Question Paper

Exam Date & Time: 14-Nov-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATIONS
NOVEMBER2019
III SEMESTER B.S. (ENGG.)
PRINCIPLES OF THERMODYNAMICS [ME 231]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.
Use of Thermodynamic data handbook is permitted
Missing data, if any, may be suitably assumed.

1)	A)	Differentiate the following terms with suitable examples. a. System and Surroundings b. Open system and closed system c. Statistical and applied thermodynamics d. Intensive and Extensive properties e. Point and path function f. Heat and work transfer	(6)
	B)	Explain the state of thermodynamic equilibrium of a system.	(6)
	C)	A Spherical balloon 1 m diameter contain as at 240 k Pa. When the gas inside the balloon is heated, its pressure raises to 485 kPa and pressure is being proportional to the diameter. Determine the work done by the gas inside the balloon.	(8)
2)	A)	Explain Joule's experiment of I^{st} law of thermodynamics applied to a closed system executes a complete cycle	(6)
	B)	Show that the energy of a system is a property of a thermodynamic system.	(6)
	C)	A quantity of gas occupying 0.14 m^3 at a pressure of 1400 kPa and 300^0C is expanded isentropically to 280 kPa pressure. Calculate, (a) Mass of gas, (b) Final temperature, (c) work transfer, and d) change in entropy.	(8)
3)	A)	Explain the first law of thermodynamics applied to a closed system executing a cyclic process and an open system executing a process.	(4)
	B)	Explain and derive the expression for the work transfer for the following processes with help of P-V diagrams i) Polytropic ii) Isothermal iii). Adiabatic iv) Isochoric v) Isobaric process.	(6)
	C)	In a rotary compressor air flow steadily at a rate of 1.5 kg/s. The air enters with a velocity of 80 m/s and leaves at 4.5 m/s. The specific volume at inlet is 0.9 m^3/ kg and at the exit is 0.4 m^3/kg. As the air passes through the compressor, the specific enthalpy of air is increased by 110 kJ/kg and	(10)

losses heat of 20 kJ/kg. Determine, a) The inlet and exit areas of the compressor in m^2 and, b) The power required to drive the compressor in kW.

4) A) State and explain two statements of the second law of thermodynamics and show that violation of Clausius statement equally violates the Kelvin-plank statement. (6)

B) Derive the relationship between COP of Refrigerator and Heat pump. (4)

C) A heat engine working on Carnot cycle converts one-fifth of the heat input in to work. When the sink temperature is reduced by 70^0C, the heat engine efficiency gets doubled. Determine temperature of source and sink. (10)

5) A) Prove that the efficiency of a reversible heat engine is always greater than the efficiency of an irreversible heat engine. (6)

B) State statements of the second law of thermodynamics and Explain the concept of PMM-I and PMM-II. (4)

C) A source at temperature T1K supplies heat to a reversible heat engine which rejects heat to a low temperature sink at 780 K. The sink at 780 K acts as a source for second reversible engine which rejects heat to a cold reservoir at 280 K. Determine T1, (a) For equal thermal efficiencies of both engines, and (b) When two engines deliver the equal amount of work. (10)

6) A) Define thermodynamic temperature scale and derive Q1/Q2 = T1/T2. (6)

B) Explain Clausius inequality of the second law of thermodynamics. (6)

C) During the polytropic expansion of 1 kg of air the pressure reduces from 8 bar to 1 bar. The temperature of air is 350 K. Determine (i) The specific volume and temperature after expansion (ii) change of internal energy, work done and heat interaction, (iii) Increase in entropy. Take R= 287 J/kg.k, γ =1.4 and n=1.2. (8)

7) A) With sketch explain the working principle of combined separating & throttling calorimeter (6)

B) Explain with a PVT diagram indicating clearly solid, liquid and vapour regions. (6)

C) During a polytropic expansion, steam changes its conditions from 15 bar and 300^0C to 1 bar. If the index of expansion is 1.2. Find a) Specific volume and temperature after expansion, b) Heat interaction and c) Change in entropy. (8)

8) A) Define the following terms applied to a mixture of ideal gases. i)Mole fraction ii) Volume fraction iii) Mass fraction iv) Partial pressure ratio (4)

B) Explain Gibb's Dalton law and derive expression for gas constant R and molecular weight M of mixture of gases (6)

C) Air at a pressure of 15 bar and a temperature of 240^{0}C expands according to law $PV^{1.3} = C$ to a pressure of 1.5 bar. Show the process on P-V and T-S diagrams. Also determine the work done heat transfer and change in entropy of the system if it contains 0.85 kg of air. (10)

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