Ex/EE/ES/B/ME/T/216/2024(S)

B.E. ELECTRICAL ENGINEERING SECOND YEAR FIRST SEMESTER SUPPLEMENTARY EXAM 2024

ENGINEERING THERMODYNAMICS & HEAT POWER

Time: Three hours **Full Marks 100**

Answer all parts of a question together in one response. Combine Group A and B into a single answer script. Assume any missing data as necessary. Use of Thermodynamic Tables and Charts permitted

Group A

Answer question 1 (compulsory)

Answer any three between question No. 2,3, 4 and 5

1. Answer any 5 questions

(a)What is the difference between intensive and extensive properties?
(b) What is a quasi-equilibrium process? What is its importance in engineering?
(c) What is the state postulate?
(d) Degree of super heat, Degree of sub cooling.
(e) Explain reversibility and irreversibility
(f) Define (i) Swept volume, (ii) Cut-off ratio.
(g) What is mean effective pressure? What is its significance?

10

2. A vertical piston with freely propagating piston contains 0.1 kg air at 1.2 bar and a small electrical resistor. The resistor is wired to an external 12 volt battery. When a current of 1.5 amps is passed through the resistor for 90 seconds, the piston sweeps a volume of 0.01 m^3. Assume (i) Piston and cylinder are insulator (ii) Air behaves as an ideal gas with c_V= 700 J/kg K. Find the rise in temperature of gas. 15

3. A Carnot heat engine receives heat from a reservoir at 900°C at a rate of 800 kJ/min and rejects the waste heat to the ambient air at 27°C. The entire work output of the heat engine is used to drive a refrigerator that removes heat from the refrigerated space at -5°C and transfers it to the same ambient air at 27°C. Determine (*a*) the maximum rate of heat removal from the refrigerated space and (*b*) the total rate of heat rejection to the ambient air. 15

4. An adiabatic steam turbine in a power plant receives 5 kg/s steam at 3000 kPa, 500°C. Twenty percent of the flow is extracted at 1000 kPa, 350°C to a feed water heater, and the remainder flows out at 200 kPa, 200°C (see Fig. 1). Find the turbine power output. 15

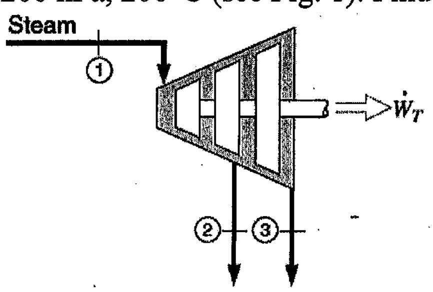

Fig. 1

[Turn over

5.	Air at 100 kPa and 280 K is compressed steadily to 600 kPa and 400 K. The mass flow rate of the air is 0.02 kg/s, and a heat loss of 16 kJ/kg occurs during the process. Assuming the changes in kinetic and potential energies are negligible, determine the necessary power input to the compressor.	15
	Group B **(Answer any three questions)**	
Q:6 (a) (b)	What is PMM2? Why is it impossible? A reversible power cycle is used to drive a reversible heat pump cycle. The power cycle takes Q1 heat units at T1 and rejects Q2 at T2. The heat pump abstracts Q4 from the sink at T4 and discharges Q3 at T3. Prove that Q4/Q1=T4(T1-T2)/T1(T3-T4).	5 10
Q:7 (a) (b)	Define entropy. Prove that entropy is a property of a system. 1 kg of water at 272K is brought into contact with a heat reservoir at 373K. When the water has reached 373K, find the entropy change of the water, of the reservoir and of the universe.	7 8
Q:8 (a) (b)	State the assumptions made in an Air standard cycle. In an air standard Diesel cycle, the compression ratio is 15 and at the beginning of the isentropic compression, the temperature is 200C and the pressure is 0.1 MPa. Heat is added until the temperature at the end of the constant pressure process is 15000C. Calculate (i) the cut-off ratio, (ii) the heat supplied per kg of air, and (iii) the cycle efficiency.	5 10
Q:9 (a) (b)	State the difficulties associated with employing Carnot cycle for a steam power plant. Consider a steam power plant operating on the ideal Rankine cycle. Steam enters the turbine at 3 MPa and 350°C and is condensed in the condenser at a pressure of 75 kPa. The mass flow rate of steam in the cycle is 15 kg/s. Determine (i) the thermal efficiency of the cycle, (ii) the net power output of the plant, and (iii) the rate of heat input in the boiler.	5 10