2/4 B.Tech. FOURTH SEMESTER

ME4T2 APPLIED THERMODYNAMICS Credits: 4

Lecture:- - 4 periods/week **Internal assessment: 30marks**
Tutorial: - 1 periods/week **Semester end examination: 70 marks**

Objectives:

1. Explain the basic concepts of steam power plant
2. Describe the working principles of various components of steam power cycles

Learning outcome

At the end of course the students will have:

1. Describe the working of steam power plant cycles and its performance improvement methods.
2. Recall the knowledge in working of steam boilers and steam nozzles.
3. Memorize the working principles, performance evaluation of impulse and reaction steam turbines.
4. List the classification and importance of steam condensers
5. Interpret the technical aspects, performance evaluation of reciprocating, centrifugal and axial flow compressors

Pre-Requisite

Basic Thermodynamics

UNIT – I
BASIC CONCEPTS:
Rankine cycle - schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance – regeneration & reheating. COMBUSTION: Fuels and combustion, concepts of heat of reaction, adiabatic flame temperature, stoichiometry, flue gas analysis.

UNIT- II
BOILERS :
Classification – working principles – with sketches including H.P.Boilers – mountings and accessories – working principles, boiler horse power, equivalent evaporation, efficiency and heat balance – draught, classification – height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney – artificial draught- induced and forced.

UNIT – III

STEAM NOZZLES:

Function of a nozzle – applications - types, flow through nozzles, thermodynamic analysis – assumptions -velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity coefficient, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape: Super saturated flow, its effects, degree of super saturation and degree of under cooling - Wilson line.

UNIT – IV

STEAM TURBINES:

Classification – impulse turbine; mechanical details – velocity diagram – effect of friction – power developed, axial thrust, blade or diagram efficiency – condition for maximum efficiency. De-laval turbine - methods to reduce rotor speed-velocity compounding, pressure compounding and velocity & pressure compounding, velocity and pressure variation along the flow – combined velocity diagram for a velocity compounded impulse turbine, condition for maximum efficiency

UNIT V

REACTION TURBINE:

Mechanical details – principle of operation, thermodynamic analysis of a stage, degree of reaction –velocity diagram – Parson's reaction turbine – condition for maximum efficiency – calculation of blade height.

UNIT VI

STEAM CONDENSERS:

Requirements of steam condensing plant – classification of condensers – working principle of different types – vacuum efficiency and condenser efficiency – air leakage, sources and its affects, air pump- cooling water requirement.

UNIT – VII

COMPRESSORS –

Classification –positive displacement and roto dynamic machinery – Power producing and power absorbing machines, fan, blower and compressor – positive displacement and dynamic types – reciprocating and rotary types.

RECIPROCATING COMPRESSORS: Principle of operation, work required, Isothermal efficiency volumetric efficiency and effect of clearance, stage compression, under cooling, saving of work, minimum work condition for stage compression.

UNIT – VIII

DYNAMIC COMPRESSORS:

Centrifugal compressors: Mechanical details and principle of operation – velocity and pressure variation. Energy transfer-impeller blade shape-losses, slip factor, power input factor, pressure coefficient and adiabatic coefficient – velocity diagrams – power.

AXIAL FLOW COMPRESSORS: Mechanical details and principle of operation – velocity triangles and energy transfer per stage degree of reaction, work done factor - isentropic efficiency- pressure rise calculations – Polytropic efficiency.

Learning resources

Text books:

1. Thermal Engineering, by Mahesh M. Rathore, MC Graw Hill publications, 2010
2. Thermal Engineering, by Rajput, Lakshmi publications, 2005

Reference books:

1. Treatise on Heat Engineering, by V.P. Vasandani and D.S. Kumar Metropolitan book Co Pvt Ltd , 2000
2. Engineering Thermodynamics, by Achuthan ,PHI publications, 2005.
3. Engineering Thermodynamics, by Cengle and Boles, MC Graw Hill publications , 2002