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

Autonomous Institute Affiliated to VTU

May 2023 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 **Date: 15.05.2023**

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) Define the following: **06**

i. Macroscopic and Microscopic approaches.
ii. Closed system and Open system.
iii. Intensive property and Extensive property

b) How temperature is measured using thermocouple? Explain with the help of neat sketch. **06**

c) The equation $R = R_0 (1 + \alpha T)$ is used to a resistance thermometer, in which R and R_0 are the resistance values at T ºC and 0 ºC respectively. The thermometer is calibrated by immersing in boiling water (100 ºC) and boiling Sulphur (445 ºC) and the indicated resistance values are 14.7 ohms and 29.2 ohms respectively. Determine the fluid temperature when resistance thermometer reads 25 ohms. **08**

UNIT - II

2 a) Explain the following with help of neat sketch: **06**

i) Paddle-wheel work.
ii) Electrical work.

b) Derive an expression for pdV-work in a reversible adiabatic process. **06**

c) 1 kg of air at 11 bar and 80 °C is expanded to 10 times the original volume by (i) isothermal process and (ii) isobaric process. Plot these two processes on a *P-V* diagram. Determine final pressure, final temperature and work done for each of these processes. Take R =287J/kg K and γ =1.4 **08**

UNIT - III

3 a) Prove that internal energy is a property of system. **06**

b) Derive an expression for SFEE. **06**

c) A blower delivers 1.2 kg/s of air at 20ºC with a power consumption of 12 kW. The inlet and outlet velocities of air are 120 m/s and 180 m/s, respectively. Assuming the adiabatic conditions, estimate the exit temperature of air. Take Cp = 1.005 kJ/kg K. **08**

UNIT - IV

4 a) Explain by means of a suitable sketch the working principle of a heat pump. **06**

b) Prove that all the reversible engines operating between same temperature limits have same Efficiencies. **06**

c) Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200kJ 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. **08**

OR

5 a) Show that COP of a heat pump is greater than COP of a refrigerator **06**

b) Explain by means of suitable sketch the meaning of Kelvin-Planck statement **06**

c) A heat engine operating between two reservoirs at temperature 627°C and 47°C. It drives a refrigerator operation between reservoirs at temperatures of 47°C and −13°C. The heat transfer to the heat engine is 2500 kJ and the network output of the combined engine and refrigerator plant is 400 kJ. The efficiency of the heat engine and the COP of the refrigerator are each 40% of their maximum possible values. (a) Estimate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 47°C. Re estimate (a) if the efficiency of the heat engine and COP of the refrigerator are each 40% of their maximum value. **08**

UNIT - V

6 a) Draw the Otto cycle on p-V and T -s diagrams mark the various processes and obtain an expression for thermal efficiency of an Otto cycle. **10**

b) In an engine working on Diesel cycle, inlet pressure and temperature are 1 bar and 17°C, respectively. Pressure at the end of adiabatic compression is 35 bar. The ratio of expansion, i.e. after constant pressure heat addition is 5. Calculate the heat addition, heat rejection and the efficiency of the cycle. Assume $\gamma = 1.4$, Cp = 1.004 kJ/kg K and Cv = 0.717 kJ/kg K. **10**

OR

7 a) Draw the Diesel cycle on p-V and T -s diagrams mark the various processes and obtain an expression for thermal efficiency of Diesel cycle. **10**

b) In an Otto cycle, air at 17°C and 1 bar is compressed adiabatically until the pressure is 15 bar. Heat is added at constant volume until the pressure rises to 40 bar. Calculate the air-standard efficiency, the compression ratio and the mean effective pressure for the cycle. Assume Cv = 0.717 kJ/kg K and R = 8.314 kJ/kmol K **10**

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