THERMAL TURBOMACHINES

II Semester

Course Code: 19ME2206

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Prerequisites: Fluid Mechanics and Thermal Engineering

Course Outcomes: At the end of the course the student shall be able to

CO1: Apply thermodynamic principles to nozzles, diffusers and methods to estimate the stage work and efficiency of radial turbines.
CO2: Apply the methods to estimate the stage work and efficiency of axial turbines.
CO3: Apply the methods to estimate the stage work and efficiency of axial compressors.
CO4: Apply the methods to estimate the stage work and efficiency of centrifugal compressors.
CO5: Explain the parameters required for the design of fans.

UNIT-I: **(10-Lectures)**

Turbo machines, thermodynamics -basic definitions and laws, energy equation, adiabatic flow through nozzles, adiabatic flow through diffusers, work and efficiencies in turbine stages, work and efficiencies in compressor stages. Radial turbine stages -elements of a radial turbine stage, stage velocity triangles, enthalpy-entropy diagram, stage losses, performance characteristics, outward flow radial stages.

Learning outcomes: At the end of this unit, the student will be able to

1. Define turbo machines and apply basic laws of thermodynamics for a flow through nozzles, diffusers and turbomachines (L1 & L2)
2. Define and determine various performance parameters of single and multi-stage turbo machines (L1 & L5)
3. Derive and determine the stage work, efficiency and other performance parameters of radial flow turbine. (L5)

UNIT-II: **(10-Lectures)**

Axial turbine stages -stage velocity triangle, single impulse stage, multi stage velocity and pressure compounded impulses, reaction stages, blade-to-gas speed ratio, losses and efficiencies, performance charts, low hub-trip ratio stages.

Learning outcomes: At the end of this unit, the student will be able to

1. Illustrate the working of Axial turbine for an impulse and reaction stages (L2)
2. Define, derive and determine various performance parameters of an axial turbine stage by making use of stage velocity triangles & h-s diagram (L1 & L5)
3. Explain various losses across the axial turbine stage and interpret the performance of low hub-trip ratio stages (L3)

UNIT-III: **(10-Lectures)**

Axial compressor stages -stage velocity triangles, enthalpy-entropy diagram, flow through blade rows, stage losses and efficiency, work done factor, low hub-tip ratio stages, supersonic and transonic stages, performance characteristics, stalling.

Learning outcomes: At the end of this unit, the student will be able to

1. Describe the working of axial compressor with help of velocity triangles and h-s diagram (L2)
2. Define, derive and determine various performance parameters of an axial compressor stage and List out various stage losses (L1 & L5)
3. Analyze low hub-tip ratio stages, supersonic and transonic stages (L3)

UNIT-IV: (10-Lectures)

Centrifugal compressor stages -elements of centrifugal compressor stage, stage velocity triangle, enthalpy-entropy diagram, nature of impeller flow, slip factor, diffuser, performance characteristics.

Learning outcomes: At the end of this unit, the student will be able to

1. Explain the working of centrifugal compressor with help of velocity triangles and h-s diagram (L2)
2. Analyze the performance of centrifugal compressors according to the nature of impeller for different arrangements of diffuser blades. (L4)
3. Explain the performance characteristics of centrifugal compressor (L2)

UNIT-V: (10-Lectures)

Axial fans and centrifugal fans -fan applications, axial fans, fan stage parameters, types of axial fan stages, types of centrifugal fans, centrifugal fan stage parameters, design parameters.

Learning outcomes: At the end of this unit, the student will be able to

1. Distinguish the working of fans, blowers and compressors (L2)
2. Classify and analyze the axial and centrifugal fan stages (L2)
3. Identify various design parameters and stage parameters of axial and centrifugal fan stages. (L3)

TEXT BOOK:

1. S.M. Yahya, *Turbines, Compressors and fans*, 4th Edition, Tata McGraw Hill, 2010.

REFERENCE BOOKS:

1. Maneesh Dubey, B.V.S.S.S. Prasad and Archana Nema, *Turbo Machinery*, McGraw Hill Education, 2019
2. Charles A Parsons, *The steam turbine*, Cambridge University Press, 2012.
3. Norman Davey, *Gas Turbines – Theory and practice*, Illustrated Edition, Merchant Books, 2006.
4. S.M. Yahya, *Fundamentals of Compressible flow with aircraft and rocket propulsion*, Sixth Edition, New Age International Publishers, 2018.
5. Seppo A. Korpela, *Principles of turbomachinery*, Second Edition, John Wiley & Sons, 2019.