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Question Paper Code : 90372

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Fifth Semester

Mechanical Engineering

ME 8595 – THERMAL ENGINEERING – II

(Regulations 2017)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions.

Use of steam tables, psychrometric chart and Mollier diagram is permitted.

PART – A **(10×2=20 Marks)**

1. What is the effect of friction on the flow through a steam nozzle ?
2. What do you mean by a metastable flow ?
3. How are boilers classified ?
4. How do boiler accessories differ from boiler mountings ?
5. Differentiate an impulse and a reaction turbine.
6. What do you mean by compounding of stem turbines ?
7. What is a cogeneration plant ?
8. What is a back pressure turbine ?
9. Show the simple vapour compression cycle on a P-h chart.
10. What are the variables involved in the estimation of room sensible heat ?

PART – B **(5×13=65 Marks)**

11. a) An impulse turbine having a set of 16 nozzles receives steam at 20 bar, 400°C. The pressure of steam at exit is 12 bar. If the total discharge is 260 kg/min and nozzle efficiency is 90%, find the cross-sectional area of the exit of each nozzle. If the steam has a velocity of 80 m/s at entry to the nozzles, find percentage increase in discharge.

(OR)

b) A steam nozzle is supplied steam at 15 bar, 350°C and discharges steam at 1 bar. If the diverging portion of the nozzles is 80 mm long and the throat diameter is 6 mm, determine the cone angle of the divergent portion. Assume 12% of the total available enthalpy drop is lost in friction in the divergent portion. Also determine the velocity and temperature of the steam at throat.

12. a) Explain with neat sketches the construction and working of any one of the water tube boilers.

(OR)

b) The following data were taken during the test on a boiler for a period of one hour. Steam generated = 5000 kg : coal burnt = 700 kg, calorific value of coal = 31402 kJ/kg, quality of steam = 0.92. If the boiler pressure is 1.2 MPa and the feed water temperature is 45°C, find the boiler equivalent evaporation and the efficiency.

13. a) A single stage steam turbine is supplied with steam at 5 bar, 200°C at the rate of 50 kg/min. It expands into a condenser at a pressure of 0.2 bar. The blade speed is 400 m/s. The nozzles are inclined at an angle of 20°C to the plane of the wheel and the outlet blade angle is 30°. Neglecting friction losses, determine the power developed, blade efficiency and stage efficiency.

(OR)

b) Explain the pressure compounded impulse steam turbine showing pressure and velocity variations along the axis of the turbine.

14. a) A textile factory requires 10000 kg/h of steam for process heating at 3 bar saturated and 1000 kW of power, for which a back pressure turbine of 70% internal efficiency is to be used. Find the steam condition required at the inlet to the turbine.

(OR)

b) Explain with neat sketches the working of any one type of recuperators.

15. a) In a standard vapour compression refrigeration cycle, operating between an evaporator temperature of 10°C and a condenser temperature of 40°C, the enthalpy of the refrigerant at the end of compression is 220 kJ/kg. Show the cycle diagram on T-s plane. Calculate : i) the C.O.P. of the cycle. ii) the refrigerating capacity and the compressor power assuming a refrigerant flow of 1kg/min. The following table gives the properties of the refrigerant.

Saturation Temperature (°C)	Pressure (MPa)	Enthalpy of liquid h_f (kJ/kg)	Enthalpy of vapour h_g (kJ/kg)
-10°C	0.2191	26.85	183.1
40°C	0.9607	74.53	203.1

(OR)

b) An office is to be air conditioned for 50 staff when the outdoor conditions are 30°C DBT and 75% R.H. If the quantity of air supplied is 0.4 m^3/min/person, find the following :

i) Capacity of the cooling coil in tonnes of refrigeration
ii) Capacity of the heating coil in kW
iii) Amount of water vapour removed per hour.

Assume that required air inlet conditions are 20°C DBT and 60% R.H. Air is conditioned first by cooling and dehumidifying and the heating coil.

PART – C (1×15=15 Marks)

16. a) Supersaturated (metastable) expansion occurs in a nozzle supplied with steam at 20 bar and 325°C. The law for the expansion may be taken as $pv^{1.3} = C$ upto the exit pressure of 3.6 bar. For a flow rate of 40 kg/min, determine i) the throat and the exit areas and ii) the degree of undercooling at the exit.

(OR)

b) A food storage locker requires a refrigeration system of 2400 kJ/min capacity at an evaporator temperature of 263 K and a condenser temperature of 303 K. The refrigerant is subcooled by 6°C before entering the expansion valve and the vapour is superheated by 7°C before leaving the evaporator coil. The compression of refrigerant is reversible adiabatic. The refrigeration compressor is two cylinder single acting with stroke equal to 1.25 times the bore and operates at 1000 r.p.m. The following table gives the properties of the refrigerant.

Saturation Temperature (K)	Pressure (MPa)	Specific Volume of vapour m^3/gk	Enthalpy kJ/kg		Entropy (kJ/kg K)	
			Liquid (h_f)	Vapour (h_g)	Liquid (S_f)	Vapour (S_g)
263	2.19	0.0767	26.9	183.2	0.1080	0.7020
303	7.45	0.0235	64.6	199.6	0.2399	0.6854

Take liquid specific heat = 1.235 kJ/kg K ; vapour specific heat = 0.733 kJ/kg K
Determine : i) Refrigerating effect per kg ii) mass of refrigerant to be circulated per minute iii) theoretical piston displacement per min iv) theoretical power required to run the compressor, in kW iv) heat removed through the condenser per min vi) theoretical diameter and stroke of the compressor.

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