CBCS SCHEME

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18AU32

Third Semester B.E. Degree Examination, Jan./Feb. 2021
Engineering Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. What are meant by Microscopic and Macroscopic point of views? Explain. **(06 Marks)**

b. State Zeroth law of thermodynamics. **(04 Marks)**

c. The temperature 'T' on a thermometric scale is defined as T = a lnk + b, where a and b are constants. The values of K are found to be 1.83 and 6.78 at 0°C and 100°C respectively. Calculate the temperature for a value of K = 2.42. **(10 Marks)**

OR

2 a. Define work thermodynamically. What are path and point functions? **(06 Marks)**

b. Derive an expression for displacement work of a polytropic process. **(06 Marks)**

c. A mass of gas is compressed in quasi-static process from 80 kPa 0.1 m^3, to 0.4 MPa, 0.03 m^3. Assuming that the pressure and volume are related by PV^n = constant, find the work interaction during the process. Is it a work producing system or work absorbing system? **(08 Marks)**

Module-2

3 a. Derive steady flow energy equation for a flow process. **(10 Marks)**

b. A piston and cylinder machine contains a fluid system, which passes through a complete cycle of four processes. During a cycle the sum all heat transfer is –170 kJ. The system completes 100 cycles per minute. Complete the following table showing the method for each item and compute the net rate of work output in KW.

Process	Q (kJ/min)	W (kJ/min)	ΔE (kJ/min)
a – b	0	-2,170	–
b – c	21,000	0	–
c – d	–2100	–	–36,600
d – a	–	–	–

(10 Marks)

OR

4 a. State Kelvin Planck's and Clausius statements of 2nd law of thermodynamics. Prove that they are equivalent. **(10 Marks)**

b. Two Carnot Engines A and B are connected in series between two thermal reservoirs maintained at 1000 K and 300 K respectively. Engine A receives 1750 kJ of heat from the high temperature reservoir and rejects heat to the Carnot Engine B. Engine B takes in heat rejected by engine A and rejects heat to the low temperature reservoir. If engine A and B have equal thermal efficiencies, determine:

(i) Heat rejected by engine B

(ii) The temperature at which heat is rejected by engine A.

(iii) The work done during the process by engine A and B respectively. **(10 Marks)**

Module-3

5 a. Sketch and explain working of Carnot engine. **(10 Marks)**

b. A heat engine absorbs 200 kJ/s of heat at 227°C and rejects heat at 27°C. Three separate cases of heat rejection are reported. (i) 180 kJ/s heat rejected (ii) 120 kJ/s heat rejected (iii) 60 kJ/s heat rejected. Classify each cycle. **(10 Marks)**

OR

6 a. With a neat diagram, explain P-V-T surface. **(06 Marks)**

b. With a neat diagram, explain the working of throttling calorimeter. **(06 Marks)**

c. The following data were recorded in a test on a combined separating and throttling calorimeter. Pressure of steam sample = 15 bar ; Pressure of steam at exit = 1 bar ; Temperature of steam at exit = 150°C ; Discharge from separating calorimeter = 0.5 kg/min ; Discharge from throttling calorimeter = 0.5 kg/min . Determine the dryness fraction of steam sampled. **(08 Marks)**

Module-4

7 a. With a neat sketch, explain the working of vapour absorption refrigeration system. **(10 Marks)**

b. A vapour compression refrigeration system of 10 tonnes capacity using Freon–12 as the refrigerant has an evaporator temperature of –10°C and condenser temperature of 30°C. Assuming simple saturation cycle. Determine: (i) Mass flow rate of refrigerant in kg/min (ii) Power input (iii) COP. Take C_{pv} = 0.72 kJ/kgK **(10 Marks)**

OR

8 a. Define the following terms: (i) Dew point (ii) Relation humidity (iii) Absolute humidity (iv) Degree of saturation (v) Dry bulb temperature (vi) Wet bulb temperature. **(06 Marks)**

b. For a hall to be air conditioned, the following conditions are given Outdoor Conditions 40° DBT, 20°CWBT required indoor conditions 20° DBT, 60% RH. Seating capacity of the hall – 1500. Amount of outdoor air supplied – 0.3 m^3/min per person. If the required condition is achieved first by adiabatic humidification and then by cooling. Estimate: (i) Capacity cooling coil in tons (ii) The capacity of humidifier in kg/hr. **(10 Marks)**

c. With the help of psychrometric chart, explain the various psychrometric processes. **(04 Marks)**

Module-5

9 a. Define the isothermal efficiency and derive an expression for the same for a reciprocating air compressor. **(06 Marks)**

b. A single stage double acting compressor is required to deliver 14 m^3 of air per minute measured 1.013 bar and 15°C. The delivery pressure is 7 bar and the speed is 300 rpm. Take the clearance volume is 5% of swept volume with a compression and expansion index of n = 1.3. Calculate the swept volume of the cylinder delivery pressure and indicated power. **(10 Marks)**

c. Explain multi-stage compression. **(04 Marks)**

OR

10 a. Draw P-V and T-S diagrams for Brayton cycle and derive an expression for its thermal efficiency. **(08 Marks)**

b. In a simple gas turbine plant air is compressed from 1 bar and 25°C through pressure ratio 4:1. It is then heated by 150°C in a combustion chamber and expanded back to atmospheric pressure of 1 bar in the turbine. Calculate cycle efficiency and turbine outlet temperature. **(04 Marks)**

c. A simple gas turbine plant operating on Brayton cycle has air entering the compressor at 100 kPa and 27°C. The pressure ratio is 9.0 and the maximum cycle temperature = 727°C. What will be the percentage change in the cycle efficiency and net work output if the expansion in the turbine is divided into two stages of pressure ratio 3, with intermediate reheating to 727°C. Assume compression and expansion are isentropic. **(08 Marks)**