Graphic Era HILL UNIVERSITY

End Term (Odd) Semester Examination November 2025

Roll no.....

Name of the Course and semester: B.Tech/III (ME)
Name of the Paper: Thermal Engineering
Paper Code: TME 308

Time: 3 hour Maximum Marks: 100

Note:

(i) All the questions are compulsory.
(ii) Answer any two sub questions from a, b and c in each main question.
(iii) Total marks for each question is 20 (twenty).
(iv) Each sub-question carries 10 marks.

Q1. (2X10=20 Marks)

a. Explain first law of thermodynamics for a closed system undergoing a cycle and a change of state. [CO1]

b. If a gas of volume 6000 cm^3 and at a pressure of 100 kPa is compressed quasistatically according to pV^2 = constant until the volume becomes 2000 cm^3, determine the final pressure and the work transfer. [CO1]

c. In a steam turbine steam at 20 bar, 360°C is expanded to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. Assume ideal processes. Find the net work per kg of steam and the cycle efficiency. Relevant steam table extract is given below. [CO1]

P (bar)	Specific volume (m^3/kg)	Specific enthalpy (kJ/kg)		Specific entropy (kJ/kg K)	
	v_f	h_f	h_{fg}	s_f	s_{fg}
0.08	0.001008	173.88	2403.1	0.5926	7.6361

20 bar, 360°C Superheat table	h	3159.3 kJ/kg
	s	6.9917 kJ/kgK

Q2. (2X10=20 Marks)

a. Describe the working principle of Carnot cycle with the help of p-v and T-s diagrams. [CO2]

b. A turbine, operating under steady-flow conditions, receives 4500 kg of steam per hour. The steam enters the turbine at a velocity of 2800 m/min, an elevation of 5.5 m and a specific enthalpy of 2800 kJ/kg. It leaves the turbine at a velocity of 5600 m/min, an elevation of 1.5 m and a specific enthalpy of 2300 kJ/kg. Heat losses from the turbine to the surroundings are 16000 kJ/h. Determine the power output of the turbine. [CO2]

c. A domestic food refrigerator maintains a temperature of – 12°C. The ambient air temperature is 35°C. If heat leaks into the freezer at the continuous rate of 2 kJ/s, determine the least power necessary to pump this heat out continuously. [CO2]

Q3. (2X10=20 Marks)

a. State and explain principle of increase of entropy. [CO3]

b. Derive the following expression: [CO3]

$$\left(\frac{\partial C_p}{\partial p}\right)_T = -T\left(\frac{\partial^2 V}{\partial T^2}\right)_p$$

c. A mass of 0.25 kg of an ideal gas has a pressure of 300 kPa, a temperature of 80°C, and a volume of 0.07 m^3. The gas undergoes an irreversible adiabatic process to a final pressure of 300 kPa and final volume of 0.10 m^3, during which the work done on the gas is 25 kJ. Calculate the C_P and C_v of the gas and the increase in entropy of the gas. [CO3]

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Q4. (2X10=20 Marks)

a. Describe Otto cycle with the help of p-v & T-s diagrams. Derive an expression for efficiency of the cycle. [CO4]

b. An air standard dual cycle has a compression ratio of 16, and compression begins at 1 bar, 50°C. The maximum pressure is 70 bar. The heat transferred to air at constant pressure is equal to that at constant volume. Determine (i) the pressures and temperatures at the cardinal points of the cycle, and (ii) the cycle efficiency. (For air, C_P = 1.005 kJ/kg K, C_v = 0.718 kJ/kg K, and R = 0.287 kJ/kg K). [CO4]

c. Describe closed cycle gas turbine with neat diagram. State also its merits and demerits. [CO5]

Q5. (2X10=20 Marks)

a. Explain, with the help of a neat sketch, the principle of operation of a single stage, single acting reciprocating compressor. [CO6]

b. Discuss the advantages of vapour absorption refrigeration system over vapour compression refrigeration system. [CO

c. 1.5 kW per tonne of refrigeration is required to maintain the temperature of – 40°C in the refrigerator. the refrigeration cycle works on reversed Carnot cycle, determine (i) COP of the cycle, (ii) temperature of the sink, (iii) heat rejected to the sink per tonne of refrigeration and (iv) heat supplied, if the cycle is used as heat pump. [CO6]