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12MTP/MTH23

Second Semester M.Tech. Degree Examination, Dec.2014/Jan.2015
Advanced Power Plant Cycles

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

1 a. With a neat circuit diagram, explain the regenerative feedwater heating with T-S and h-s diagram. **(08 Marks)**

b. Steam at 40 bar, 500°C flowing at the rate of 5500 kg/h expands in a h.p turbine to 2 bar with an isentropic efficiency of 83%. A continuous supply of steam at 2 bar, 0.87 quality and a flow rate of 2700 kg/h is available from a geothermal energy source. This steam is mixed adiabatically with the h.p. turbine exhaust steam and the combined flow then expands in a I.P. turbine to 0.1 bar with an isentropic efficiency of 78%. Determine the power output and the thermal efficiency of the plant. Assume that 5500 kg/h of steam is generated in the boiler at 40 bar, 500°C from the saturated feedwater at 0.1 bars. Had the geothermal steam not been added, what would have been the power output and efficiency of the plant? Neglect pumps work. **(12 Marks)**

2 a. With a neat sketch, explain binary vapour cycle with the help of a T-S diagram. **(10 Marks)**

b. A mercury cycle is superposed on the steam cycle operating between the boiler outlet condition at 40 bar, 400°C and the condenser temperature of 40°C. The heat released by mercury condensing at 0.2 bar is used to impart the latent heat of vapourization to the water in the steam cycle. Mercury enters the mercury turbine as saturated vapour at 10 bar. Compute (i) kg of mercury circulated per kg of wter and (ii) the efficiency of the combined cycle. **(10 Marks)**

The property values of saturated mercury are given below:

P(bar)	t°C	h_f	h_g	S_f	S_g	V_f	V_g
		KJ/kg		(K/kgK)		(m^3/kg)	
10	515.5	72.23	363.0	0.1478	0.5167	80.9×10^{-6}	0.0333
0.2	277.3	38.35	336.55	0.0967	0.6385	77.4×10^{-6}	1.163

3 a. With the help of a block diagram, explain the coal gasification process. **(08 Marks)**

b. The ultimate analysis of a fuel oil is given to be: Carbon 83.7%, hydrogen 12.7, Sulphur 0.7, nitrogen 1.7 and oxygen 1.2. The combustion air has a dry bulb temperature of 27°C and a wet bulb temperature of 21°C with 30% excess air and assuming complete combustion. Find i) The total volume of combustion products at 200°C and 1.013 bar and ii) the dry fuel gas analysis based on CO_2, O_2 and N_2. **(12 Marks)**

4 a. Explain with a neat sketch pulverized coal firing system. Also mention the advantages and disadvantages of pulverized coal firing. **(10 Marks)**

b. A bed of particles of mean size 427 μm is fluidized by air under the ambient conditions where the air density is 1.21 kg/m^3 and the viscosity is 1.82×10^{-5} kg/m-s. The density of the loosely packed bed is 1620 kg/m^3. If the density of solids is 2780 kg/m^3. Find i) The Voidage of the bed and ii) The minimum fluidization velocity. **(10 Marks)**

5 a. Explain with a neat sketch fluidized bed boilers system. **(10 Marks)**

b. Find the number and length of superheater coils of 50 mm id and 5 mm thickness to be provided if steam at exit is at 60 bar, 500°C and flows with a velocity of 10 m/s and mass flow of 80 kg/s. Due to restriction by materials, the heat flux in the superheater coils is to be limited to 140 kW/m^2. **(10 Marks)**

6 a. Explain the necessity of condenser. **(05 Marks)**

b. Explain with neat sketch, Barometric condenser. **(05 Marks)**

c. Water at 30°C flows into a cooling tower at the rate of 1.15 kg per kg air. Air enters the tower at the dbt of 20°C and a relative humidity of 60% and leaves it at a dbt of 28°C and 90% relative humidity. Make up water is supplied at 20°C. Determine i) the temperature of water leaving the tower ii) the fraction of water evaporated and iii) the approach and range of the cooling tower. **(10 Marks)**

7 a. With a neat sketch, explain the boiling water reactor (BWR) power plant. **(10 Marks)**

b. A 230 g piece of boron (mol.wt.10) absorbs thermal neutrons at the rate of 9.57×10^{13} per (cm^3.s). Boron density is 2.3 g/cm^3. Find i) the thermal neutron flux and ii) the average distance that a neutron travels before it is absorbed. For thermal neutrons σ_a = 755 barns and σ_s = 4 barns. **(10 Marks)**

8 a. Give the classification of hydraulic turbines. **(04 Marks)**

b. Sketch and explain the bulb turbine. **(06 Marks)**

c. A Kaplan turbine develops 10000 kW under a head of 12 m when the following conditions prevail. Speed ratio = 2, flow ratio = 0.66, diameter of hub = 0.3 times the external diameter of the vane and the overall efficiency = 94%. Estimate i) the speed ii) the diameter of the runner and iii) the specific speed. **(10 Marks)**

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