Question Paper

Exam Date & Time: 31-Dec-2019 (08:30 AM - 11:30 AM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

THIRD SEMESTER B.TECH MECHANICAL END SEMESTER MAKE UP EXAMINATIONS, DEC 2019

THERMODYNAMICS -I [MME 2155]

Marks: 50 **Duration: 180 mins.**

Instructions to Candidates:
Answer ALL the questions
Missing data if any may be suitably assumed
Thermodynamic data handbook is permitted.

1)	A)	Define the following (i) Process (ii) Closed system (iii) Thermodynamic work (iv) Zeroth Law of thermodynamics	(2)
	B)	Define internal energy and show that it is property of the system	(3)
	C)	A centrifugal pump delivers 60 kg of water per second. Inlet and outlet pressures are 100 kPa and 500 kPa respectively. Suction is 2 m below the centre of the pump and delivery is 8 m above the centre of the pump. Determine the capacity of the electric motor to run the pump. Suction and delivery pipes are 20 cm and 10 cm in diameter respectively.	(5)
2)	A)	Briefly discuss the limitations of the first law of thermodynamics.	(2)
	B)	Define Clausius statement of Second law of thermodynamics. Prove that violating Clausius statement will also violate Kelvin Planck's statement.	(3)
	C)	Two reversible heat engines A and B are arranged in series. A rejects heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from the hot source at A while engine B is in communication with a cold sink at a temperature of 5°C. If the work output of A is twice that of B find (a) Intermediate temperature between A and B (b) Efficiencies of both engines (c) heat rejected to the sink.	(5)
3)	A)	Draw the phase equilibrium diagram p-V for the pure substance that expand on freezing explain all the phases and phase boundaries	(2)
	B)	How do you determine the dryness fraction if steam is in extremely wet condition? Explain with a sketch a sketch.	(3)
	C)	Ten kg of water at 45°C is heated at constant pressure of 10 bar until it becomes superheated vapour at 300°C. Find the changes in volume, enthalpy, internal energy and entropy	(5)
4)	A)	Prove Clausius inequality of providing criteria for reversibility of the cycle.	(3)
	B)	Derive the following equation for the polytropic process	(3)

$$Q_{1-2} = C_v \frac{\gamma - n}{1 - n} \Delta T$$

C) A mixture of perfect gases at 20°C contains 55% N_2, 20% O_2 and 25% CH_4 by volume. If the partial pressures of CH_4 is 50 kPa, determine (a) Partial pressures of O_2 and N_2 (b) Mass proportions of the mixture (c) Gas constant and volume per mole of the mixture. (4)

5) A) Prove that for a reversible adiabatic process $pV^{\gamma} = C$ (3)

B) A lump of ice with mass 1.5 kg with an initial temperature of 260 K melts at the pressure of 1 bar and after some time resulting water attains the environmental temperature of 293K. Calculate the entropy change of the universe associated with the process. Take latent heat of fusion of ice as 333.4 kJ/kg, specific heat of ice and water are 2.07 and 4.2 kJ/kg K respectively and ice melts at 273.15 K. (3)

C) One kg of air at 7 bar and 90°C undergoes a non-flow process which follows $pv^{1.1} = C$ till its pressure falls to 1.4 bar. Find (a) final temperature, specific volume change in entropy (b) work done and heat transfer. (4)

-----End-----