

Course Code	Course Name	Credits
<b>MEC502</b>	<b>Thermal Engineering</b>	<b>03</b>

### Objectives

1. To study the heat transfer concepts applicable for steady state and transient conditions.
2. To study mathematical modeling and design concepts of heat exchangers.
3. To familiarize with the working of S.I. and C.I. engines and their performance.

### Outcomes: Learner will be able to...

1. Analyze the three modes of heat transfer in engineering application.
2. Develop mathematical models for different modes of heat transfer.
3. Analyze performance parameters of different types of heat exchangers.
4. Identify and analyze the Transient heat Transfer in engineering applications.
5. Explain construction and working of different components of internal combustion engines.
6. Evaluate engine performance and emission characteristics.

Module	Details	Hrs
<b>1</b>	<p>1.1. <b>Modes of Heat Transfer:</b> Mechanism of conduction, Convection and radiation heat transfer and it's Governing laws.</p> <p>1.2. Generalized heat conduction equation in rectangular, cylindrical and spherical coordinates (only equations for cylindrical and spherical coordinates, no derivation).</p> <p>1.3. Steady state heat conduction through plane wall, composite wall, cylinder, composite cylinder, sphere and composite sphere. Thermal contact resistance. Critical radius of insulation in cylinder and sphere.</p>	<b>07</b>
<b>2</b>	<p>2.1 <b>Heat transfer from Extended Surfaces:</b> Types of extended surfaces and its significance. Governing differential equation for fin (Finite, Infinite, and Insulated tips) and its solution. Fin efficiency and effectiveness. Analysis of Thermometric well.</p> <p>2.2 <b>Unsteady state heat transfer:</b> Lumped heat capacity Analysis. Applications of unsteady state heat transfer, Thermal time constant.</p>	<b>06</b>
<b>3</b>	<p>3.1 <b>Convection:</b> Free and Forced convection. <b>External Flow:</b> Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate. <b>Internal Flow:</b> Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes. General thermal analysis: Constant heat flux and constant surface temperature.</p> <p>3.2 <b>Boiling and Condensation:</b> Introduction to Different boiling regimes, Film condensation, Drop wise Condensation.</p> <p>3.3 <b>Radiation:</b> Basics laws of radiation and heat exchange between two bodies.</p>	<b>07</b>

<b>4</b>	<p>4.1 <b>Mass Transfer:</b> Introduction to Mass Transfer, governing equations of mass transfer. Mass transfer coefficient.</p> <p>4.2 <b>Heat Exchangers:</b> Types of heat exchangers, Overall heat transfer coefficient, LMTD, Effectiveness, Effectiveness – Number of Transfer Unit (<math>\epsilon</math>- NTU) method, Correction factor for multi pass (up to 2 passes on shell and tube side) and cross flow heat exchanger.</p>	<b>07</b>
<b>5</b>	<p>5.1 Introduction to I.C. Engines and its Classification. Working of Four stroke and Two-stroke engines, Valve Timing Diagram. Fuel air cycles, Actual cycle.</p> <p>5.2 Introduction to Fuel Supply, Ignition, combustion and knocking in SI Engines. MPFI in SI Engine.</p> <p>5.3 Introduction to Fuel Injection system, Combustion and detonation in CI Engines.</p>	<b>06</b>
<b>6</b>	<p>6.1 <b>Engine Testing and Performance:</b> Measurement of various performance parameters, Performance characteristic of SI and CI Engine, Effect of load and speed on performance parameters, Heat balance sheet.</p> <p>6.2 <b>Engine Emission and Control:</b> Sources of Engine Emissions, Constituents of S.I. and C.I. Engine exhaust and their effects on environment and health. Study of emission (Euro &amp; Bharat stage) norms, Control methods for S.I and C I engine emissions.</p>	<b>06</b>

**Assessment:**

**Internal Assessment for 20 marks:**

Consisting **Two Compulsory Class Tests**

First test based on approximately 40% of content and second test based on remaining content (approximately 40% but excluding contents covered in Test I)

**End Semester Examination:**

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20marks**
2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module3)
4. Only Four questions need to be solved.

### **Text/Reference Books:**

1. Fundamentals of Heat and Mass Transfer by F.P. Incropera and D P deWitt, Wiley India 3rd Edition.
2. Introduction to thermodynamics and Heat transfer by YunusACengel 2ndEdition, McGraw Hill.
3. Fundamentals of Heat and Mass Transfer, M. Thirumaleshwar, Pearson Education India, 2009.
4. Introduction to Heat Transfer, Som S. K ,PHI Publication.
5. Heat Transfer by P S Ghoshdastidar, 2nd Edition, Oxford University Press.
6. Heat and Mass Transfer, by R Rudramoorthy and L Malaysamy, 2nd Edition, PEARSON.
7. Heat Transfer by J P Holman, McGraw Hill.
8. Heat Transfer by S P Sukhatme, University Press.
9. Heat and Mass Transfer by PK Nag, TMH.
10. Internal Combustion Engines, Willard W.Pulkrabek, Pearson Education.
11. Internal Combustion Engines, Shyam Agrawal, New Age International
12. Internal Combustion Engine, Mathur and Sharma
13. Internal Combustion Engines, Mohanty, Standard Book House
14. Internal Combustion Engine, Gills and Smith
15. Internal Combustion Engines Fundamentals, John B. Heywood , TMH
16. Internal Combustion Engines, Gupta H N, 2<sup>nd</sup> ed, PHI
17. Internal Combustion Engine, V Ganesan, TMH
18. Introduction to Internal Combustion Engines, Richard Stone, Palgrave Publication, 4<sup>th</sup> Edition
19. Internal Combustion Engine, S.L. Beohar
20. Internal Combustion Engine, P.M Heldt.
21. Internal Combustion Engine, E.F. Oberi.
22. Internal Combustion Engine by Domkundwar

### **Links for online NPTEL/SWAYAM courses:**

<https://nptel.ac.in/courses/112/101/112101097/> - Heat and Mass Transfer, IIT Bombay

<https://nptel.ac.in/courses/112/105/112105248/> - Heat Exchangers: Fundamentals and Design Analysis, IIT Kharagpur

<https://nptel.ac.in/courses/112/104/112104033/> - Engine Combustion, IIT Kanpur

<https://nptel.ac.in/courses/112/103/112103262/> - IC Engines and Gas Turbines, IIT Guwahati