Fundamentals of Thermodynamics and Heat Transfer

Course Objectives:

After the completion of this course, students will able to understand basic concepts, laws of thermodynamics and heat transfer and their applications as well.

1. Introduction(4 hours)
    a. Definition and Scope of Engineering Thermodynamics
    b. Value of energy to society
    c. Microscopic versus Macroscopic Viewpoint
    d. Concepts and Definitions
        i. System, Surroundings, Boundary and Universe; Closed Systems, Open Systems, and Isolated Systems
        ii. Thermodynamic Properties: Intensive, Extensive and Specific Property
        iii. Thermodynamic Equilibrium
        iv. State, Process, and Path, Cyclic Process, Quasi-equilibrium Process, Reversible and Irreversible Process
        v. Common Properties: Pressure, Specific Volume, Temperature
    e. Zeroth Law of Thermodynamics, Equality of Temperature

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2. Energy and Energy Transfer(3 hours)
    a. Energy and its Meaning
    b. Stored Energy and Transient Energy: Total Energy
    c. Energy Transfer
        i. Heat Transfer
        ii. Work Transfer
    d. Expressions for displacement Work Transfer
    e. Power

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3. Properties of Common Substances(6 hours)
    a. Pure Substance and State Postulate
    b. Ideal Gas and Ideal Gas Relations
    c. Two Phase (Liquid and Vapor) Systems: Phase Change, Subcooled Liquid, Saturated Liquid, Wet Mixture, Critical Point, Quality, Moisture Content, Saturated Vapor and Superheated Vapor
    d. Properties of Two Phase Mixture
    e. Other Thermodynamic Properties: Internal Energy, Enthalpy and Specific Heats
    f. Development of Property Data: Graphical Data Presentation and Tabular Data Presentation

4. First Law of Thermodynamics(8 hours)
    a. First Law of Thermodynamics for Control Mass: First Law of Thermodynamics for Control Mass Undergoing Cyclic Process
    b. First Law of Thermodynamics for Control Volume
    c. Control Volume Analysis: Steady State Analysis and Unsteady State Analysis
    d. Control Volume Application: Steady and Unsteady Work Applications and Steady and Unsteady Flow Applications
    e. Other Statements of the First Law

5. Second Law of Thermodynamics(8 hours)
    a. Necessity of Formulation of Second Law
    b. Entropy and Second Law of Thermodynamics for an Isolated System
    c. Reversible and Irreversible Processes
    d. Entropy and Process Relation for an Ideal Gases and Incompressible Substances
    e. Control Mass and Control Volume Formulation of Second Law
    f. Isentropic Process for an Ideal Gas and for an Incompressible Substances
    g. Carnot Cycle, Carnot Efficiency, Heat Engine and Thermal Efficiency, Heat Pump, Refrigerator and coefficient of Performance(COP)
    h. Kelvin-Planck and Clausius Statements of the Second Law of Thermodynamics and their Equivalence

6. Thermodynamic Cycles(8 hours)
    a. Classification of Cycles
    b. Air Standard Analysis
        i. Otto Cycle
        ii. Diesel Cycle
        iii. Brayton Cycle
        iv. Rankine Cycle
        v. Vapor Compression Refrigeration Cycle

7. Introduction to Heat Transfer (8 hours)
    a. Basic Concepts and Modes of Heat Transfer
    b. One dimensional steady state heat conduction through a plane wall
    c. Radial steady state heat conduction through a hollow cylinder
    d. Heat flow through composite structures
        i. Composite Plane Wall
        ii. Multilayer Ttubes
    e. Electrical Analogy for Thermal Resistance
    f. Combined Heat Transfer and Overall Heat Transfer Coefficient for Plane Wall and Tube
    g. Nature of Convection: Free and Forced Convection
    h. Heat Radiation, Stefan's Law, Absorptivity, Reflectivity and Transmisivity; Black Body, White Body and Gray Body

References:

1. “Engineering Thermodynamics”, E. Rathakrishnan, Tata Mc Graw Hill.
2. “Fundamentals of Engineering Thermodynamics", J. R. Howell & R. O. Buckius, McGraw Hill Publishers
3. “Fundamentals of Thermodynamics”, V. Wylen, Sonntag & Borgnakke, 6th Edition, Wiley
4. “Fundamentals of Engineering Thermodynamics", M. J. Moran & H. N. Shapiro, 5th Edition, John Wiley & Sons, Inc.
5. "Thermodynamics: An Engineering Approach", Y. A. Cengel & M.A. Boles,5th Edition, McGraw-Hill, 2006
6. "Heat Transfer", J. P. Holman, McGraw-Hill
7. "Heat Transfer: A Practical Approach", Y. A. Cengel,2nd Edition, McGraw-Hill