

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL (THERMAL ENGINEERING) (21)

ADVANCED INTERNAL COMBUSTION ENGINE

SUBJECT CODE: 2722107

SEMESTER: II

Type of course: Core Course

Prerequisite:

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

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
				ESE (E)	PA (M)	ESE (V)		PA(I)		
		ESE	OEP			PA	RP			
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No	Topics	Teaching Hrs	Module 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	5	6
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	6	12
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	6	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	5	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	6	12

	and evaporation		
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	5	8
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	6	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	6	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	6	12

Reference 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

Course Outcome:

After learning the course the students should be able to:

- Understand the operating characteristics of IC engines.
- Perform a thermodynamic analysis of IC engine cycles.
- Perform a combustion analysis of IC engines.
- Understand the generation of undesirable exhaust emissions and ways to reduce them
- Understand the various heat transfer mechanisms in the engine.

List of experiments:

1. To study the constructional details and working principal of IC engines.
2. To prepare variable speed performance test of a multi / single cylinder petrol / diesel engine and prepare the curve:
 - (i) BP, IP, FP Vs Speed
 - (ii) Indicated specific fuel consumption Vs Speed
3. To find the indicated horse power on multi cylinder diesel engine / petrol engine by Morse test.
4. To find friction horse power of multi cylinder diesel engine / petrol engine by Willian's line method and motoring method.
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.

Open Ended Problem:

1. To prepare velocity contour plot on a cut through the intake valve within the intake stroke.
2. Stress Analysis and Optimization of Crankshafts
3. To study about improvement in efficiency of internal combustion engine.

Equipments:

1. Multi / single cylinder four stroke petrol engine
2. Multi / single cylinder four stroke diesel engine
3. Multi / single cylinder Two stroke petrol engine
4. Multi / single cylinder Two stroke diesel engine
5. Exhaust gas analyzer

Websites:

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

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.