INTERNATIONAL CENTRE FOR APPLIED SCIENCES
MAHE, MANIPAL

B.S. (ENGG.) End – Semester Theory Examinations – Nov./ Dec. 2020

III SEMESTER - PRINCIPLES OF THERMODYNAMICS – I (ME 231)

(BRANCH: MECHANICAL)

Time: 3 Hours **Date: 19 November 2020** **Max. Marks: 100**

- ✓ **Answer any FIVE full questions.**
- ✓ **Missing data, if any, may be suitably assumed**

1A. Derive an expression for displacement work of an adiabatic process. **10**

1B. To a closed system 150 kJ of work is supplied. If the initial volume is 0.6 m^3 and pressure of the system changes as p = 8 – 4V, where p is in bar and V is in m^3, determine the final volume and pressure of the system. **10**

2A. Show that energy is a property of the system. **10**

2B. A fluid system undergoes a non-flow frictionless process following the pressure-volume relation as p = (5/V) + 1.5 where p is in bar and V is in m^3. During the process the volume changes from 0.15 m^3 to 0.05 m^3 and the system rejects 45 kJ of heat. Determine (i) Change in internal energy (ii) Change in enthalpy. **10**

3A. Derive Steady Flow Energy Equation. Mention the assumptions also. **10**

3B. 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 amount to 16000 kJ/h. Determine the power output of the turbine. **10**

4A. State and prove Carnot's theorem as applicable to reversible heat engines. **10**

4B. A reversible heat engine operates between two reservoirs at temperatures 700°C and 50°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 50°C and – 25°C. The heat transfer to the engine is 2500 kJ and the network output of the combined engine refrigerator plant is 400 kJ. Determine the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C. **10**

5A. State and prove clausius theorem. **10**

5B. 3 kg of water at 80°C is mixed with 4 kg of water at 15°C in an isolated system. Calculate the change of entropy due to mixing process. **10**

6A. Draw PVT surface for water. Indicate all the relevant phases on it. **10**

6B. Determine the amount of heat, which should be supplied to 2 kg of water at

25°C to convert it into steam at 5 bar and 0.9 dry. **10**

7A. Derive the expression for Wander walls constants in terms of critical properties. **10**

7B. A rigid cylinder containing 0.004 m^3 of nitrogen at 1 bar and 300 K is heated reversibly until temperature becomes 400 K. Determine : (i) The heat supplied. (ii) The entropy change. Assume nitrogen to be perfect gas (molecular mass = 28) and take $\gamma = 1.4$. **10**

8. Write short notes on:

(a) Statements of II law of thermodynamics
(b) Thermodynamic equilibrium
(c) Quasistatic process
(d) Throttling calorimeter
(e) Clausius inequality **20**

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