GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Mechanical (I.C Engine & Automobile Engineering)

Course / Subject Code : ME01080021

Course / Subject Name : Automobile Refrigeration and Air Conditioning

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	Refrigeration & Air Conditioning at the undergraduate level
Rationale:	This course aims to equip students with an understanding of the basic and advanced concepts of automobile refrigeration and air conditioning systems. The course covers the operation of refrigeration cycles, diagnostic and repair techniques, proper handling of refrigerants, and the operation of air conditioning and heating controls. Students will also learn about maintenance and service procedures for automotive air conditioners, ensuring safety and efficiency in their operation.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level	%Marks Weightage
1	Understand the various methods of refrigeration and their applications in automobiles.	2	15
2	Identify the properties and applications of different refrigerants, including eco-friendly alternatives.	1	10
3	Apply Psychrometric principles and perform load calculations for automotive air conditioning systems.	3	30
4	Comprehend and design various air conditioning systems and their components, specifically for automotive applications.	4	25
5	Perform maintenance, service, and troubleshooting of automotive air conditioning systems, ensuring optimal performance.	5	20

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Unit 1: Introduction** Methods of refrigeration: Vapour compression refrigeration system, Vapour absorption refrigeration system. Applications of refrigeration & air conditioning in automobiles: Air conditioning for passengers, isolated vehicles, transports vehicles. Applications related to very low temperatures.	08	15%
2.	**Unit 2: Refrigerants** Classification of refrigerants, properties, selection criteria. Commonly used refrigerants, alternative refrigerants, eco-friendly refrigerants. Applications of refrigerants, refrigerants used in automobile air conditioning.	07	10%
3.	**Unit 3: Psychrometry and Load Calculations** Psychrometry definitions and processes; Applied Psychrometry for summer and winter air conditioning. Review of refrigeration and air conditioning load calculations: Cooling & heating load calculations for automobiles, factors affecting load. Effect of air conditioning load on engine performance. Human comfort and comfort charts.	12	30%
4.	**Unit 4: Air Conditioning Systems** Classification and layouts: Central and unitary air conditioning systems. Components: Compressors, evaporators, condensers, expansion devices, fan blowers, automotive heaters. Controls used in refrigeration systems, air conditioning protection, engine protection. Distribution duct system: Sizing, supply/return ducts, types of grills, diffusers, ventilation, air noise level. Layout of duct systems for automobiles and their impact on load calculations.	10	25%
5.	**Unit 5: Air Conditioning Service** Air conditioner maintenance & service: Servicing heater systems, removing & replacing components. Troubleshooting of air conditioning systems; Compressor service; Methods of dehydration, charging & testing. Air Conditioning Controls: Common controls such as thermostats,	08	20%

	humidistat's, control dampers, pressure cut-outs, relays.		
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**10**	**20**	**25**	**30**	

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. **Heating & Air Conditioning Systems** – Mitchell Information Services
2. **Refrigeration and Air Conditioning** – Stoecker, McGraw Hill
3. **Automotive Air Conditioning** – Paul Lung, C.B.S. Publisher & Distributor, Delhi.
4. **Modern Air Conditioning** – Harris
5. **ASHRAE Handbook** – Fundamentals, American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
6. MACS Worldwide (Mobile Air Conditioning Society Worldwide) publications and guidelines.
7. **Automotive Air Conditioning** – William H. Crouse & Donald L. Anglin, McGraw Hill, Inc. 1990.
8. **Mitchell Automatic Heating & Air Conditioning Systems** – Michel Information Services, Inc., Prentice Hall, Inc. 1989.
9. **Automotive Air Conditioning** – Paul Weisler, Reston Publishing Co. Inc. 1990.
10. **A Textbook of Refrigeration and Air Conditioning** – Arora and Domkundwar.

(b) Open-source software and website:

Open-Source Software:

- OpenFOAM (Open Field Operation and Manipulation): Website: https://www.openfoam.com/
- FreeCAD: Website: https://www.freecadweb.org/
- KiCad: Website: https://kicad.org/
- OpenModelica: Website: https://www.openmodelica.org/

- ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers):Website: https://www.ashrae.org/
- HVAC-Talk:Website: https://hvac-talk.com/
- HVAC School:Website: https://hvacrschool.com/
- CoolProp:Website: http://www.coolprop.org/
- EnergyPlus:Website: https://energyplus.net/

Suggested Course Practical List:

1. Study of Refrigeration Cycle Components
2. Performance Analysis of Vapour Compression Refrigeration System
3. Experiment on Psychrometric Processes
4. Cooling Load Calculation for an Automobile
5. Study and Measurement of Refrigerant Properties
6. Troubleshooting of Air Conditioning Systems
7. Experiment on Automotive Air Distribution Systems
8. Compressor Service and Maintenance
9. Experiment on Alternative Refrigerants
10. Charging and Testing of Air Conditioning System
11. Study of HVAC Control Systems
12. Experiment on the Impact of Air Conditioning Load on Engine Performance

List of Laboratory/Learning Resources Required:

- Refrigeration and Air Conditioning Test Rig:
- Automotive Air Conditioning System Model:
- Psychrometric Chart and Calculator:
- Refrigerant Charging Station:
- Pressure and Temperature Sensors:
- Digital Manifold Gauge Set:
- Leak Detection Equipment:
- HVAC Control System Trainer:
- Compressor Maintenance Tools:
- Refrigerant Recovery Unit:
- Computer with CAD Software:
- Alternative Refrigerant Samples:
- Airflow Measurement Tools:
- Personal Protective Equipment (PPE):

Suggested Project List:

1. Design and Simulation of an Automotive Air Conditioning System:
2. Performance Comparison of Alternative Refrigerants:
3. Development of a Psychrometric Calculator Tool:
4. Design of a Compact HVAC System for Electric Vehicles:
5. Automated Air Conditioning System Diagnostic Tool:
6. Energy Efficiency Study of Automotive Air Conditioning Systems:
7. Smart HVAC Control System for Automobiles:
8. Integration of Renewable Energy in Automotive HVAC Systems:
9. Development of a Training Simulator for HVAC Systems:
10. Study of Air Conditioning Load Impacts on Engine Performance:
11. Design and Implementation of a Vehicle Air Quality Monitoring System:
12. Development of a Mobile App for HVAC System Troubleshooting:

Suggested Activities for Students: If any

1. Industry Visits:
2. Guest Lectures and Workshops:
3. Case Studies Analysis:
4. Simulation Exercises:
5. Group Projects:
6. Technical Paper Presentations:
7. Design Competitions:
8. Hands-On Maintenance Workshops:
9. Simulation and Modeling Software Training:
10. Interactive Webinars:
11. Field Studies:
12. Problem-Solving Challenges:

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