

**Module 1**

**Chapter 1 : Modes of Heat Transfer and Heat Conduction 1-1 to 1-68**

**Syllabus :** Modes of Heat Transfer : Mechanism of conduction, Convection and radiation heat transfer and it's Governing laws. Generalized heat conduction equation in rectangular, cylindrical and spherical coordinates (only equations for cylindrical and spherical coordinates, no derivation). 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.

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1.1.1 Application Areas of Heat Transfer ..... 1-2

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1.5.4 Thermal Conductivity of Materials ..... 1-5

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1.6.1 Heat Conduction in a Thick wall with Variable Thermal Conductivity ..... 1-9

1.6.2 Thermal Diffusivity,  $\alpha$  ..... 1-9

**1.7 Analogy between Heat Conduction and Electricity (Concept of Thermal Resistance in Heat Transfer)..... 1-10**

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**1.8 Convection..... 1-10**

1.8.1 Coefficient of Convective Heat Transfer ..... 1-11

1.8.2 Newton’s Law of Cooling ..... 1-12

**1.9 Radiation ..... 1-12**

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1.9.2 Emissivity ( $\epsilon$ ) ..... 1-13

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1.10.2 Kirchoff’s Law ..... 1-13

1.10.3 Stefan-Boltzmann Law ..... 1-13

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**1.18 One Dimensional (Radial) Steady State Heat Conduction through Hollow Sphere without Heat Generation ..... 1-26**

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**Module 2**

**Chapter 2 : Heat Transfer from Extended Surfaces (FINS) and Unsteady State Heat Transfer 2-1 to 2-44**

**Syllabus : Heat transfer from Extended Surfaces:** 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. **Unsteady state heat transfer:** Lumped heat capacity Analysis. Applications of unsteady state heat transfer, Thermal time constant.

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**2.2 Extended Surfaces-Fins ..... 2-1**

**2.3 Types of Fins and Applications..... 2-2**

**2.4 Analysis of Fins of Uniform Cross-Sectional Area (Rectangular Plate Fin / Pin Fin) ..... 2-3**

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2.4.2 Case II : Adequately Long Fin with Insulated End Tip ..... 2-5

2.4.3 Case III : Analysis of Short Fin..... 2-6

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2.5.1 Overall Fin Effectiveness (  $E_0$  ) ..... 2-8

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**2.7 Concept of Thermo Well and Error in Temperature Measurement by Thermometer..... 2-9**

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**2.11 Use of Heisler Charts in Transient Heat Conduction Problems .....2-31**

**Module 3**

**Chapter 3 : Convection 3-1 to 3-57**

**Syllabus : Convection :** Free and Forced convection.

**External Flow :** Velocity Boundary layer and Thermal Boundary layer, Laminar and turbulent flow over a flat plate.

**Internal Flow :** Velocity Boundary layer and Thermal Boundary layer, Laminar and Turbulent flow in tubes.

**General thermal analysis:** Constant heat flux and constant surface temperature.

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3.2.1 Applications..... 3-2

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**3.5 Newton’s Law of Cooling ..... 3-4**

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3.6.1 Heat Transfer In Forced Convection is Higher Than Natural convection..... 3-5

**3.7 Boundary Layer Concept ..... 3-6**

**3.8 The Thermal Boundary Layer ..... 3-7**

3.8.1 Heat Transfer Coefficient ..... 3-8

3.8.2 Mean Film Temperature or Reference Temperature ( $T_{mf}$ ) ..... 3-9

**3.9 Velocity Boundary Layer Development in Circular Pipes in Forced Convection ..... 3-9**

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3.9.2 Turbulent Flow through Pipe ( $Re > 4000$ ) ..... 3-10

**3.10 Thermal Boundary Layer in Circular Pipes ..... 3-10**

**3.11 Method of Finding Convective Heat Transfer Coefficient..... 3-11**

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**Chapter 4 : Boiling and Condensation 4-1 to 4-8**

Introduction to Different boiling regimes, Film condensation, Drop wise Condensation.

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**4.2 Condensation ..... 4-1**

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4.3.1 Modes/Methods of Boiling..... 4-3

**4.4 Regimes of Pool Boiling ..... 4-4**

4.4.1 Critical Heat Flux..... 4-6

**4.5 Forced Convection Boiling..... 4-6**

**Chapter 5 : Radiation 5-1 to 5-45**

**Syllabus** : Basics laws of radiation and heat exchange between two bodies.

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**5.2 Theories of Radiation ..... 5-1**

5.2.1 Wave or Maxwell Theory ..... 5-1

5.2.2 Quantum Theory or Planck's Theory ..... 5-2

**5.3 Total Emissive Power of a Surface (E)..... 5-2**

**5.4 Basic Concepts and Definitions..... 5-2**

5.4.1 Properties of Radiation ..... 5-3

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5.9.3 Application Shape Factor for Standard Configurations and Radiant Heat Exchange..... 5-16

**5.10 Heat Exchange Between Grey Bodies..... 5-17**

5.10.1 Net Radiation Heat Exchange from A Surface and Electrical Analogy : (Radiosity-Irradiation Approach) ..... 5-18

5.10.2 Net Heat Exchange between Two Grey Bodies/Surfaces..... 5-18

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5.11.3 Radiation Heat Exchange between Two Concentric Spheres ..... 5-20

**5.12 Radiation Shields ..... 5-20**

**Module 4**

**Chapter 6 : Mass Transfer and Heat Exchangers 6-1 to 6-63**

**Syllabus : Mass Transfer :** Introduction to Mass Transfer, governing equations of mass transfer. Mass transfer coefficient.

**Heat Exchangers :** Types of heat exchangers, Overall heat transfer coefficient, LMTD, Effectiveness, Effectiveness – Number of Transfer Unit ( $\epsilon$ - NTU) method, Correction factor for multi pass (up to 2 passes on shell and tube side) and cross flow heat exchanger.

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**6.2 Modes of Mass Transfer..... 6-1**

6.2.1 Mass Transfer by Diffusion..... 6-1

6.2.2 Mass Transfer by Convection ..... 6-2

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6.3.3 Fluxes ..... 6-4

**6.4 A Physical Law for Diffusion – Fick’s Law ..... 6-5**

**6.5 General Mass Diffusion Equation in Cartesian Co-ordinates in Stationary Medium ..... 6-9**

6.5.1 Specific Cases of Mass Diffusion Equation.....6-10

**6.6 Steady State Equimolar Counter Diffusion ..... 6-10**

**6.7 Molecular Diffusion Through a Stagnant Gas Film (Isothermal Evaporation From Liquid into Air From Surface)..... 6-11**

**6.8 Comparison Between Fick’s Law of Diffusion and Fourier’s Law of Heat Conduction ..... 6-13**

6.8.1 Dimensionless Parameters As Applied to Convective Mass Transfer .....6-14

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6.11.2 Heat Exchangers According to Heat Transfer Process.....6-21

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**6.18 Design Aspects of Heat Exchanger and It's Selection..... 6-40**

**Module 5**

**Chapter 7 : Constructional Features and Working of IC Engines 7-1 to 7-40**

**Syllabus :** Introduction to I.C. Engine and its Classification. Working of Four stroke and Two-stroke engines, Valve Timing Diagram. Fuel air cycle, Actual Cycle.

**7.1 Internal Combustion (I.C.) Engines..... 7-1**

7.1.1 Comparison between External and Internal Combustion Engines ..... 7-1

7.1.2 Applications of I.C. Engines ..... 7-2

**7.2 Engine Components ..... 7-3**

7.2.1 Materials for Main Components of I.C. Engine ..... 7-5

7.2.2 Valve Mechanism..... 7-6

7.2.3 Valve Mechanism for Valves in Engine Block..... 7-6

7.2.4 Valve Mechanism for Overhead Valves in Engine Cylinder..... 7-6

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7.5.2 Working of Four Stroke C.I. Engine or Diesel Engines ..... 7-13

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7.7.2 Working of Two Stroke C.I. (Diesel) Engine..... 7-18

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<b>Chapter 8 : Fuel Supply, Ignition and Combustion</b>			8.11	<b>Gasoline Injection in S.I Engines (Drawbacks of Carburettor System) .....</b>	<b>8-17</b>
<b>In S.I. Engines</b>			8.12	<b>Types of Gasoline Injection systems in S.I. Engines .....</b>	<b>8-17</b>
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<b>Syllabus</b> : Introduction to Fuel Supply, Ignition, Combustion and knocking in SI Engines. MPFI in SI Engine.			8.13	<b>M.P.F.I. System for Modern Automobile Engines .....</b>	<b>8-19</b>
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**Syllabus** : Introduction to Fuel Injection system, Combustion and detonation in CI Engines.

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**Module 6**

**Chapter 10 : Testing and Performance of Engines 10-1 to 10-52**

**Syllabus : Engine Testing and Performance** : Measurement of various performance parameters, Performance characteristic of SI and CI Engine, Effect of load and speed on performance parameters, Heat balance sheet.

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