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B. Tech 3rd Semester Examination

Applied Thermodynamics (N.S.)

ME-212

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt five questions in all, select one question from each sections A, B, C and D. Section E is compulsory. Use of steam tables is permitted and assume any suitable data if not given

SECTION - A

1. In a boiler trail, the following observations were obtained:

   Mass of feed water=1520kg/h; Temperature of feed water=30°C; Dryness fraction of steam=0.95; Pressure of steam=8.5bar; Coal burnt/hour=200kg; Calorific value of coal=27300kJ/kg of coal; Ash and unburnt coal collected = 16kg/h; Calorific value of ash and unburnt coal =3780kJ/kg; Mass of flue gases=17.3kg/kg of coal; Temp of flue gases=330 °C; Boiler room temperature =17°C; Mean specific heat of flue gases 1kJ/kgK. Estimate the thermal efficiency of the boiler and draw the heat balance sheet. **(20)**

2. (a) Describe with a neat diagram, the construction and working of a Babcock-Wilcox water tube boiler. **(10)**

   (b) Derive an expression for the power required to drive a forced draught fan. **(10)**

SECTION - B

3. A steam turbine receives superheated steam at a pressure of 17 bar and having a degree of superheat of 110°C. The exhaust pressure is 0.07 bar and the expansion of steam takes place isoentropically. Calculate (i) heat supplied (ii) heat rejected (iii) net work done (iv) thermal efficiency. **(20)**

4. Draw the 'discharge' versus 'ratio of pressure at outlet to inlet' curve for a convergent steam nozzle. Discuss the physical significance of critical pressure ratio. **(20)**

SECTION - C

5. At a particular stage of a reaction steam turbine the mean blade speed is 60m/s. Steam is at a pressure of 3 bar with a temperature of 200°C. If the fixed and moving blades, at this stage, have inlet angle 30° and exit angle 20°, determine (i) blade height at this stage, if the blade height is 1/10 of the mean blade ring diameter and the steam flow is 10kg/s, (ii) power developed by a pair of fixed and moving blade rings at this stage (iii) heat drop required by the pair, if the steam expand with an efficiency of 85%. **(20)**

6. What are the methods of governing a steam turbine? Describe different methods of governing. **(20)**

SECTION - D

7. In a condenser test, the following observations were made: Vacuum =690mm of Hg; Barometer reading =750 mm of Hg; Mean temperature of condensation=35°C; Hot well temperature=28°C; mass of cooling water=50000kg/h; inlet temperature=17°C; outlet temperature=30°C; Mass of condensate/hr=1250kg;

   Find (i) mass of air present per m^3 of condenser volume (ii) the state of steam entering the condenser (iii) vacuum efficiency. Take R=287J/kgK **(20)**

8. Show from the considerations of maxwell's thermodynamic relations that

   (i) For a perfect gas, $C_p - C_v = R$

   (ii) For a gas obeying Vander waal's equations

$$C_p - C_v = \frac{R}{1 - 2a(v_s - b)^2 / RTv_s^3}$$ **(20)**

SECTION - E

9. (i) What are the conditions of reversibility?

   (ii) Differentiate between a water tube and a fire tube boiler.

   (iii) What is the significance of draught in boiler practice?

   (iv) State Dalton's law of partial pressure.

   (v) Discuss the effect of friction on nozzle efficiency.

   (vi) Define the term 'degree of reaction' as applied to a reaction turbine.

   (vii) Enumerate the different losses in a steam turbine.

   (viii) What is compressibility factor? What is its significance?

   (ix) Describe how vacuum in a condenser is measured and what is vacuum efficiency?

   (x) Explain the term 'compounding' of steam turbine?

(10×2=20)