



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Automobile Engineering

Subject Code: BE05002031

Subject Name: Automotive HVAC

w. e. f. Academic Year:	2024-25
Semester:	5
Category of the Course:	Professional Elective Course - 1

Prerequisite:	Nil
Rationale:	The course is prepared to provide the detailed fundamentals of refrigeration and air conditioning, Study automotive HVAC system components and working, Analyse cooling load and system performance, Learn modern climate control systems used in vehicles, Develop troubleshooting and maintenance skills

Course Outcomes:

Sr. No.	CO statement	Marks% weightage
CO-1	Explain principles of refrigeration cycles used in automobiles	20
CO-2	Describe construction and working of HVAC components	22
CO-3	Analyze heating, ventilation, and air distribution systems	18
CO-4	Evaluate cooling load and performance of HVAC systems	22
CO-5	Diagnose faults and suggest maintenance practices	18

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
L	T	P	PBL	Total no of hours per semester		Theory		Tutorial / Practical			
						ESE (E)	PA / CA (M)	PA/C A (I)	PBL (I)	ESE (V)	
45	00	30	15	120	03	70	30	20	30	50	200

Content:

Sr. No.	Content	Total Hrs
1	Basic of Air Conditioning: HVAC System, Heat and Heat Transfer, Classification of Heat, Rules of Heat Transfer, Factors Affecting Heat Transfer Efficiency, Refrigeration System and cycle, Refrigerants and their properties, Environmental impact (ODP, GWP), Psychrometric properties of air, Psychrometric chart and processes, Automobile Air-conditioning System.	08
	Automotive Air Conditioning System Components: Layout of automotive HVAC system, Compressor: Types and working, Condenser and evaporator, Expansion devices, Blower and air	10



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	distribution system, Receiver-drier and accumulator, Manual HVAC control systems, Refrigerant piping and lubrication, Safety devices and controls	
3	Heating, Ventilation & Air Distribution: Heating systems in automobiles, Engine heat-based heating system, Ventilation requirements, Cabin airflow patterns, Duct design and air distribution, Air filtration and air quality, Defrosting and demisting	8
4	Cooling Load & Performance Analysis: Factors affecting cooling load, Solar heat gain in vehicles, Cooling load estimation methods, Human comfort conditions, Performance parameters, System efficiency and losses, Testing and evaluation, Case studies	8
5	Automatic Climate Control & Advanced Systems: Automatic climate control systems, Sensors and actuators, ECU-based HVAC control, Multi-zone climate control, HVAC in electric and hybrid vehicles, Smart HVAC systems	6
6	Maintenance, Troubleshooting & Future Trends: Common faults and diagnosis, Refrigerant charging and servicing, Leak detection methods, Preventive maintenance, Environmental regulations, Future trends in automotive HVAC	5
Total		45

Suggested Specification table with Marks (Theory): (For B.E. only)

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

R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

The syllabus contributes to Sustainable Development Goals (SDGs)

SDG Goal	Relevance to Automotive HVAC Course
SDG 7: Affordable and Clean Energy	Focus on energy-efficient HVAC systems, improved COP, and reduction in energy consumption in vehicles.
SDG 9: Industry, Innovation and Infrastructure	Emphasizes advanced HVAC technologies, smart climate control, and innovations in electric and hybrid vehicles.
SDG 11: Sustainable Cities and Communities	Enhances passenger comfort while reducing environmental impact through efficient air-conditioning systems.
SDG 12: Responsible Consumption and Production	Promotes use of eco-friendly refrigerants, proper handling, recycling, and sustainable maintenance practices.
SDG 13: Climate Action	Addresses environmental concerns like ODP and GWP and encourages sustainable HVAC design and operation.



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Reference Books:

1. Automobile Engineering (Volume – VI) - Anil Chhikara
2. Automotive Air-conditioning - William H. Carouse & Donald L. Anglin
3. Automotive Air-conditioning - Clifford L. Samuels Prentice Hall Int.
4. Automotive Air-conditioning & Climate control system. - Steven Daly

List of Experiments

1. To study the construction and working of automotive air conditioning system.
2. To study different types of compressors used in automotive HVAC systems.
3. To perform refrigerant charging and recovery in automotive air conditioning system.
4. To determine the coefficient of performance (COP) of an automotive air conditioning system.
5. To study the psychrometric properties of air using psychrometric chart.
6. To estimate the cooling load of a passenger car cabin under given conditions.
7. To study the working of heating and ventilation system in an automobile.
8. To diagnose common faults in automotive air conditioning system.
9. To detect refrigerant leakage using different leak detection methods.
10. To study the HVAC system used in electric and hybrid vehicles.

List of Major Equipment

1. **Automotive Air Conditioning Test Rig**
2. **Refrigerant Charging & Recovery Unit**
3. **Compressor Test Setup / Cut Section Model**
4. **Leak Detection Device**
5. **Psychrometric Apparatus**

List of Open-Source Software/learning website: SWAYAM / NPTEL: Refrigeration & Air Conditioning

1. **List of learning website:** Virtual Labs by IITs (Government of India Initiative) (<https://vlab.co.in/>) – Simulations and experiments related to Automotive HVAC.
2. Reputed Research Journal Website

List of suggested activities for Problem-based Learning (PBL):

Sr. No.	PBL category	Name of the activity	No. of hours	Evaluation Criteria
1.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Mini Project	15h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding,



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				report quality and presentation
2.	Case Study Analysis / Seminar	Seminar	15h (need to be changed as per total PBL hours)	Based on the quality of report and presentation, technical understanding
3.	Micro project	Micro project	8h (need to be changed as per total PBL hours)	Based on the novelty of project, technical understanding, quality of report and demonstration
4.	Industry/Research laboratory visit	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
5.	Video Based Learning	Technical video-based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
6.	Assignment / Technical Writing / Research Writing	Assignment writing. Numerical based assignment is preferable.	5 assignments of 4 h each Total = 20h	Based on the correctness of submitted assignment
7.	Group Discussion / Quiz / Simulation	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB, modeling and Analysis software or any other software	5 small coding-based assignment of 2h each Total = 10h	Based on the coding solution submitted.
8.	Video Based Learning	Self-learning online course	Minimum duration of the course should be 10h	Examination based assessment at the end of course. Based on the certificate produced.
9.	Complex Problem-Solving targeting relevant SDGs / Mini Project	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.



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10.	Video Based Learning	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
11.	Research Paper Review / Analysis	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20h	Summarize research paper and evaluation critical parameters
12.	Poster / Chart / PowerPoint presentation	Poster/chart/power point preparation on technical topics	Duration = 6h	Based on poster/chart preparation and presentation skills
13.	Industry/Research laboratory visit	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15h for industrial exposure Problem identification and tentative solution = 10h Total = 20h	Based on evaluation of critical problems and solutions
14.	Group Discussion / Quiz / Simulation	Group Discussion on emerging/trending technical topics based on subject	Duration = 1h – 3h per topic	Based on performance in group discussion, technical depth, knowledge etc.
15.	Case Study Analysis / Seminar	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
16.	Group Discussion / Quiz / Simulation	Application/Software development	Duration = 10h	Depending on the complexity of the Application/Software
17.	Assignment / Technical Writing / Research Writing	Research paper publication	Duration = 10h	Based on submission of proof of publication
18.	Micro project	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10h	Based on the performance of the equipment
19.	Industry/Research	Expert lecture/session	Duration 3h	Based on the proof



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	laboratory visit		For attending the lecture/session– 2h and for report writing 1h	of attendance and report submitted
20.	Video Based Learning	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
21.	Assignment / Technical Writing / Research Writing	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.
22.	Assignment / Technical Writing / Research Writing	Preparation of a report on Indian Standard(s)	10h (study of Indian Standard(s) + report)	Based on report quality and understanding of the relevant Indian Standard(s).

Note:

1. In alignment with Outcome-Based Education (OBE) and NBA accreditation requirements, the subject **Automotive HVAC compulsorily incorporates Micro Project and 5 marks as PBL activities for PEC and Seminar and Mini Project for PCC.**
These activities are incorporated as integral Project-Based Learning (PBL) components. These activities are designed to foster experiential learning, encourage innovation, and strengthen problem-solving skills by engaging students in practical applications of power converter design, simulation, and analysis. The inclusion of PBL ensures that learners develop higher-order cognitive abilities mapped to Bloom's taxonomy, while simultaneously enhancing teamwork, communication, and research competencies essential for professional engineering practice.
2. The hours allocated to specific activities should be proportionate to the total no. of PBL hours and marks.
3. All the suggested activity should be related to the subject.
4. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
5. Rubrics for the evaluation can be prepared by the faculty.
6. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.
