TD question bank

UNIT-1

1. Define system and list out the types of systems with one example each.(2M)

2. Define a) state b)path c)process d) cycle e)reversible process and irreversible process(4M)
3. Write any three differences between microscopic and macroscopic approach. (4M)
4. Write the difference between the heat and work (4M)
5. Define quisistatic process (2M)
6. Explain the concept of continuum (2M)
7. Define zeroth law of thermodynamics (2M)
8. What is thermodynamic property and list out the types of properties with examples (4M)
9. Write the difference between the path function and point function (4M)
10. A new scale N of temperature is divided in such a way that the freezing point of ice is 100°N and the boiling point is 400°N. What is the temperature reading on this new scale when the temperature is 150°C? At what temperature both the Celsius and the new temperature scale reading would be the same? (4M)
11. The piston of an oil engine, of area 0.0045 m2, moves downwards 75 mm, drawing in 0.00028 m3 of fresh air from the atmosphere. The pressure in the cylinder is uniform during the process at 80 kPa, while the atmospheric pressure is 101.325 kPa, the difference being due to the flow resistance in the induction pipe and the inlet valve. Estimate the displacement work done by the air finally in the cylinder (4M)
12. An engine cylinder has a piston of area 0.12 m3 and contains gas at a pressure of 1.5 MPa. The gas expands according to a process which is represented by a straight line on a pressure-volume diagram. The final pressure is 0.15 MPa. Calculate the work done by the gas on the piston if the stroke is 0.30 m. (4M)
13. A mass of 1.5 kg of air is compressed in a quasi-static process from 0.1MPa to 0.7 MPa for which pv = constant. The initial density of air is 1.16 kg/m3. Find the work done by the piston to compress the air (4M)
14. A fluid, contained in a horizontal cylinder fitted with a frictionless leak proof piston, is continuously agitated by means of a stirrer passing through the cylinder cover. The cylinder diameter is 0.40 m. During the stirring process lasting 10 minutes, the piston slowly moves out a distance of 0.485 m against the atmosphere. The net work done by the fluid during the process is 2 kJ. The speed of the electric motor driving the stirrer is 840 rpm. Determine the torque in the shaft and the power output of the motor. (4M)
15. A steam turbine drives a ship's propeller through an 8: 1 reduction gear. The average resisting torque imposed by the water on the propeller is 750×10^3 mN and the shaft power delivered by the turbine to the reduction gear is 15 MW. The turbine speed is 1450 rpm. Determine (a) the torque developed by the turbine, (b) the power delivered to the propeller shaft, and (c) the net rate of working of the reduction gear. (8M)
16. A system of volume V contains a mass m of gas at pressure p and temperature T. The macroscopic properties of the system obey the following relationship:
    $(p + a/v^2)(v-b) = MRT$ Where a, b, and R are constants.
    Obtain an expression for the displacement work done by the system during a constant-temperature expansion from volume V_1 to volume V_2.Calculate the work done by a system which contains 10 kg of this gas expanding from 1 m3 to 10 m3 at a temperature of 293 K. Use the values a = 15.7 ×10 Nm4 , b = 1.07 ×10−2m3 , and R = 0.278 kJ/kg-K. (10M)

UNIT-2

1. A mass of 8 kg gas expands within a flexible container so that the p–v relationship is of the from $pv^{1.2}$ = constant. The initial pressure is 1000kPa and the initial volume is 1 m^3. The final pressure is 5 kPa. If specific internal energy of the gas decreases by 40 kJ/kg, predict the heat transfer in magnitude and direction.
2. 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

   $$u = 1.5\, pv - 85 \text{ kJ/kg}$$

   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.

3. A turbine operates under steady flow conditions, receiving steam at the following state: Pressure 1.2 MPa, temperature 188°C, enthalpy 2785kJ/kg, velocity 33.3 m/s and elevation 3 m. The steam leaves the turbine at the following state: Pressure 20 kPa, enthalpy 2512 kJ/kg, velocity 100 m/s, and elevation 0 m. Heat is lost to the surroundings at the rate of 0.29kJ/s. If the rate of steam flow through the turbine is 0.42 kg/s, what is the power output of the turbine in kW?
4. A nozzle is a device for increasing the velocity of a steadily flowing stream. At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000 kJ/kg and the velocity is 60 m/s. At the discharge end, the enthalpy is 2762 kJ/kg. The nozzle is horizontal and there is negligible heat loss from it. (a) Identify the velocity at exists from the nozzle. (b) If the inlet area is 0.1 m2 and the specific volume at inlet is 0.187m3/kg, examine the mass flow rate.

   (c) If the specific volume at the nozzle exit is 0.498 m3/kg, predict the exit area of the nozzle.
5. Show that work done in polytrophic process is $\frac{P_1 v_1 - P_2 v_2}{n-1}$
6. Show that work done in isothermal process is $P_1V_1 \ln (V_2/V_1)$
7. One mol of air at 0.5 MPa and 400 K, initially undergoes following processes, sequentially

   (a) heating at constant pressure till the volume gets doubled.

   (b) expansion at constant temperature till the volume is six times of initial volume. Report the work done by air.
8. a) State the first law of thermodynamic b) Describe about the PMM-I
9. Explain the fallowing process

   a) Isentropic process b)Free expansion process c) Throttling process

UNIT-3

1.Explain the limitations of first law of thermodynamics
2.Explain the terms a) Thermal reservoir b) Heat pump c) heat engine
3.State the kelvin-planck and clausius statements
4.State and explain the carnot theorem(carnot principle)
5.Explain about kelvin-planck and clausius equivalence
6.Derive the thermal efficiency of carnot cycle and state its specialties
7.Explain about clausius inequality
8.Two reversible heat engines A and B are arranged in series, A rejecting heat directly to B. Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C. If the work output of A is twice that of B, find
(a) The intermediate temperature between A and B
(b) The efficiency of each engine
(c) The heat rejected to the cold sink

9. A heat engine operating between two reservoirs at 1000 K and 300 K is used to drive a heat pump which extracts heat from the reservoir at 300K at a rate twice that 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 to 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
10. A heat pump is to be used to heat a house in winter and then reversed to cool the house in summer. The interior temperature is to be maintained at 20°C. Heat transfer through the walls and roof is estimated to be 0.525 kJ/s per degree temperature difference between the inside and outside.
(a) If the outside temperature in winter is 5°C, what is the minimum power required to drive the heat pump
(b) If the power output is the same as in part (a), what is the maximum outer temperature for which the inside can be maintained at 20°C?