and advanced combustion techniques in reducing CI engine emissions.	4	4	L4