B.E. ELECTRICAL ENGINEERING SECOND YEAR FIRST SEMESTER EXAMINATION, 2023

THERMODYNAMICS AND HEAT POWER ENGINEERING

Time: Three hours **Full Marks 100**

	All parts of the same question must be answered together. Assume any unfurnished data suitably Use of Thermodynamic Tables and Charts permitted	
	Group I **Answer any one question**	
1 (a)	What is meant by thermodynamic property?	
(b)	When a system is said to be in thermodynamic equilibrium?	5 x 2 = 10
(c)	State first law of thermodynamics for a closed system.	
(d)	What is the difference between heat pump and refrigerator?	
(e)	Define triple point and critical point for pure substance.	
(f)	An automobile vehicle of 1500 kg is running at a speed of 60 km/h. The brakes are suddenly applied and the vehicle is brought to rest. Calculate the rise in temperature of brake shoes, if their mass is 15 kg. Take the specific heat of brake shoes material as 0.46 KJ/kg-K.	10
2 (a)	Prove that for an isolated system, there is no change in internal energy.	2
(b)	Why is a reversible process only an ideal process, never be attained in practices?	3
(c)	A room is heated by an iron that is left plugged in. Is this a heat or work interaction? Take the entire room, including the iron, as the system.	5
(d)	A gas initially at a pressure of 510 kPa and a volume of 142 litres undergoes a process and has a final pressure of 170 kPa and a volume of 275 litres. During the process, the enthalpy decreases by 65 kJ. Take c_v=0.718 kJ/kg.K. Determine (a) change in internal energy, (b) specific heat at constant pressure, and (c) specific gas constant.	10
	Group II **Answer any three questions**	
3 (a)	Explain the term: Degree of super heat, Degree of sub cooling.	2

(b)	What is the work transfer in free expansion process? And why?	4
(c)	A rigid tank with a volume of 2.5 m^3 contains 15 kg of saturated liquid–vapor mixture of water at 75°C. Now the water is slowly heated. Determine the temperature at which the liquid in the tank is completely vaporized. Also, show the process on a T-v diagram with respect to saturation lines.	14
4 (a)	Explain reversibility and irreversibility. State the factors responsible for irreversibility of a process.	5
(b)	A reversed Carnot cycle operating as a refrigerator has a refrigerating capacity of 100 kJ/s while operating between temperature limits of -20^{0}C and 35^{0}C. Determine (a) Power input and (b) COP. If the system is used for heating purpose only, find its COP. What would be its efficiency if it runs as an engine?	15
5 (a)	Demonstrate the Kelvin-Planck and the Clausius statements. Prove that violation of Kelvin-Planck statement leads to violation of Clausius statements.	10
(b)	Consider a heat engine that receives heat at the rate of 1 MW at a high temperature of 550°C and rejects energy to the ambient at 27°C while work is produced at the rate of 450 kW. Find out how much heat is discarded to the ambient and engine efficiency. Also compare both of these values with a Carnot heat engine operating between the same two reservoirs.	10
6 (a)	What is the concept of entropy? Explain. What is entropy generation? Explain.	4
(b)	A system undergoes a process between two fixed states first in a reversible manner and then in an irreversible manner. For which case is the entropy change greater? Why?	4
(c)	Derive a general expression for the change in entropy of a system during a process.	12
	Group III	
	Answer any one question	
7 (a)	Write the drawback of Carnot cycle. Define (i) Swept volume, (ii) Cut-off ratio.	4
(b)	What is mean effective pressure? What is its significance.	4

(c)	Derive the expression of thermal efficiency of Diesel cycle with p-v and T-s diagram.	12
8 (a)	Draw a schematic diagram of a simple steam power plant and explain it.	5
(b)	Describe the effect of operating variables on Rankine cycle. (i) Effect of condenser pressure, (ii) Effect of superheating.	5
(c)	A steam power plant operating on the Rankine cycle has steam at 3.5 MPa, 400°C leaving the boiler. The turbine exhausts to the condenser operating at 10 kPa. Find the specific work and the heat transfer in each of the ideal components and the cycle efficiency.	10
9 (a)	Sketch the ideal vapour compression cycle on a T-s diagram and derived an expression for its COP.	8
(b)	What is a steady flow process? Define and explain the flow work.	5
(c)	Calculate the ideal air-standard cycle efficiency of a petrol engine operating on Otto-cycle. The cylinder bore is 50 mm, a stroke is of 75 mm and the clearance volume is of 21.3 cm^3.	7