GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Automobile Engineering
Subject Code: BE04002011
Subject Name: Automobile Engines

w.e.f. Academic Year:	2024-25
Semester:	4
Category of the Course:	Basic Science Course

Prerequisite:	Basic knowledge of Engineering Thermodynamics and Applied Thermodynamics, Familiarity with properties of fuels and fundamentals of heat transfer
Rationale:	Internal Combustion (IC) Engines are the backbone of the automobile, power generation, and transport sectors. Understanding their construction, operation, fuel systems, combustion process, cooling, lubrication, and performance testing is essential for a Mechanical/Automobile engineer. This course develops the student's ability to analyze IC engine performance, diagnose problems, and explore recent advancements such as MPFI, CRDI, turbocharging, and alternative fuels.

Course Outcomes:

At the end of the course, students will be able to:

Sr.No.	CO statement	Marks% weightage
CO-1	Explain the construction, operation, and thermodynamic cycles of IC engines.	15
CO-2	Compare SI and CI engine fuel systems and analyze their working principles.	20
CO-3	Apply knowledge of combustion, cooling, and lubrication to assess engine behavior.	20
CO-4	Analyze engine performance, testing methods, and diagnose engine problems.	25
CO-5	Evaluate advanced concepts like scavenging, supercharging, turbocharging, and recent fuel injection systems.	20

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/CA (I)	PBL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

Content:

Sr.No.	Content	Total Hrs
1	Engine Construction and Operation: Constructional details of 4-stroke engines; Working principle; Otto and Diesel cycle; Valve timing diagrams; Actual indicator diagram; Fuels (Petrol & Diesel), Ignition quality, Octane & Cetane numbers.	5
2	Two-Stroke Engines: Construction and operation; Comparison with four-stroke; Port timing diagrams; Firing order and its significance.	3
3	SI Engine Fuel System: Carburetor working principle; Circuits (starting, idling, acceleration, normal, compensation, maximum power); Constant choke/vacuum carburetors; Fuel feed systems (mechanical/electrical pumps); Petrol injection; LPG & CNG fuel systems; MPFI systems.	6
4	CI Engine Fuel System: Requirements of injection system; Air & solid injection; Jerk & distributor type pumps; Pressure waves, Injection lag; Unit injector; Mechanical & pneumatic governors; Fuel injectors & nozzle types; Spray characteristics; Injection timing; Pump calibration; CRDI systems.	6
5	Cooling & Lubrication Systems: Need for cooling; Liquid cooled, Thermosyphon, Pressure cooling systems; Mist lubrication, Wet sump, Dry sump; Properties of lubricants & coolants.	4
6	Combustion & Combustion Chambers: Combustion in SI & CI engines; Stages of combustion; Flame propagation; Pressure rise; Abnormal combustion, knocking, detonation; Effect of engine variables; Combustion chamber types & design factors.	6
7	Scavenging: Types; Theoretical methods; Scavenging pumps.	2
8	Supercharging & Turbocharging: Necessity; Limitations; Charge cooling; Types & relative merits; Matching of turbochargers.	4
9	Engine Testing & Performance: Automotive and stationary tests; Standards; Engine power & efficiencies.	4

10	Performance Characteristics: Variables affecting performance; Methods to improve performance; Heat balance; Performance maps; Drivability diagnosis.	**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
25	**20**	**20**	**20**	**15**	**-**

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.

ReferenceBooks:

1. V. Ganesan, Internal Combustion Engines, Tata McGraw Hill.
2. M.L. Mathur and R.P. Sharma, Internal Combustion Engines.
3. R.K. Rajput, Thermal Engineering.
4. Heywood J.B., Internal Combustion Engine Fundamentals, McGraw Hill.
5. Domkundwar, IC Engines.

List of Experiments:

1. Study of constructional details of SI & CI engines.
2. Valve timing diagram of a 4-stroke SI/CI engine.
3. Port timing diagram of a 2-stroke SI engine.
4. Performance test on a 4-stroke SI engine.
5. Performance test on a 4-stroke CI engine.
6. Morse test on multi-cylinder petrol engine.
7. Retardation test on diesel engine.
8. Heat balance test on CI engine.
9. Study of carburetor and MPFI system.
10. Study of fuel injection pump and injector (CI engine).
11. Study of CRDI system.
12. Study of cooling systems.
13. Study of lubrication systems.
14. Study of turbocharger/supercharger.
15. Emission measurement test using exhaust gas analyzer.

Major Equipment:

1. Single-cylinder 4-stroke petrol engine test rig

2. Multi-cylinder diesel engine test rig
3. Carburetor model & MPFI trainer kit
4. Fuel injection pump and injector cut-section
5. CRDI system trainer kit
6. Supercharger/turbocharger demo unit
7. Cooling system and lubrication system models
8. Exhaust gas analyzer and smoke meter

List of Open Source Software/learning website:

- **OpenFOAM / Ansys Fluent (for IC engine CFD analysis)**
- **AVL Boost (engine simulation software)**
- **NPTEL Online Courses** – IC Engines, Combustion, Automotive Engineering
- **MIT OpenCourseWare** – Internal Combustion Engines
- **SAE MOBILUS Digital Library**

- **List of suggested activities for Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5hrs., Report preparation = 5hrs. Total = 10hrs.	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numericals based assignment is preferable.	5 assignments of 4hrs. each. Total = 20hrs.	Based on the correctness of submittedassignment.
4.	Problem solving/Coding using C, C++, MATLAB, Python, SCILAB,modeling and Analysis software or any other software	5 small coding-based assignment of 2hrs. each. Total = 10hrs.	Based on the coding solution submitted.
5.	Self-learning online course	Minimum duration of the course should be 10hrs.	Examination based assessment at the end of course. Based on the certificate produced.
6.	Identification and solution of Complex problem	Maximum 2 problems. Study of the problem and solution finding, Total = 10hrs.	Based on the depth of the solution submitted.
7	Videos on Industrial safety/Disaster Management aspects based on subject	Duration of video = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on quiz/report submitted
8	Technical paper reading and summarization of research papers based on relevant subject	5 research papers = 20 hrs.	Summarize research paper and evaluation critical parameters
9.	Poster/chart/power point preparation	Duration = 6 hrs.	Based on poster/chart

	on technical topics		preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 hrs. Non- working = 8 hrs.	Based on inter department/external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/sustainability/any other issue	Duration = 15 hrs. for industrial exposure Problem identification and tentative solution = 10 hrs. Total = 20 hrs.	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration = Min. 1 hr.per subject. Max. 3 hrs. per subject	Based on performance in group discussion, technical depth, knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5hrs. Report preparation = 5hrs. Total = 10hrs.	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration = 10 hrs.	Depending on the complexity of the Application/Software
15.	Research paper publication	Duration = 10 hrs.	Based on submission of proof of publication
16.	Upgradation/Reverse engineering studies of existing equipment of the laboratory	Duration 10 hrs.	Based on the performance of the equipment
17.	Expert lecture/session	Duration 3 hrs. For attending the lecture/session– 2 hrs. and for report writing 1 hr.	Based on the proof of attendance and report submitted
18.	Annotated Video Explanation of Concept/Problem	10h (Preparation + Recording + Submission)	Based on accuracy of explanation, clarity, and presentation style.
19.	Patent Search and Innovation Gap Identification	10h (Search + Report)	Based on number of relevant patents analyzed and identification of innovation scope.

Note:
1. All the suggested activity should be related to the subject.
2. The number of hours are suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
3. Rubrics for the evaluation can be prepared by the faculty.
4. Subject teacher can add the relevant activities other than those listed above, with the consent of head of the department and DQAC.

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