Code No : **19MET304**

R19

II B. Tech I Semester Regular Examinations, March - 2021

THERMODYNAMICS

(Mechanical Engineering)

Time : 3 Hours **Max. Marks : 60**

Note : Answer **ONE** question from each unit **(5 × 12 = 60 Marks)**

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UNIT-I

1. a) Explain the Zeroth law of thermodynamics with neat sketch. Explain how it is important in establishing the temperature scale. [6M]

   b) Determine the heat transfer and its direction for a system in which a perfect gas having molecular weight of 6 is compressed from 101.3 kPa, 20^0C to a pressure of 600 kPa following the law $PV^{1.3}$ = const. Take the specific heat at constant pressure of gas as 1.7 kJ/kg K. [6M]

(OR)

2. a) Explain about the Quasi-static process. [6M]

   b) A gas of mass 1.5 kg undergoes a quasi-static expansion which follows a relationship p = a + bV, where a and b are constants. The initial and final pressures are 1000 kPa and 200 kPa respectively and the corresponding volumes are 0.20 $m^3$and 1.20 m^3. The specific internal energy of the gas is given by the relation, u = l.5 pv – 85 kJ/kg Where p is the kPa and v is in m^3/kg. Calculate the net heat transfer and the maximum internal energy of the gas attained during expansion. [6M]

UNIT-II

3. a) Explain Joule's experiment with neat sketch. [6M]

   b) A fluid contained in a cylinder receives 150 kJ of mechanical energy by means of a paddle wheel, together with 50 kJ in the form of heat. At the same time, the piston in the cylinder moves in such a way that the pressure remains constant at 200 kN/m^2 during the fluid expansion from 2 m^3 to 5 m^3. What is the change in internal energy and in enthalpy? [6M]

(OR)

4. a) Derive the steady flow energy equation and apply in to a Heat exchanger. [6M]

   b) In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12000 kW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively, and the velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Calculate: (i) The rate at which heat is rejected to the turbine, and (ii) The area of the inlet pipe given that the specific volume of the gases at the inlet is 0.45 m^3/kg. [6M]
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UNIT-III

5. a) Explain about heat engine, heat pump and PMM2. [6M]

   b) A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat for the reservoir at 300 K at a rate twice at which the engine rejects heat to it. If the efficiency of the engine is 40% of the maximum possible and the COP of the heat pump is 50% of the maximum possible, what is the temperature of the reservoir at which the heat pump rejects heat? What is the rate of heat rejection from the heat pump if the rate of heat supply to the engine is 50 kW. [6M]

(OR)

6. a) What are the causes of entropy increase? [6M]

   b) An Aluminium block of specific heat 400 J/kg.K with a mass of 5 kg is initially at 40^0C in room air at 20^0C. It is cooled reversibly by transferring heat to a completely reversible cyclic heat engine until the block reaches 20^0C. The 20^0C room air serves as a constant temperature sink for the engine. Compute (i) the change in entropy for the block (ii) the change in entropy for the room air (iii) work done by the engine. [6M]

UNIT-IV

7. a) Draw the phase equilibrium diagram for a pure substance on T-S plot with relevant constant property lines. [6M]

   b) A large insulated vessel is divided into two chambers; one contains 6 kg of dry saturated steam at 0.1 MPa and other 10 kg of steam 0.85 quality at 0.5 MPa. If the partition between the chambers is removed and the steam is mixed thoroughly and allowed to settle, find the final pressure, steam quality and entropy change in the process. [6M]

(OR)

8. a) Write down the Vander Waals equation of state. How does it differ from the ideal gas equation of state? [6M]

   b) A rigid vessel of capacity 0.2 m^3 holds 10 bar steam at 250^0C. The vessel is slowly cooled till the steam pressure drops to 3.5 bar. Determine the (i) final temperature and dryness fraction of steam; (ii) change in entropy. [6M]

UNIT-V

9. a) Prove that partial pressure of water vapour in air remains constant as long as the specific humidity of air remains constant. [6M]

   b) A gaseous mixture consists of 1 kg of oxygen and 2 kg of nitrogen at a pressure of 150 kPa and a temperature of 20^0C. Determine the changes in internal energy, enthalpy and entropy of the mixture when the mixture is heated to a temperature of 100^0C (i) at constant volume and (ii) at constant pressure. [6M]

(OR)

10. a) Write about Psychometric properties of atmospheric air [6M]

    b) An air-water vapour mixture enters an adiabatic saturator at 30^0 C and leaves at 20^0 C, which is the adiabatic saturation temperature. The pressure remains constant at 100 kPa. Determine the relative humidity and the humidity ratio of the inlet mixture. [6M]

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