Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY

III SEMESTER B.TECH (MECHANICAL ENGG.) END SEMESTER

EXAMINATIONS, DEC 2017

SUBJECT: THERMODYNAMICS I [MME 2101]

REVISED CREDIT SYSTEM

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ALL the questions.
- Missing data may be suitably assumed.
- ✤ Use of Thermodynamics data hand book is permitted
- **1A.** State the following laws of thermodynamics: (i) Zeroth law (ii) First law of **2** applied for a closed system undergoing change of state.
- 1B. Write the SFEE with usual notations and reduce the same under ideal 3 conditions for the following cases: (i) Turbine (ii) Adiabatic nozzle (iii) Throttle valve.
- 1C. Two kg of air is compressed reversibly according to Pv^{1.3} =C from 1 bar 37^oC to 5 bar. Find the (i) increase in internal energy, (ii) heat transfer (iii) magnitude and direction of work transfer.(iv) Entropy change
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- 2A. Define heat engine and refrigerator with schematic diagrams. 2
- 2B. Derive an expression for change in entropy of an ideal gas in terms of specific 3 heat ratio, pressure ratio, gas constant and temperature ratio.
- 2C. One kg of steam at 10 bar absolute pressure and 50% dryness is heated at constant pressure till its dryness fraction increases to 90% and then it is heated at constant volume in a vessel reversibly until the vessel is filled completely with saturated steam. Calculate the final state of the steam and total heat supplied. Write the p-v diagram for the process.
- **3A.** Define (i) mole fraction (ii) mass fraction (iii) volume fraction (iv) partial **2** pressure fraction.
- **3B.** Prove that violation of Clausius statement leads to violation of Kelvin Plank **3** statement.

3C. A refrigerator is used to produce 800kg/hr of ice at - 4^{0} C from water at 20⁰C. The refrigerator operates between 20⁰C and $-4^{0}C$. Take C_{Pice}= 2kJ/kg K, latent heat of fusion of ice is 335kJ/kg. Calculate the power input required for the refrigerator if the actual COP is 30% of maximum possible COP. If the electricity in the region is Rs.4 per unit, calculate the monthly electricity bill for the company assuming the ice plant works in a two shifts of 8 hours in a day for 30 days in that month. What is the percentage saving in bill if the refrigerator is reversible?

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- **4A.** Define: Ideal gas, Point function, Reversible process, Pure substance
- **4B** A rigid vessel contains a mixture of 1kg of carbon monoxide (CO) and 1kg of hydrogen (H₂) at a pressure of bar and a temperature of 18 °C. Assuming CO and H₂ to be ideal gases, evaluate:
 - (a) The partial pressures of the components.
 - (b) Specific volume of the mixture.
 - (c) The Gas constant for the mixture
- **4C.** Air flows steadily at the rate of 0.4kg/s through an air compressor, entering at 6m/s with a pressure of 1bar and a specific volume of 0.85m³/kg and leaving at 4.5m/s, with a pressure of 6.9 bar and specific volume of 0.16m³/kg. The internal energy of air leaving is 88kJ/kg greater than that of air entering. Cooling water in the jacket surrounding the cylinder absorbs heat from air at the rate of 59 kW. Calculate the power required to drive the compressor and inlet and outlet cross sectional area
- **5A.** Draw the phase equilibrium diagram (P-T diagram) for water clearly showing **2** the phases and phase boundaries.
- **5B.** With a neat sketch explain the working of throttling calorimeter. What are the disadvantages of the calorimeter?
- **5C.** Ten grams of water at 20[°]C is converted into ice so that final temperature of ice is **-10[°]C** at constant atmospheric pressure. Assuming specific heat of liquid water to remain constant at 4.184 J / g [°]C and that of ice to be half of this value, and taking the latent heat of fusion of ice at 0[°]C to be 335 J / g, calculate the total entropy change of the system

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