

<b>ME- 442</b>	<b>INTERNAL COMBUSTION ENGINES</b>	<b>L-T-P-CH-CR: 3-0-0-3-3</b>	<b>Prerequisites: Thermodynamics</b>
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## **Course Instructor: Dr Barnali Chowdhury**

### **Course Objectives:**

- i. To understand the engine fundamentals, operation and performance under various design and operating conditions.
- ii. To understand thermodynamic efficiencies and losses associated with internal combustion engines.
- iii. To acquaint with fuel and air supply systems, injection and ignition systems.
- iv. To understand the combustion phenomena and emissions in SI and CI engines.
- v. To provide knowledge on various alternative fuels and modern trends.

### **Course Contents:**

#### **Unit 1: Introduction:**

Basic components and terminology, classification and application of IC engines, working of two- and four-stroke engines.

SI and CI engine components and their working, engine design and operating parameters and their effects on engine performance, mean effective pressure, efficiency and specific fuel consumption.

**(3 lectures)**

#### **Unit 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, Pressure-crank angle diagram, valve and port timing diagrams. **(5 lectures)**

#### **Unit 3: Combustion stoichiometry:**

Combustion equations, stoichiometric air fuel ratio, enthalpy of formation, adiabatic flame temperature, determination of calorific values of fuels. Calorimeters.

**(5 lectures)**

#### **Unit 4: Fuels and its supply system for SI and CI engine:**

Important qualities of IC engine fuels, rating of fuels, Carburetion, mixture requirement for different loads and speeds, carburetor and its working, Injection systems in CI engine. Nozzles and spray formation

**(4 lectures)**

#### **Unit 5: Ignition and Governing System**

Battery and magneto ignition system, spark plug, firing order, quality, quantity. Governing systems.

**(3 lectures)**

#### **Unit 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 lectures)**

#### **Unit 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.

**(4 lectures)**

**Unit 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 lectures)**

**Unit 9: Measurement and Testing of IC engines:**

Measurement of indicated power, brake power, fuel consumption and emission, Measurement of friction power, calculation of brake thermal efficiency, brake power and brake specific fuel consumption, heat balance sheet of IC Engines.

**(3 lectures)**

**Unit 10: Engine Emission and their control:**

Air pollution due to IC engine emissions, Euro I to VI norms, BS VI norms. Formation of NO<sub>x</sub>, HC, CO and particulate emissions. Methods of controlling emissions; Catalytic convertors; particulate traps. Exhaust Gas Recirculation.

Modern concepts of HCCI and GDI engines

**(3 lectures)**

**Unit 11: Alternative Fuels:** Alcohol, Hydrogen, Natural Gas, LPG, CNG, Biodiesel, batteries, fuel cell etc. and their behavior in engines.

**(2 lectures)**

**Textbooks**

1. Ganesan, V. *Internal combustion Engines*, 3rd ed., Tata McGraw Hill, New Delhi, 2008.
2. Heywood, J. B. *Internal Combustion Engine Fundamentals*, 2nd ed., McGraw-Hill Education, 2018.

**Reference Books**

1. Mathur R.P. & Sharma, M.L. *Internal combustion Engines*, 2nd ed., Dhanpat Rai Pub., New Delhi, 2005.
2. Ferguson, C.R. & Kirkpatrick, A.T., *Internal Combustion Engines*, John Wiley & Sons, 2001.
3. Pundir, B. P. *IC Engines Combustion and Emissions*, Narosa Publishing, New Delhi, 2010.
4. Stone, R. *Introduction to Internal Combustion Engines*, 3rd ed., The Macmillan Press Limited, London, 1999.
5. Pulkrabek, W. W. *Engineering Fundamentals of the Internal Combustion Engine*, 2nd ed., Prentice Hall, 2006.

**Evaluation Plan**

Test No.	Marks	Type	Duration (minutes)	To be completed within
Sessional Test I	10	Assignments	-	18.02.2025
Mid-Semester examination	30	Written	90	29.03.2025
Sessional Test II	10	Seminar/written/quiz	-	30.04.2025
End-Semester Examination	50	Written	120	31.05.2024
<b>Total Marks</b>	<b>100</b>			

All the examinations/tests will be held as per the Tezpur University notified Academic Calendar.

## **Pedagogy**

Teaching-learning methods to be used:

- Lecture and Discussion
- Visit to the IC Engines lab
- Video lectures
- Problem solving sessions
- Assignment problems
- Class Tests/Quiz

## **Course Outcomes:**

After successful completion of the course, the students would be able to

- CO1. Identify the factors that affect engine performance.
- CO2. Explain phenomena of fuel combustion and engine emissions.
- CO3. Evaluate torque, power and fuel efficiency of an IC Engine and determine how these parameters change with load.
- CO4. Carry out performance analysis of various IC engines