Fundamentals of Thermal-Fluid

Course Code: 46506
Course Type: Theoretical
Credits: 3
Course Status: Compensatory Course
Prerequisite:

***Aim/Scope/Objectives*:** The aim of this course is to overview the fundamental topics in thermodynamics, fluid mechanics and heat transfer and familiarize the students with BSc degree in Electrical Engineering with the theory and practical aspects of thermal-fluids.

Course Outline:

1- Introduction and Overview
Introduction to thermal-fluid sciences, Thermodynamics, Heat transfer, Fluid mechanics, Importance of dimensions and unites.

2- Basic Concepts of Thermodynamics
Systems and control volumes, Properties of a system, Density and specific gravity, State and equilibrium, Processes and cycles, Temperature and the zeroth law of thermodynamics, Pressure, Pressure measurement devices.

3- Energy, Energy Transfer, and General Energy Analysis
Introduction, Forms of energy, Energy transfer by heat, Energy transfer by work, Mechanical forms of work, the first law of thermodynamics.

4- Properties of Pure Substances
Pure substance, Phases of a pure substance, Phase-change processes of pure substances, Property diagram for phase-change processes, Property tables, the Ideal gas equation of state, Compressibility factor- a measure of deviation from ideal-gas behavior.

5- Energy Analysis of Closed System
Moving boundary work, Energy balance for closed systems, Specific heats, Internal energy, enthalpy, and specific heats of ideal gases, Internal energy, enthalpy, and specific heats of solids and liquids.

6- Mass and Energy Analysis of Control Volumes
Flow work and the energy of a flowing fluid, Energy analysis of steady flow systems.

7- The Second Law of Thermodynamics
Introduction to the second law, Thermal energy reservoirs, Heat engines, Refrigerators and heat pumps, Reversible and irreversible processes, the Carnot cycle, the Carnot principles, the thermodynamic temperature scale, the Carnot heat engine, the Carnot refrigerator and heat pump.

8- Entropy

Entropy, the increase of entropy principle, Entropy change of pure substances, Isentropic processes, Property diagrams involving entropy, the T ds relations, Entropy changes of liquids, solids and ideal gases, Reversible steady-flow work, Isentropic efficiencies of steady flow devices.

9- Introduction and Properties of Fluids

The no-slip condition, Classification of fluid flows, Vapor pressure and cavitation, Viscosity.

10- Bernoulli and Energy Equations

Derivation of the Bernoulli Equation, Static, dynamic, and stagnation pressures, Limitations of the use of Bernoulli Equation, Hydraulic grade line (HGL) and Energy grade line (EGL), Energy analysis of steady flows.

11- Internal Flow

Introduction, Laminar and turbulent flows, the entrance region, Laminar flow in pipes, Turbulent flow in pipes, Minor losses, Piping networks and pump selection

12- Mechanism of Heat Transfer

Introduction, Conduction, Convection, Radiation, Simultaneous heat transfer mechanisms.

13- Transient Heat Conduction

Lumped system analysis, Transient heat conduction in large plane walls, long cylinders and spheres with spatial effects.

14- Forced Convection

Physical mechanism of convection, Thermal boundary layer, Parallel flow over flat plates, Flow across cylinders and spheres.

Grading: 50% Midterm, 40% Final exam, 10% Homework

References:

- Y. A. Cengel, J. M. Cimbala, A. J. Ghajar, “Fundamentals of Thermal-Fluid Sciences”, McGraw Hill, Sixth edition, 2022.