ADVANCED ENGINE TECHNOLOGIES **Course Code : 314341**

Programme Name/s : **Automobile Engineering.**
Programme Code : **AE**
Semester : **Fourth**
Course Title : **ADVANCED ENGINE TECHNOLOGIES**
Course Code : **314341**

I. RATIONALE

This course explores advanced engine technologies that power modern vehicles. Students will gain comprehensive insights into the components of fuel supply systems and combustion process in petrol and diesel engines. Additionally, they acquire insights into digitally controlled engines, alternative energy sources and air pollution and emission control. This course integrates laboratory practice work focusing on component identification, inspection and maintenance of engine and other systems, to ensure optimal engine performance. This course is also prerequisite for the course 'Vehicle Systems Maintenance'.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain advanced automotive engines.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Detect abnormal combustion in I.C. engine.
- CO2 - Use diagnostic equipment for effective engine fuel management.
- CO3 - Apply the fundamental principles of advanced technology for better engine performance
- CO4 - Perform I.C. engine test
- CO5 - Apply basic concepts of emission control to reduce automotive pollution.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
314341	ADVANCED ENGINE TECHNOLOGIES	AET	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Select fuel for the given application/ engine for better performance. TLO 1.2 Construct fuel supply system layout for gaseous fuel. TLO 1.3 Describe the procedure to locate leakage in gaseous fuel supply system of the given type of engine. TLO 1.4 Identify factors responsible for abnormal combustion in the given engine.	**Unit - I Engine Combustion and Alternative Fuels** 1.1 Combustion in S.I. and C.I. Engines: Ignition limits, Air Fuel ratio in Petrol and Diesel engines, Stages of combustion in SI engine, I- head combustion chamber, Detonation and its control, Stages of combustion in CI engine, Diesel knock and its control, DI and IDI combustion chambers. 1.2 Properties of various fuels used in IC engines- Gasoline, Diesel, LPG, CNG, Hydrogen, Alcohol, Bio diesel. 1.3 Alternative Fuels for SI and CI engines- LPG, CNG, Alcohol, Bio- diesel (Merits and demerits with respect to performance and emission), CNG conversion kit block diagram. Leak detection procedure.	Lecture Using Chalk-Board Presentations, Model Demonstration, Video Demonstrations.

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain function, location and working of component of given fuel supply system. TLO 2.2 Describe the steps to scan the faults of the given MPFI engine. TLO 2.3 Explain with sketch operation of the given component of CRDI system. TLO 2.4 State manufacturer's diagnostic procedure to diagnose the given fault in CRDI system using scan tools. TLO 2.5 Interpret the given fault codes for the CRDI engine using scanner.	**Unit - II Engine Fuel Management** 2.1 Fuel Management in S.I. engines: Throttle body injection (TBI) and Port fuel injection (PFI) systems; Methods of fuel Injection: Sequential, Continuous, grouped, simultaneous injection. 2.2 Sensors and Actuators of MPFI engine. Pressure regulators, fuel injector, and fuel pump. 2.3 Electronic Control Module: Input and output control functions as fuel injection, idle speed control, EGR, canister purge. 2.4 Diagnostic procedure of MPFI system: Use of Scan tool and reading fault codes . 2.5 Fuel Management in C.I. engines: Common Rail Direct Injection system: Major Components- Solenoid operated Fuel injector, High pressure fuel pump, High pressure accumulator. 2.6 CRDI System operation and advantages. 2.7 Diagnostic procedure of CRDI system; Use of Scan tool and reading fault codes. 2.8 Glow plugs: Construction, Circuit and operation of glow plug and its control unit.	Lecture Using Chalk-Board Presentations, Model Demonstration, Video Demonstrations.
3	TLO 3.1 Describe advanced features of the given turbocharger. TLO 3.2 Select the engine with technology/ features suitable for the given application. TLO 3.3 Compare the salient features of the given turbochargers. TLO 3.4 List the salient features of the given injection system. TLO 3.5 State the merits and demerits of using supercharger in S.I. engine	**Unit - III Advances in Automobile Engines** 3.1 Turbocharger with wastegate boost control and its limitations . 3.2 Variable Geometric Turbocharger (VGT). 3.3 Variable Valve Timing mechanism (VVT). 3.4 Gasoline Direct Injection (GDI) and Stratified-charge injection. 3.5 Supercharger.	Lecture Using Chalk-Board Presentations, Model Demonstration, Video Demonstrations.

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Interpret the given engine performance parameters and their implications. TLO 4.2 Explain with sketches the working principle of the given type of dynamometer. TLO 4.3 Calculate engine Performance parameters for the given situation. TLO 4.4 Prepare heat balance sheet for the given situation.	**Unit - IV Engine Performance** 4.1 Engine Performance parameters. Definitions: Indicated Power, Brake Power and Frictional Power; Efficiencies - Air standard, Mechanical, Brake Thermal, Indicated Thermal, Volumetric and Relative. 4.2 Dynamometers and engine testing: Working Principle and types of Dynamometers: Hydraulic and Eddy current. Engine Testing: Morse Test, Willian's line Method for finding Frictional Power. Heat balance sheet and Method of calculating Volumetric Efficiency and Fuel Consumption.	Lecture Using Chalk-Board Presentations, Model Demonstration, Video Demonstrations.
5	TLO 5.1 State the properties of the exhaust emission for the given engine. TLO 5.2 Explain with sketch method of emission control for the given engine. TLO 5.3 Tabulate prevailing Bharat Stage (BS) norms for given vehicle.	**Unit - V Fuel Economy and Emission control** 5.1 Fuel economy and methods of improving fuel economy. 5.2 Petrol engine emission and its control: Pollutants from petrol engine. Engine design modification, treatment of exhaust gas- Catalytic Converter; fuel modification. Positive crankcase ventilation (PCV) system; Evaporation emission control system. 5.3 Diesel Engine emission and its control: Diesel engine pollutants, diesel smoke and control. Exhaust-Gas recirculation (EGR) – EGR valve and control system; Selective Catalytic Reduction. 5.4 Emission Norms for two, three and four-wheeler engines.	Lecture Using Chalk-Board Presentations, Model Demonstration, Video Demonstrations.

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify the type of combustion chamber. LLO 1.2 Sketch combustion chamber showing position of valves, injector/ spark plug.	1	* Condition monitoring of combustion chamber of a multicylinder S.I. / C.I. Engine.	2	CO1
LLO 2.1 Locate LPG system leakage using soap bubble test/ combustible gas leak detector sensor. LLO 2.2 Repair or replace leaking component. LLO 2.3 Recheck for leakage	2	Test the LPG system for leakage.	1	CO1

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 3.1 Identify and locate the various sensors on vehicle engine. LLO 3.2 Diagnose any one of the sensors for functionality (standalone diagnosis as per service manual)	3	* Diagnosis of the functionality of various sensors in the MPFI engine.	2	CO2 CO3
LLO 4.1 Check fuel filter for contamination LLO 4.2 Inspect the MPFI engine fuel pump inlet for dirt and debris LLO 4.3 Check all fuel hoses and tubing on the fuel pump assembly for leakage LLO 4.4 Reassemble the fuel feed pump	4	Dismantle and assemble electrical fuel feed pump of the MPFI System	2	CO2 CO3
LLO 5.1 Connect Scan tool to MPFI engine control unit and enter vehicle identification data. LLO 5.2 Interpret the trouble code/s. LLO 5.3 Inspect relevant transducer and wiring. LLO 5.4 Rectify fault and clear diagnostic trouble code	5	Diagnosis of MPFI engine using engine scanner.	2	CO2 CO3
LLO 6.1 Identify and locate the position of CRDI system components LLO 6.2 Sketch relevant components and their connections. LLO 6.3 Check electrical connections and pipelines for leakage	6	* Identification of different components of the Common Rail Direct Injection (CRDI) System.	2	CO2 CO3
LLO 7.1 Detect fault using scanner LLO 7.2 Replace faulty sensor, actuator or ECU as required. LLO 7.3 Perform onboard diagnostics on CRDI engine.	7	Diagnosis of CRDI engine.	2	CO2 CO3
LLO 8.1 Diagnose CRDI ECU using scan tool. LLO 8.2 Replace malfunctioning components LLO 8.3 Check the system for smooth operation.	8	Servicing of the CRDI engine	2	CO2 CO3
LLO 9.1 Locate glow plug/s. LLO 9.2 Test glow plug LLO 9.3 Check glow plug operation	9	Glow Plug Testing	1	CO2
LLO 10.1 Check Engine fuel consumption LLO 10.2 Calculate power output and heat losses for different engine loads LLO 10.3 Draw heat balance sheet	10	* Engine Performance Testing	4	CO4
LLO 11.1 Calculate power output of engine LLO 11.2 Record power output with cylinders cut off LLO 11.3 Find mechanical efficiency of engine	11	* Measurement of mechanical efficiency of an engine using Morse Test	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 12.1 Check pollutants from S.I. engine using emission test equipment for S.I. engine. LLO 12.2 Tune engine to contain pollutants as per relevant pollution norms. LLO 12.3 Recheck the pollutants to meet norms	12	* Diagnosis of S.I. engine condition using Exhaust gas Analyzer	2	CO5
LLO 13.1 Check pollutants from C.I. engine using emission tester for diesel engine. LLO 13.2 Check injector for spray pattern. LLO 13.3 Recheck pollutants to meet norms.	13	Diagnosis of C. I. engine condition using Exhaust gas Analyzer	2	CO5
LLO 14.1 Locate EGR valve connecting induction and exhaust system LLO 14.2 Test EGR valve diaphragm LLO 14.3 Test EGR valve stem for operation LLO 14.4 Test EGR valve operation	14	* Functionality testing of EGR system of an engine	2	CO5
LLO 15.1 Locate PCV Valve on engine LLO 15.2 Carry out rattle test and vacuum test on PCV valve. LLO 15.3 Check PCV valve for operation after cleaning it.	15	* Test the PCV system of an engine	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Prepare a report on Turbocharger/ VGT/ VVT/ GDI/ supercharger including components, function, merits, demerits and performance.
- Prepare a report on specifications, standard operating procedure and application of Scan tool for On board diagnosis.
- List tools, steps in diagnosis and precautions taken during MPFI/ CRDI engine system using service manual or an OEM video.
- Prepare a report on power measurement by using a dynamometer.
- Prepare a report on LPG/ CNG Kit including components, function, merits, cost and performance.
- Prepare a comparison chart of alternative and conventional fuels for I.C. engines.
- Identify, sketch and compare combustion chambers of 4 different S.I. and C.I. engines
- Prepare a report on methods to improve fuel economy of an engine
- Prepare a report on methods to control engine emission including EGR system/ PCV system/ Catalytic converter/ Selective Catalytic Reduction.

Assignment

- Compare I.C. engine fuels on the basis of properties, performance and emission.
- List the make and model of car using the following technologies: VVT, VGT, GDI and supercharging. State the merits of the technologies incorporated in particular models
- Describe set up of engine test rig with specification of major components. List the formulae used in heat balance sheet.
- Prepare a chart showing advance technologies used in four cars available in market.
- Compare European and Indian emission norms for various vehicle categories.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Special purpose tools (internal and external circlip plier, Valve lifter, feeler gauge Torque wrench)- Torque wrench range- 10 Nm to 200Nm., Vacuum gun with gauge, Mechanical (Diesel) fuel Injector-Tester	1,2,3,4,6,9,14
2	General purpose tools (Spanners, ring spanner and socket- 6mm to 32 mm), screw driver set- flat head and Philips head	1,2,3,7,8,9,12,13,14,15
3	Four-stroke S.I. and C.I. engines: Make: Maruti/ Greaves Cotton/ Tata and alike, Power: 25 kW to 100 kW, Cubic Capacity: 800 CC to 2500CC	1,9
4	Multicylinder engine test rig with dynamometer; Morse test Arrangement	10,11
5	A car equipped with Liquified Petroleum Gas/ Compressed Natural Gas fuel supply system; Make: Maruti/ Hyundai; Power: up to 40 kW; Cubic Capacity: 800cc; Fuel: LPG/ Petrol; Make: Maruti; Power: up to 65 kW; Cubic capacity: 800 to 1350 cc; Fuel: CNG	2
6	Digital Multimeter: LCD Display, 0 to 50ºC Operating Temperature, DC voltage- 200mV to 1000 V DC, 2 to 1000 V Alternating Current, Current: 2mA to 20 A DC, Diode Test, Continuity Test- Audible buzzer, Resistance: 200 ? to 200 M?	3
7	Car having Multiport Fuel Injection engine with sensors, actuators and Electronic Control Module, Exhaust Gas Regulation valve and Positive Crankcase Ventilation valve; Make: Maruti/ Tata/ Ford/ Honda/ Hindustan Motors and alike Power: 25 kW @ 5000 rpm to 55kW@ 5000 rpm, Cubic Capacity: 800 CC to 2000 CC	3,4,5
8	Scan tool: Make: BOSCH and alike; On Board Diagnostics (OBD) Scan Tool compatible with vehicle available in laboratory, Controller area network enabled, Colour Display, Operating Temperature: 0 to 50ºC, Internal Storage: 4 AAA batteries, External Power: 7 to 18 volts; Generic tool; Accessories: Extender cable, OBD II Cable; Relevant optional accessories.	5,7,8

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
9	Vehicle having Common Rail Direct Injection Engine with sensors, actuators and Electronic Control Module: Make: Fiat/ Hyundai/ Tata/ Honda and alike; Cubic Capacity: up to 2200 cc; Power: up to 100 kW @ 4000 rpm.	6,7,8

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Engine Combustion and Alternative Fuels	CO1	10	6	6	0	12
2	II	Engine Fuel Management	CO2	22	2	12	8	22
3	III	Advances in Automobile Engines	CO3	8	2	4	6	12
4	IV	Engine Performance	CO4	8	2	4	6	12
5	V	Fuel Economy and Emission control	CO5	12	2	4	6	12
Grand Total				**60**	**14**	**30**	**26**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- class tests, term work , self learning

Summative Assessment (Assessment of Learning)

- end semester examination (Theory) , practical performance

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	2	2	2	-	3			
CO2	3	3	3	3	3	-	3			
CO3	3	2	2	2	2	-	2			
CO4	3	2	2	3	2	2	2			
CO5	3	3	2	3	3	-	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	V.A.W Hiller	Hiller's Fundamentals of Motor Vehicle Technology -Book 1	Nelson Thrones Ltd UK Sixth Edition 16/10987654321
2	Jack Erjavec	Automotive Technology A systems Approach 5th Edition	Delmar Cengage Learning ISBN-13: 978-1428311497
3	James D. Halderman	Automotive Technology Principles, Diagnosis and Service 4th Edition	Prentice Hall ISBN-13: 978-0-13-254261-6
4	M.L.Mathur and S.C.Sharma	Internal Combustion Engines	Dhanpat rai Publications ISBN 978-9383182428
5	V.Ganesan	Internal Combustion Engines	McGraw Hill Education ISBN 978-1259006197
6	K.K. Jain & R B Asthana	Automobile Engineering	McGraw Hill India ISBN 978-0070445291

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=_lqBLu1zBhU	Delphi Common Rail Diesel pump Autopsy Pt2 - Hyundai Terracan and Kia K2700 pump
2	https://www.youtube.com/watch?v=wJjVMi1oybM	Diesel Engine Maintenance Tip 3: How to Remove Crank Position Sensor Wire
3	https://www.youtube.com/watch?v=85IP8eY1nXY	Diesel Pressure Sensor Testing
4	https://www.youtube.com/watch?v=jDp6lEA8ETs	Lovato Gas LPG systems for vehicles installation training
5	https://dannysengineportal.com/exhaust-gas-recirculation-egr -valve-types-failure-replacement/	Exhaust Gas Recirculation – Types, Failure, Cleaning, Replacement
6	https://www.aa1car.com/library/pcv.htm	The Basics of Positive Crankcase Ventilation (PCV)
7	https://www.youtube.com/watch?v=_vAtjLil5Y0	MAP Sensor & Wiring Diagram
8	https://www.youtube.com/watch?v=zOM5o6ltxME	Electric Fuel Pump
9	https://www.youtube.com/watch?v=JtYMRrUpZr0	Toyota Corolla Fuel Pump Removal Sending Unit Testing
10	https://www.youtube.com/watch?v=fUZVKFT-U9k	Electric Fuel Pump Comparison | GM OE Fuel Pumps

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students