GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Mechanical Engineering (Thermal Engineering)

Course / Subject Code : ME01083011

Course / Subject Name : Advanced Internal Combustion Engines

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

Prerequisite:	Nil
Rationale:	The course is designed to provide the detailed understanding of internal combustion engines, its performance and emissions under various conditions.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT level
1	Explain the operating characteristics of IC engines and to utilize theory of reactive system and combustion analysis of IC engines	Understand/ Apply
2	Apply ideal models of IC engine cycles and identify gas exchange process of IC engines	Apply
3	Experiment with different IC engines, identify the generation of undesirable exhaust emissions and ways to reduce them and to choose appropriate alternate fuels for IC engines	Apply/ Evaluate
4	Analyze various heat transfer mechanisms in the engine and explain recent developments in IC Engines.	Analyze/ Understand

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.	**Engine Design and Operating Parameters:** Engine operating cycles, spark ignition engine operation, compression ignition engine operation, geometrical properties of reciprocating engine, brake torque and power, mechanical efficiency, mean effective pressure, specific fuel consumption, air/fuel and fuel/air ratio, specific emission and emission index, engine design and performance data	4	10
2.	**Reactive Systems:** Stoichiometric equation for fuel air reaction, equivalence ratio, enthalpy of formation, first law analysis for steady state reacting system, enthalpy of combustion, internal energy of combustion and heating values, adiabatic combustion temperature, dissociation, chemically reacting gas mixture	5	10
3.	**Ideal Models of Engine Cycles:** Ideal models of engine processes, thermodynamic relations for engine processes, constant volume cycle, constant pressure cycle, basics of simulation in SI and CI Engine cycles, real engine cycles	4	10
4.	**Gas Exchange Processes:** Flow through valves, phase of the flow, scavenging in two stroke cycle engines, turbulence, swirl, squish, flow in intake manifolds, analysis of suction and exhaust processes, fuel injection systems, supercharging, turbocharging	4	10
5.	**Combustion:** Combustion in SI engine with homogeneous air –fuel mixture, ignition and flame development, flame propagation and termination in SI engines, octane number, MPFI, combustion in CI engines, ignition delay, cetane number, cold weather problems, fuel spray structure, spray penetration and evaporation	5	10
6.	**Emission from IC Engines and its Control:** Formation of nitrogen oxides, carbon monoxide, hydrocarbon emission in petrol and diesel engines, SI and CI engine particulates, soot formation and control, exhaust gas temperature, catalytic convertor, Indian emission standards for SI and CI engines	5	10
7.	**Alternate Fuels for IC Engines:** Fuels and their properties : hydrogen, bio gas, alcohols, producer gas, LPG, CNG, non-edible vegetable oils, nonedible wild oil, NH_3 as substitute fuel for SI and CI engine, fuel additives, pros and cons of alternate fuels, biodiesel processing and production, fuels rating, coal gasification & liquefaction	4	10

8.	**Heat Transfer, Friction and Lubrication in IC Engines:** Convective and radiative heat transfer, thermal loading on components, friction fundamentals, engine friction components, lubricant requirement, lubrication system	5	10
9.	**Measurements and Testing of IC Engines:** Measurement of friction power, indicated power, brake power, fuel consumption, air consumption, emission, noise, endurance test of IC engines as per Indian standards	5	10
10.	**Recent Developments in IC Engines:** PIV in turbulence measurement, optical methods for flame velocity measurement, new materials for engine components, improved two stroke engines, hybrid engines and vehicles, lean burn engines, stratified charge engines, HCCI engines	4	10
	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**
-	**20**	**50**	**10**	**20**	

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. Internal Combustion Engine Fundamentals by John B. Heywood, McGraw Hill Education Pvt Ltd.
2. Fundamentals of Internal Combustion Engines by H N Gupta, PHI Learning
3. Internal Combustion Engine by V Ganeshan, McGraw Hill Education Pvt Ltd.
4. Internal Combustion Engine by M L Mathur and R P Sharma, Dhanpat Rai Publications (P) Ltd.
5. Internal Combustion Engines: Applied Thermo-sciences, Colin R Ferguson, John Wiley and Sons.

(b) Open-source software and website:

1. http://nptel.ac.in/
2. http://ocw.mit.edu/
3. http://www.catool.org

Suggested Course Practical List:

1. To perform variable speed test of a multi / single cylinder petrol / diesel engine as per IS standard and prepare the curves of (i) BP, IP, FP Vs Speed (ii) Indicated specific fuel consumption Vs Speed
2. To find the indicated power on multi cylinder diesel engine / petrol engine by Morse test.
3. To find friction power of multi cylinder diesel engine / petrol engine by Willian's line method or motoring method.
4. To evaluate comparative performance of CI engine operated with Diesel and Diesel/Biodiesel blend.
5. To study about first law analysis for steady state reacting system and combustion stoichiometric.
6. To prepare heat balance sheet on multi cylinder diesel engine / petrol engine.
7. To study the effect of A/F ratio on the performance of the two-stroke single cylinder petrol engine.
8. To analyze the exhaust gases emission from single / multi cylinder petrol engine.
9. To study and draw the valve timing diagram four stroke petrol and diesel engine.
10. To prepare a report on Indian emission norms.
    It is desirable to arrange a student visit of any Diesel Power Plant.

List of Laboratory/Learning Resources Required: Multi / single cylinder four stroke petrol engine, Multi / single cylinder four stroke diesel engine, Multi / single cylinder Two stroke petrol engine, Exhaust gas analyzer

Suggested Project List:

Suggested Activities for Students: Students are required to download 3-5 research papers from reputed international journals on the recent advancement in the areas of internal combustion engines. They need to go through the same and prepare a review for the research papers. The review should have three parts: Summary, Critical Evaluation and Creative synthesize

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