

AUTOMOBILE AIR CONDITIONING**Course Code : 316349**

Programme Name/s : Automobile Engineering.
Programme Code : AE
Semester : Sixth
Course Title : AUTOMOBILE AIR CONDITIONING
Course Code : 316349

I. RATIONALE

Automobile air conditioning is essential for modern vehicles, enhancing comfort and safety. This course offers a thorough understanding of air conditioning systems, covering principles, components, and operation. Students will gain diagnostic and problem-solving skills to ensure efficient cooling and passenger comfort. Mastering these aspects prepares students to contribute to the development of more efficient and eco-friendly vehicles.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the students to attain the following industry identified outcome through various teaching learning experiences: Maintain air conditioning system for automotive applications using relevant knowledge & skills related to HVAC system.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Interpret the Heating, Ventilation and Air-conditioning system in various environmental conditions.
- CO2 - Illustrate various components of automobile air conditioning system.
- CO3 - Select relevant duct system for vehicles.
- CO4 - Troubleshoot air conditioning control systems
- CO5 - Maintain air-conditioning system.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme						Credits	Assessment Scheme										Total Marks	
				Actual Contact Hrs./ Week			SL	NH	LL		Paper Duration	Theory				Based on LL & TL				Based on SL		
				CL	TL	LL						Practical				Based on SL						
												FA-TH	SA-TH	Total	FA-PR		SA-PR		SLA			
															Max	Min	Max	Min	Max	Min		Max
316349	AUTOMOBILE AIR CONDITIONING	AAC	DSE	4	-	2	-	6	3	3	30	70	100	40	25	10	25#	10	-	-	150	

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.

AUTOMOBILE AIR CONDITIONING**Course Code : 316349****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 Explain the vapour compression refrigeration cycle and its key components TLO 1.2 Distinguish between controlled and uncontrolled ventilation systems on the basis of given parameters TLO 1.3 Explain the effects of air movement, wind chill factor, odor problems, and humidity on human comfort. TLO 1.4 Compare the requirements of heating ventilation and air conditioning (HVAC) systems in light motor vehicles, heavy goods vehicles, and heavy passenger vehicles. TLO 1.5 Describe handling and disposal of refrigerant in automobile safely	Unit - I Overview of HVAC System 1.1 Vapour compression refrigeration cycle and Basic components 1.2 Uncontrolled and controlled ventilation 1.3 Human comfort factors: comfort zone, air movement, wind chill factor, odor problems and effects of humidity. 1.4 Requirements of heating, ventilation and air conditioning system in- light Motor Vehicle, driver cabin of heavy goods vehicle, goods compartment of heavy goods vehicle and heavy passenger motor vehicle 1.5 Environmental and safety aspects in heating, ventilation and air conditioning systems.	Lecture Using Chalk-Board Presentations Demonstration Video Demonstrations
2	TLO 2.1 Explain the operational flow of air and refrigerant within the system. TLO 2.2 Explain the function and operation of the given component of air conditioning system TLO 2.3 Differentiate between reciprocating, scroll, and rotary vane compressors in terms of design, application, and performance. TLO 2.4 Explain the properties of refrigerants used in automotive AC systems TLO 2.5 List different refrigerants used in AC system TLO 2.6 Explain the operation of the electromagnetic clutch in controlling compressor engagement. TLO 2.7 Explain with sketch the construction and working of the given type of metering device of vehicle air conditioning system. TLO 2.8 Explain the throttling action, modulating action, and controlling action in an automotive air conditioning system. TLO 2.9 Explain the working of automotive heating systems in given situation	Unit - II AC System Components 2.1 General layout of automotive air conditioning system , constructional details. 2.2 Types of AC Systems: AC system with thermostatic expansion valve with components evaporator, compressor, condenser, receiver drier, thermostatic expansion valve & its type (internally equalized, externally equalized). 2.3 Throttling action, modulating action and controlling action, remote bulb. 2.4 AC system with orifice tube with components evaporator, accumulator, compressor, condenser, fixed orifice Tube. 2.5 Types of compressor - Scroll compressor, rotary vane compressors. 2.6 Construction and working of electromagnetic clutch. 2.7 Drive systems for compressor for IC engine & electric vehicle. 2.8 Types of automobile refrigerants, properties.	Lecture Using Chalk-Board Model Demonstration Presentations Video Demonstrations Demonstration
3	TLO 3.1 Explain the functions of the air intake section, core section, and distribution section in an automotive air conditioning system. TLO 3.2 Explain the purpose and	Unit - III Case and Duct System 3.1 Air intake section, core section, and distribution section 3.2 Air filter and air blower in A.C. system 3.3 Downstream, upstream, split and hybrid	Lecture Using Chalk-Board Video Demonstrations Presentations

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	operation of air filters and air blowers in AC systems. TLO 3.3 Select case and duct system for the given seating capacity of vehicle with justification. TLO 3.4 Explain with sketch the construction and working of the given type of duct. TLO 3.5 Explain the components and operation of a rear cooling system for given Vehicle.	case & duct systems, case & duct System in electric vehicle. 3.4 Construction and working of rear cooling system 3.5 Air Conditioning system in electric vehicle & hybrid Vehicles 3.6 Heating system: Construction working and functions of I.C, engine vehicle and electric vehicle	Demonstration
4	TLO 4.1 Explain the components and operation of vacuum control systems and electronic temperature control systems. TLO 4.2 Explain the function and operation of given vacuum operated device. TLO 4.3 Explain the function and operation of given switch used in automotive air conditioning systems. TLO 4.4 State the purpose and location of given sensor used in automotive air conditioning systems. TLO 4.5 Explain the function and operation of given AC control devices used in automotive air conditioning systems. TLO 4.6 Compare manual climate control systems and electronic climate control systems.	Unit - IV Vehicle Climate Control Systems 4.1 System controls – Vacuum control system and electronic temperature control system. 4.2 Vacuum operated devices i.e. vacuum reserve tank, vacuum restrictor, vacuum motor, check valve and check relays. 4.3 Switches - High-Side temperature switch, low-side temperature switch, high-pressure switch, low- pressure switch, pressure regulator and superheat switch. 4.4 Sensors- Sunload sensor, outside temperature sensor and in-car temperature sensor. 4.5 A.C. Control devices: aspirator, blower motor speed control, heater control, and time delay relay for heater control. 4.6 Manual climate control system and automatic climate control system.	Lecture Using Chalk-Board Model Demonstration Presentations Video Demonstrations
5	TLO 5.1 List potential faults of AC systems using visual and acoustic methods. TLO 5.2 Write the operating procedure of manifold gauge to measure low-side and high-side pressures in an air conditioning system. TLO 5.3 Describe the procedure to perform a temperature test. TLO 5.4 Explain different leak detection tests and their applications. TLO 5.5 Describe the procedure to check hoses and connectors of an air conditioning system. TLO 5.6 Write the procedure of evacuation and charging procedures for refrigerant charging. TLO 5.7 List common symptoms and faults in an air conditioning system, compressor, electromagnetic clutch and heating system.	Unit - V HVAC System Diagnostic and Repair Procedures 5.1 Inspection of A.C. System: Visual and acoustic, sight glass. 5.2 Service equipment and tools: Vacuum pump, Manifold and gauge i.e. low side and high side, gauge calibration recovery unit and recycling unit, Halide (Freon) and Fluorescent leak detector, Nitrogen leak tester. 5.3 Leak test and Temperature test, Evacuation, Charging of refrigerant and Moisture removal. 5.4 Proper use and safety precautions when working with hoses and connectors. 5.5 Symptoms, Faults, Causes and Remedies in compressor and electromagnetic clutch. 5.6 Maintenance of the heating system in IC engine vehicle and electric vehicle: Fault diagnosis, remedial action.	Lecture Using Chalk-Board Site/Industry Visit Video Demonstrations Presentations

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

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify different processes used in vapour compression cycle Draw the vapour compression cycle P-V and H-S diagram, compressor, condenser, expansion valve, and evaporator.	1	*Basics of vapour compression cycle	2	CO1
LLO 2.1 Identify the different types of environmental effect of automobile heating ventilation and air conditioning (HVAC) system LLO 2.2 Calculate heat transfer by automotive HVAC system	2	Assessment of Environmental Effect of automotive heating ventilation and air conditioning (HVAC) Systems	2	CO1
LLO 3.1 Identify the major components of (HVAC) system used in given type of vehicle LLO 3.2 Draw the layout and arrangement of the HVAC system components in given type of vehicle.	3	* Layout of automobile air conditioning system and sub systems.	2	CO2
LLO 4.1 Identify parts of given at expansion device in an automotive AC system. LLO 4.2 Check the functionality of given expansion valve	4	*Types of expansion devices used in automotive AC system	2	CO2
LLO 5.1 Dismantle a scroll/rotary vane type compressor and identify its components. LLO 5.2 Clean and inspect the compressor components for wear and damage LLO 5.3 Assemble the compressor	5	*Dismantle and assemble Scroll/Rotary vane type Compressor	2	CO2
LLO 6.1 Check case & duct system of IC vehicle /electric vehicle LLO 6.2 Draw various components of the case & duct system in ic vehicle/electric vehicle	6	Types of Case Duct system	2	CO3
LLO 7.1 Identify the different types of air blowers and air filters used in HVAC systems. LLO 7.2 Write procedure of regular maintenance of the air blower and air filter in an HVAC system.	7	*Servicing of air filters and air blowers	2	CO3
LLO 8.1 Check the components and operation of manual and automatic climate control systems LLO 8.2 Differentiate the principles of temperature control and humidity control in manual and automatic climate control systems	8	Comparative Study of Manual & Automatic Climate Control System	2	CO4
LLO 9.1 Identify different types of sensors and switches utilized in AC systems, including their specific functions and applications LLO 9.2 Compare the operational principles and performance characteristics of sensors & switches	9	*Various types of Sensors & Switches used in AC System.	2	CO4
LLO 10.1 Diagnose faults in climate control systems using appropriate diagnostic tools and methodologies. LLO 10.2 Perform corrective action based on service, information and technical resources of given system	10	*Troubleshoot the climate control system of Vehicle	2	CO4
LLO 11.1 Prepare the vehicle's AC system for temperature testing by ensuring it is properly charged with the appropriate refrigerant LLO 11.2 Interpret temperature readings to assess the performance and efficiency of the AC system	11	Perform AC System Temperature test of Given Vehicle	2	CO5
LLO 12.1 Identify various leak detection methods, including soap trace solutions,	12	Leak detection test of automotive A.C. System.	2	CO5

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
electronic leak detectors, halogen leak detectors, and dye solutions LLO 12.2 Perform leak tests on A.C. systems using different detection methods, accurately locating and diagnosing leaks. .				
LLO 13.1 Identify faults within an Air Conditioning control. LLO 13.2 Diagnose faults within an Air Conditioning control	13	* Evacuation & charging of refrigerant in automotive A.C. system	4	CO5
LLO 14.1 Identify components of automotive heating systems, including their functions and interrelationships. LLO 14.2 Carry out repairing of faulty heating system components, ensuring compliance with manufacturer specifications.	14	Troubleshoot of heating system	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)**Not applicable**

- Not applicable

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	Evaporator of Commonly used car A.C. System (any car AC system of 1 Ton Capacity)	1,3
2	Condenser of commonly used car A.C System (any car AC system of 1 Ton Capacity)	1,3
3	Accumulator of commonly used car A C System(any car AC system of 1 Ton Capacity)	1,3
4	Working model of Automobile HVAC system of any Car model Make: car manufacturer in India Power supply: 220 V AC 50 Hz 110 V AC 60 Hz Compressor Scroll / Rotary Vane type Condenser parallel flow type suitable for car Evaporator serpentine type with a thermostatic expansion valve, blower motor, and grill. Receiver with sight glass and other accessories. All ideal controls and safety controls for car ac. Single phase electric motor 2 HP Suitable 12volt battery to run condenser fan, evaporator fan and to operate magnetic clutch of the compressor.	1,3,4

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Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
	Battery Charger to recharge Battery.	
5	Scroll Type, Rotary Vane Type AC Compressor (For Dismantling & Assembly)(any car AC system of 1 Ton Capacity)	1,3,6
6	Digital Temperature Guage (Temp Range -200C to 700C)	12
7	Halide & Fluorescent Refrigerant Leak Detector (HFC Halogen Gas Refrigerant Leak Detector in Automobile Air Conditioning	13
8	Refrigerant tank for R-134a(Capacity 13.6)	13,14
9	Refrigerant Recovery, Recycling, and recharging Machine Power supply: 220 V AC 50 Hz 110 V AC 60 Hz Evacuating air speed of vacuum pump: 4.5 CFM Compressor power: 3/8 HP Accuracy of electronic scale: 5 g Maximum weight of the electronic scale: 50 Kg Drying filter: 500 cc, 3/8 connecting port Capacity of refrigerant tank: 23.5 L 13.6 L Maximum working pressure: 17.5 bar Maximum recovery speed: 0.5 Kg/Min Maximum recharging speed: 2 Kg/Min	14
10	Thermostatic Expansion valve commonly used car A.C System and orifice tube	4,5
11	Electromagnetic Clutch of commonly used car A C System (any car AC system of 1 Ton Capacity)	6
12	Manifold gauge Set, Compressor & Vacuum pump (Single Stage Rotary Vane R134A, 1/3HP Deep Vacuum Pump of Car AC)	6,14
13	Car Heater Blower Assembly	7,8
14	General Purpose Tools (Spanner, Ring Spanner & Socket)(6mm to 32mm)	All

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	Overview of HVAC System	CO1	10	2	6	4	12
2	II	AC System Components	CO2	16	4	6	8	18
3	III	Case and Duct System	CO3	10	2	6	4	12
4	IV	Vehicle Climate Control Systems	CO4	12	4	4	6	14
5	V	HVAC System Diagnostic and Repair Procedures	CO5	12	2	4	8	14
Grand Total				60	14	26	30	70

X. ASSESSMENT METHODOLOGIES/TOOLS**Formative assessment (Assessment for Learning)**

- Two-unit tests of 30 marks and average of two-unit tests.
- For laboratory learning 25 Marks

Summative Assessment (Assessment of Learning)

- End semester assessment of 25 marks for laboratory learning.
- End semester assessment of 70 marks.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and	PO-2 Problem	PO-3 Design/	PO-4 Engineering	PO-5 Engineering	PO-6 Project Management	PO-7 Life	PSO-1	PSO-2	PSO-3

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	Discipline Specific Knowledge	Analysis	Development of Solutions	Tools	Practices for Society, Sustainability and Environment		Long Learning			
CO1	3	--	--	--	3	--	2			
CO2	3	--	--	2	2	2	2			
CO3	3	--	--	--	2	2	2			
CO4	2	2	--	2	2	2	2			
CO5	2	3	--	3	2	2	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	Dwiggins, Boyce H.	Automobile Air Conditioning	Delmar Cengage Learning; 8th Revised edition edition, ISBN: 978-0827358188
2	Haynes, John H. ; Stubblefield, Mike	Automotive Heating & Air Conditioning Manual	Haynes Manuals N. America, Incorporated, 2011 ISBN 1563929139
3	Ananthanarayanan, P. N.	Basic Refrigeration and Air Conditioning	McGraw Hill Education; Fourth edition (2013) ISBN-10: 9781259062704
4	Halderman , J. D.	Automotive Heating and Air Conditioning	Pearson Prentice Hall; 7 edition (2014) ISBN: 978-0133514995
5	Khurmi, R. S. ; Gupta , J. K.	Textbook of Refrigeration & Air conditioning	S. Chand Limited, New Delhi (2008) ISBN: 8121927811, 9788121927819
6	Arora; Domkundwar	Refrigeration and Air-Conditioning	Dhanpatrai & Son's, New Delhi ISBN: 9780000229663

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.youtube.com/watch?v=nHZEae08sE8	Understanding working of HVAC system.
2	https://www.youtube.com/watch?v=I5rrZSu4PxQ	Understanding the working of Car AC
3	https://www.youtube.com/watch?v=Pdq8JAlct6s	Procedure to Recharge refrigerant in AC System
4	https://www.youtube.com/watch?v=F5w3lR88fqQ	Procedure to evacuate refrigerant from AC System
5	https://www.2carpros.com/articles/re-charge-an-air-conditioner-system	Evacuation and charging of A.C. System
6	https://www.youtube.com/watch?v=Yyf30wStUE4	Leak Detection in A.C. System
7	https://www.youtube.com/watch?v=WncHNLdU4EA	Trouble diagnosis of A.C. System
8	https://www.youtube.com/watch?v=FzbM0YoUZgo	Cleaning air conditioner evaporator
9	https://www.youtube.com/watch?v=rulXlnG2Unk	Servicing of Compressor in car
10	https://www.youtube.com/watch?v=UW1GDioa0kE	How To Diagnose Car Air Conditioning Problems

Note :

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

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