B.E. (ME) Part-Ill 6th Semester Examination, 2010

Boiler and Steam Turbine

(ME-602)

Time : 3 hours **Full Marks : 70**

Use separate answerscript for each half.
Answer SIX questions, taking THREE from each half.
The questions are of equal value.

FIRST HALF

1. a) Derive the expression for draught in terms of height of column of hot gas in a chimney draught.

   b) Derive the condition to have maximum discharge through a chimney.

   c) Derive power requirement oflnduced draught fan and Forced draught fan, and compare.

2. a) With a **neui** iabciled sketch, describe how an ejector condenser works.

   b) The following data refers to a two-pass surface condenser:
   Steam condensed 15,500 kg/hr; Condenser vacuum 670 mm of Hg; Barometer reading 752 mm of Hg; Condensate temperature 32°C; Cooling water inlet and outlet temperature I6°C and 30°C respectively; Qualify of steam at inlet of condenser 93%; Water velocity within the tubes 2.5 m/s; Thickness of the tubes 0.03cm; Outside diameter of the tubes 2.8 cm; Overall heat transfer coefficient, U 3.36 kJ/hr/cm^{2}°C.
   Determine the following :-
   (i) Area of the tube surfaces required;
   (ii) Number of tubes and
   (iii) Length of lubes.

3. a) Draw a neat sketch of a high pressure boiler where there is no drum and describe how it functions. Write down the advantages of this boiler.

   b) What is a pressurized fluid ized bed boiler? What are it merits and demerits?

4. a) How does an Induced draft cooling tower works? Mention its merits and demerits.

b) Water at 30°C flows into a cooling Tower at a rate of 1.14 kg/kg of air. Air enters the tower at a dry bulb temperature of 20°C with relative humidity of 60% and leaves at a dry bulb temperature of 27°C and 89% relative humidity. Make up water is supplied at 20°C. Determine the following:-

(i) the fraction of water evaporated ,

(ii) the temperature of water leaving the tower and

(iii) the approach and range of the cooling tower.

5. Write notes on <u>any three</u> of the following :-

a) Bubbling fluidized bed boiler.

b) Loeffler boiler,

c) Hyperbolic Cooling Tower, its merits and limitations,

d) Low level counterflow jet condenser,

e) Steam-jet draught.

SECOND HALF

6. a) What is the velocity at the nozzle exit if the velocity at inlet is $V_{(}$ and enthalpy at inlet and outlet are Hj and **H2,** respectively. Which equation do you use to get this? What is the gain in kinetic energy (momentum equation) for isentropic flow in the nozzle? Derive the expression for nozzle efficiency?

b) Steam at the rate of 7.5 kg/s flows through a set of nozzles. The inlet pressure is 14 bar and the temperature is 250°C. The exit pressure is 6 bar. Neglect the velocity of approach and assume that the expansion of steam is isentropic. Find the number of nozzles used if the outlet area of each nozzle is approximately $2.3 cm^2$. What should be the exact exit area of each nozzle?

7. a) Draw the combined vector diagram for flow of steam through an impulse turbine. What one blade or diagram efficiency and gross stage efficiency?

b) For an impulse turbine use following data :

Rotor diameter = 80cm, N = 3000rpm, $V_, = 300 m/s$, $a_1 = 20°$, $(3, = p_2$, K = 0.86.

Axial thrust = 140N

Compute the power in kW developed by the turbine.

8. In a Parson's steam turbine, there is one ring of fixed blades and one ring of moving blades using the following data,

Blade ring diameter = 70 cm, N = 300 rpm

Steam velocity at exit from blades = 160 m/s.

Blade outlet angle = 20°; steam flow through blades = 7 kg/s, draw the velocity diagram and find the following:

(a) Blade inlet angle; (b) Tangential force on ring of moving dates and (c) power developed in stage.

9. a) A four-stage presume-compounded turbine is supplied with steam at 11 bar and 200°C. The exhaust pressure is 0.16 bar. The stage efficiency is 70%, the reheat factor is 1.03, and the work done in each stage per kg of steam is the same. If steam for regenerative feed heating is tapped off after first three stages, estimate the quantity of steam to be withdrawn in each case and the theoretical gain in thermal efficiency through use of heaters.

b) From the test of a steam turbine operating at fractional load, the following data are obtained:

Steam pressure before governor valve = 27 bar

Steam temperature before governor valve = 371°C

Steam pressure after governor valve = 8 bar

Steam pressure in exhaust branch = 0.07 bar

Steam temperature in exhaust branch = 49°C

What is the internal efficiency of the turbine? If the steam flow through the turbine is 1818 kg/hr, and the power absorbed in bearing friction and governor drive is 7.35 kW, What is the approximate power at the turbine coupling?