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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

April 2024 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Industrial Engineering and Management **Duration: 3 hrs.**
Course Code: 22IM3PCETD **Max Marks: 100**
Course: Engineering Thermodynamics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) Distinguish between the following with example for each: **06**
i). Microscopic and Macroscopic Approach
ii). Open system and Closed system
iii). Intensive and extensive properties.

b) Discuss the thermodynamic equilibrium and state zeroth law of Thermodynamics with its significance **08**

c) Two Celsius thermometers A and B with temperature readings T_A and T_B agree at ice point and steam point, but else where they are related by **06**

$$T_A = p + qT_B + rT_A^2,$$

Where, p, q and r are constants. When the thermometers are immersed in an oil bath, A shows a temperature of 51 °C, while B shows 50°C. Determine the temperature T_A when T_B is 25°C.

UNIT - II

2 a) Explain the thermodynamic definition of work and enumerate the dissimilarity between Heat and work. **06**

b) Derive an expression for the work done during adiabatic expansion process. **06**

c) Consider a gas contained in a piston–cylinder assembly as the system. The gas is initially at a pressure of 1000 kPa and occupies a volume of 0.1 m^3. The gas is taken to the final state where pressure is equal to 200 kPa, by the following two different processes. **08**

i). The volume of the gas inversely proportional to the pressure.
ii). The process follows the path pV^n =constant, where n =1.4.

UNIT - III

3 a) State the first law of thermodynamics for a closed system undergoing a change of state. Show that energy is a point function. **06**

b) Distinguish between the following: **08**

i). Internal Energy and Enthalpy of a system

ii). Specific heat at constant Pressure and constant volume

c) A steam turbine operating under steady flow conditions receives 3600 kg of steam per hour. The steam enters the turbine at a velocity of 80 m/s an elevation of 10 m and specific enthalpy of 3276 kJ/kg. It leaves the turbine at a velocity of 150 m/sec, an elevation of 3m and a specific enthalpy of 2465 kJ/kg. Heat losses from the turbine to the surrounding amount to 36 MJ/hr. Estimate the power output of turbine. **06**

OR

4 a) With aid of neat sketch of open system write the steady flow energy equation starting from first law of thermodynamics for a single stream entering and a single stream leaving a control volume and explain the various terms in it. Deduces SFEE for Nozzle. Also mention assumption made. **10**

b) A gas undergoes a thermodynamic cycle consisting of the following processes: **10**

i). Process 1-2: Constant pressure p = 1.4 bar, V_1 = 0.028 m3, W_{12} = 10.5 kJ

ii). Process 2-3: Compression with pV = constant, $U_3 = U_2$

iii). Process 3-1: Constant volume, $U_1 - U_3$ = -26.4 kJ. There are no significant changes in KE and PE.

a). Sketch the cycle on a p-V diagram.

b). Calculate the net work for the cycle in kJ.

c). Calculate the heat transfer for process 1-2.

UNIT-IV

5 a) Distinguish between heat engine, heat pump and refrigerator. Prove that $COP_{Ref} = COP_{HP} - 1$ **06**

b) State Kelvin-Planck's and Clausius statements of second law of thermodynamics and prove that violation of Classius statement violates Kelvin plank' statement of second law of thermodynamics. **08**

c) Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, find (a) The intermediate temperature between A and B, (b) The efficiency of each engine (c) The heat rejected to the cold sink **06**

UNIT - V

6 a) State the assumption made in air standard cycle and with the aid of P-V and T-S explains working principles of Otto cycle. **08**

b) An engine operates on air standard Diesel cycle. The pressure and temperatures at the beginning of compression are 100kPa and 27°C. The compression ratio is 18. The heat added per kg of air is 1850 kJ. Determine (i) maximum pressure, (ii) maximum temperature, iii) thermal efficiency, iv) network done. Assume y = 1.4 and CP = 1.005 kJ/kg·K. **12**

OR

7 a) With the aid of PV and TS diagram, prove that efficiency of Carnot cycle is a function of temperature only. **10**

b) In an air-standard Otto cycle the pressure ratio during the compression is 15. The temperature of air at the beginning of compression is 37°C and maximum temperature attained in the cycle is 1950°C. Determine: **10**

i). Compression ratio,
ii). Thermal efficiency of the cycle.
iii). Work done.

Take $\gamma = 1.4$, Cv = 0.717 kJ/kg·K.

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