

GUJARAT TECHNOLOGICAL UNIVERSITY

MECHANICAL ENGINEERING (19) INTERNAL COMBUSTION ENGINE SUBJECT CODE: 2161902 B.E. 6th SEMESTER

Type of course: Fundamental

Prerequisite: Elements of Mechanical Engineering

Rationale: The course is designed to provide the detailed understanding of internal combustion engine mainly based on its performance and emission parameters.

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)	
				PA	ALA	ESE	OEP			
3	0	2	5	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction: Basic components and terminology of IC engines, working of four stroke/two stroke - petrol/diesel engine, classification and application of IC engines, engine performance and emission parameters	2	5
2	Fuel Air Cycles and Actual Cycles: Assumptions for fuel–air cycles, Reasons for variation of specific heats of gases, change of internal energy and enthalpy during a process with variable specific heats, isentropic expansion with variable specific heats, effect of variable specific heats on Otto, Diesel and Dual cycle, dissociation, comparison of air standard and fuel air cycles, effect of operating variables, comparison of air standard and actual cycles, effect of time loss, heat loss and exhaust loss in Petrol and Diesel engines, valve and port timing diagrams	7	15
3	Combustion: Combustion equations, stoichiometric air fuel ratio, enthalpy of formation, adiabatic flame temperature, determination of calorific values of fuels – calorimeter*- Bomb and Junkers gas calorimeter	4	10
4	Fuels and its supply system for SI and CI engine: Important qualities of IC engine fuels, rating of fuels, Carburation, mixture requirement for different loads and speeds, simple carburetor and its working, types of carburetors, MPFI, types of injection systems in CI engine, fuel pumps and injectors, types of nozzles, spray formation	4	10

* To be covered during laboratory sessions.

5	Ignition and Governing System: Battery and magneto ignition system, spark plug, firing order, quality, quantity & hit and miss governing	4	10
6	Supercharging: Need for supercharging, Effect of supercharging, types of supercharger, methods of supercharging, thermodynamic analysis of supercharged engine cycle, limitations of supercharging, turbocharging	4	10
7	Combustion in SI and CI Engines: Stages of combustion in SI engines, abnormal combustion and knocking in SI engines, factors affecting knocking, effects of knocking, control of knocking, combustion chambers for SI engines, Stages of combustion in CI engines, detonation in C.I. engines, factors affecting detonation, controlling detonation, combustion chamber for SI and CI engine	7	15
8	Engine Lubrication and Cooling: Lubrication of engine components, Lubrication system – wet sump and dry sump, crankcase ventilation, Types of cooling systems – liquid and air cooled, comparison of liquid and air cooled systems	3	8
9	Measurement and Testing of IC engines: Measurement of indicated power, brake power, fuel consumption and emission, Measurement of friction power by Willan’s Line Method* and Morse Test*, calculation of brake thermal efficiency, brake power and brake specific fuel consumption of IC Engines, variable compression ratio engines, heat balance sheet of IC Engines	4	10
10	Engine Emission and their control: Air pollution due to IC engines, Euro I to VI norms, HC, CO and NO _x emission, catalytic convertor	2	5
11	Application of diesel engines in power field, merit and demerits of diesel engine power plants, layout of diesel engine power plants	1	2

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	10	17	18	11	7

Legends: 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.

Reference Books:

1. Internal Combustion Engine Fundamentals by John B. Heywood, McGraw Hill Education Pvt Ltd.
2. Internal Combustion Engine by V Ganeshan, McGraw Hill Education Pvt Ltd.
3. Internal Combustion Engine by M.L.Mathur and R.P.Sharma, Dhanpat Rai Publications (P) Ltd.
4. Fundamentals of Internal Combustion engine by H.N.Gupta, PHI Learning.
5. Internal Combustion Engines 2nd Edition by Colin Ferguson and Allan Kirkpatrick, Wiley India Pvt. Ltd.

Course Outcome:

After learning the course the students should be able to:

- Do in-depth cycle analysis for different types of engines.
- Analyze fuel supply systems, ignition and governing systems of IC Engines.
- Understand combustion process of SI and CI Engines.
- Measure operating characteristics of IC Engines.
- Compare the experimental results with theoretical trends.

List of Experiments (Any Ten):

1. Determination of valve timings for four stroke Petrol/Diesel Engine.
2. Study about ignition and governing system of I C engines.
3. Study about supercharging and turbo charging of I C engines.
4. Study about various methods for measurements and testing of I C engines.
5. Study about engine emissions and their control.
6. Performance test of 2 stroke Petrol Engine.
7. Performance test of 4 stroke Petrol Engine.
8. Performance test of 2 stroke Diesel Engine.
9. Performance test of 4 stroke Diesel Engine.
10. Determination of friction power of multi cylinder petrol engine using Morse Test Method.
11. Determination of friction power of single/multi cylinder petrol engine using Willan's Line Method.
12. Calibration of fuel injector for optimized fuel injection pressure.
13. Measurement of calorific value for solid/liquid/gaseous fuel.

Design based Problems (DP)/Open Ended Problem:

1. Develop a working model of stirling engine
2. Develop a working model of wankle engine
3. Develop a working model of six stroke engine

Major Equipment:

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
6. Model for fuel supply system of petrol and diesel engine
7. Cut section models of various carburetors
8. Model of battery and magneto ignition system
9. Model of engine cooling system
10. Model of engine lubricating system

List of Open Source Software/learning website:

1. <http://nptel.ac.in/>
2. <http://ocw.mit.edu/>

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.