Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 40836

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fifth/Seventh Semester

Mechanical Engineering

ME 8595 — THERMAL ENGINEERING — II

[Common to Mechanical Engineering (Sandwich)]

(Regulations 2017)

Time : Three hours　　　　Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is the function of divergent nozzle?

2. What are the major effects of friction in nozzle?

3. What are the disadvantages of solid fuels?

4. What is the significance of factor of evaporation in boilers?

5. How does pressure and velocity change as the flow proceeds though the runner of the impulse turbine?

6. What is meant by diagram efficiency?

7. List the benefits of waste heat recovery.

8. Differentiate a recuperative heat exchanger from a regenerative heat exchanger.

9. What is the basic working principle of vapour compression refrigeration cycle?

10. What is GSHF?

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain various types of nozzles. (5)

(ii) Describe the flow of steam through nozzles and hence deduce the expression for a critical pressure ratio. (8)

Or

(b) (i) Explain the supersaturated flow in nozzles and their effects. (5)

(ii) A convergent-divergent nozzle is required to discharge 350 kg of steam per hour. The nozzle is supplied with steam at 8.5 bar and 90% dry and discharges against a back pressure of 0.4 bar. Neglecting the effect of friction, find the throat and exit diameters. (8)

12. (a) (i) Briefly explain the working of a water-tube boiler and list their merits and demerits. (5)

(ii) Compare the boiler mountings with accessories and give one examples for each. (4+4)

Or

(b) The following data was obtained in a steam boiler trial :

Feed water supplied per hour 690 kg at 28°C, steam produced 0.97 dry at 8 bar, coal fired per hour 91 kg of calorific value 27,200 kJ/kg, ash and unburnt coal collected from beneath the fire bars 75 kg/hour of calorific value 2760 kJ/kg, mass of flue gases per kg of coal burnt 173 kg, temperature of flue gases 325°C, room temperature 17°C, and the specific heat of the flue gases 1026 kJ/kg K.

Estimate the boiler efficiency, the percentage heat carried away by the flue gases, the percentage heat loss in ashes, and the percentage heat loss unaccounted for.

13. (a) (i) Mention the differences between Impulse and Reaction Turbines. (5)

(ii) Derive the value of blade speed ratio for maximum efficiency of impulse turbine. (8)

Or

(b) Describe the various methods of compounding with suitable diagrams. (13)

14. (a) (i) Explain the various sources of waste heat and their quality. (5)

(ii) Explain the advantages and disadvantages of various co-generation systems. (8)

Or

(b) (i) Explain the functioning of heat pipes. (5)

(ii) Describe the working of Fixed Bed Regenerators and Rotary Bed Regenerators. (8)

15. (a) A cold storage plant is required to store 20 tonnes of fish. The fish is supplied at a temperature of 30°C. The specific heat of fish above freezing point is 2.93 kJ/kg K. The specific heat of fish below freezing point is 1.26 kJ/kg K. The fish is stored in colds storage which is maintained at –8°C. The freezing point of fish is –4°C. The latent heat of fish is 235 kJ/kg. If the plant requires 75 kW to drive it.

Assume actual C.O.P. of the plant as 0.3 of the Carnot C.O.P.

(i) Find the capacity of the plant. (5)

(ii) Calculate the time taken to achieve cooling. (8)

Or

(b) (i) Explain the working of Thermoelectric cooling with its merits and demerits. (5)

(ii) List different parts of a cooling tower and their function and hence explain the working of natural and forced draught cooling towers. (8)

PART C — (1 × 15 = 15 marks)

16. (a) Consider a Parson's stage with a rotor (at mid-height of blades) diameter of 1.2 m, operating at a speed of 3000 rpm, with the steam entry angle of steam be 20°.

Steam enters the stator at 12 bar, 300°C and an isentropic enthalpy drop of 50 kJ/kg is chosen per row of blades. The isentropic efficiency of each row is assumed as 0.84.

(i) Plot the process of expansion in the turbine on the h-s diagram and find the pressure at the exit of stator and rotor. (8)

(ii) Draw the combined velocity triangles and label all the components of the velocity and find the specific work delivered. (7)

Or

(b) The following are the Cogeneration Gas turbine Parameters :

Capacity of gas turbine generator: 4000 kW

Plant operating hours per annum 8000 hrs.

Plant load factor : 90%

Heat rate as per standard given by gas.turbine supplier : 3049.77 kCal / kWh

Waste heat boiler parameters — unfired steam output: 10 TPH

Steam temperature :200°C

Steam pressure :8.5 kg /cm^2.

Steam enthalpy :676.44 kCal / kg.

Fuel used : Natural gas

Calorific value — LCV :9500 kCal/ 5m^3

Price of gas : Rs. 3000/1000 Sm^3

Capital investment for total co-generation plant : Rs. 1300 Lakhs

Plant Load Factor (PLF) : 90%

Estimate the cost of fuel per annum and cost of power per kWh.(15)

Take 1 kCal = 4.2 kJ.

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B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2020
Fifth/Seventh Semester
Mechanical Engineering
ME 8595 – THERMAL ENGINEERING – II
(Regulations 2017)
(Common to Mechanical Engineering (Sandwich))

Time : Three Hours Maximum : 100 Marks

Answer ALL questions
(Use of steam tables, Refrigeration charts, psychrometric chart and mollier diagram is permitted)

PART – A **(10×2=20 Marks)**

1. Define critical pressure ratio in steam nozzles.
2. What is degree of undercooling in nozzle ?
3. Distinguish between boiler mountings and accessories.
4. Classify the types of boiler according to circulation of gases and water respectively.
5. Define blade velocity coefficient in an impulse turbine.
6. What is the operating principle of a reaction turbine ?
7. Why regenerators are normally preferred for high pressure ratio gas turbine cycle ?
8. Write the advantages of cogeneration system.
9. Define refrigeration and air conditioning.
10. What is the function of the throttling valve in vapour compression refrigeration system ?

PART – B **(5×13=65 Marks)**

11. a) Dry saturated steam at a pressure of 11 bar enters a steam nozzle and leaves at a pressure of 2 bar. If the flow is adiabatic and frictionless, determine : (i) the exit velocity of steam (ii) ratio of cross-section at exit and that at throat. Assume the index of adiabatic expansion to be 1.135

(OR)

b) Derive the following expression for nozzle flow : $\frac{dA}{A} = \frac{1}{\gamma}\frac{dp}{p}\left[\frac{1-M^2}{M^2}\right]$ where, the symbols having usual meanings.

12. a) How are boilers classified ? Explain the unique features of the high pressure boilers.

(OR)

b) An oil fired package boiler was tested for 2 hours duration at steady state condition. The fuel and water consumption were 250 litres and 3500 litres respectively. The specific gravity of oil is 0.92. The saturated steam generation pressure is 7 kg/cm^2 (g). The boil feed water temperature is 30°C. Determine the boiler efficiency and evaporation ratio

13. a) In a single stage impulse turbine, nozzle angle is 20° and blade angles are equal. The velocity coefficient for blade is 0.85. Find maximum blade efficiency possible. If the actual blade efficiency is 92% of the maximum blade efficiency, find the possible ratio of blade speed to steam speed.

(OR)

b) Explain various type of compounding in steam turbine.

14. a) With suitable circuit, explain the function wise differences between topping and bottoming cycle

(OR)

b) Explain about Recuperative and Regenerative heat exchangers with neat sketch.

15. a) The following data relates to the office air conditioning plant having maximum seating capacity of 25 occupants :

Outside design conditions	=	34°C DBT, 28°C WBT
Inside design conditions	=	24°C DBT, 50% RH
Solar heat gain	=	9120 W
Latent heat gain per occupant	=	105 W
Sensible heat gain per occupant	=	90 W
Lightening load	=	2300 W
Sensible heat load from other sources	=	11630 W
Infiltration load	=	14 m^3/min

Assuming 40% fresh air and 60% of recirculated air passing through the evaporator coil and the by-pass factor of 0.15. Estimate the capacity of the plant and the dew point temperature of the coil.

(OR)

b) Explain any four psychometric processes with neat sketch.

PART – C (1×15=15 Marks)

16. a) A textile factory requires 10t/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 used. Find the steam condition required at inlet of the turbine.

(OR)

b) An air conditioned auditorium is to be maintained at 27°C dry bulb temperature and 60% relative humidity. The ambient condition is 40°C dry bulb temperature and 30°C wet bulb temperature. The total sensible heat load is 100000 kJ/h and the total latent heat load is 40000 kJ/h. 60% of the return air is recirculated and mixed with 40% of make-up air after the cooling coil. The condition of air leaving the cooling coil is at 18°C.

Determine the following :

i) Room sensible heat factor

ii) The condition of air entering the auditorium

iii) The amount of make-up air

iv) Apparatus dew point

Show the processes on the psychrometric chart.

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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.