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B.E. / B.Tech (Full Time) : DEGREE END SEMESTER EXAMINATIONS, NOV 2012

MECHANICAL ENGINEERING BRANCH

III SEMESTER

ME 9202 ENGINEERING THERMODYNAMICS

Time : 3 Hrs **Max Marks : 100**

INSTRUCTIONS

Approved Steam Tables, Mollier Chart and Psychrometric Chart Permitted
Assume any missing data with proper justification

Answer All Questions

PART A (10 x 2 = 20 Mark)

1. Differentiate point function from path function with examples from thermodynamics.
2. State Zeroth law of thermodynamics and identify its significance.
3. What are the reasons for irreversibility?
4. Calculate the enthalpy of two kg of air stored at 5 bar and 300K in the 5 m^3 air reservoir of an air compressor.
5. What are the advantages and limitations of Carnot cycle?
6. Plot the isobaric and isochoric process at a point in T – s diagram, showing their relative slope with a reason.
7. What is the state of H_2O at 10 bar and 233°C? and calculate its enthalpy.
8. Define Rankine Cycle efficiency and heat rate.
9. What is meant by By-pass-factor and Sensible heat factor?
10. Plot the adiabatic saturation process on psychrometric chart and indicate how do DBT and RH change.

PART B (5 x 16=80 Mark)

11) A system consisting of 1 kg of an ideal gas at 6 bar pressure and 0.01 m^3 volume executes a cyclic process with 3 operations (1) reversible expansion to 0.05 m^3 volume and 2 bar, by process p = a + bV, (2) reversible cooling process at constant pressure and (3) reversible hyperbolic compression process (pV = C). (i) Sketch the cycle on p-V diagram, (ii) Calculate the work done in each process with direction and net cyclic work and net cyclic heat transfer. (16)

12) (a) (i) A Carnot engine operates between reservoirs at temperature T_1 and T_2 and a second engine operates between reservoirs maintained at T_2 and T_3. Determine the efficiency of the third engine operating between T_1 and T_3 in terms of the efficiencies of the other two engines. (8)

(ii) A thermal power plant operates between the temperature limits of 600 K and 322 K, the upper temperature being maintained in the boiler where heat is received and the lower temperature being maintained in the condenser where heat is rejected. It is claimed that 2200 kJ/kg of heat is added in the boiler and 500 kJ/kg of heat is rejected in the condenser, while it produces 1700 kJ/kg of work is produced. Check the validity of the claim and explain the reason. (8)

(OR)

(b) A certain quantity of gas with a mean molecular weight of 36 kg/kmol and specific heat ratio of 1.4 is compressed in a polytropic process from 104 kPa, 1.1 m^3, 20°C to 115°C. The amount of heat rejected is 3.80 kJ. Plot the process on p – V and T – s diagram on proportionate scale. Calculate the value of polytropic index, final pressure, heat transfer, work transfer and change in entropy. (16)

13) (a) (i) What do you understand by available and unavailable energy of a Heat Source and explain with the help of suitable T-s diagram. (8)

(ii) Five kg of air at 800kPa, 375K in a leak proof cylinder piston arrangement expands adiabatically till its volume becomes 3 times its original volume. The air finally comes to thermal equilibrium with the surrounding which is at 101 kPa and 288K. Calculate the maximum possible work, change in availability and irreversibility. (8)

(OR)

(b) (i) Prove that irreversibility is proportional to change in entropy of universe. (8)

(ii) Air flows through an adiabatic compressor at 2 kg/s. The inlet conditions are 100 kPa and 310 K, and the exit conditions are 700 kPa and 560 K. Consider the surrounding to be at 298 K. Determine the change of availability and the irreversibility. (8)

14) (a) (i) Draw p – T diagram for normal substance and water and describe the reason for the change in its shape. (8)

(ii) A steam turbine under steady flow condition receives steam at the following state, pressure : 15 bar, internal energy : 2700 kJ/kg, specific volume: 0.17 m^3/kg and velocity : 100 m/s. The exhaust of steam from the turbine is at 0.1 bar with internal energy : 2175 kJ/kg, specific volume : 15 m^3/kg and velocity: 300 m/s. The intake is 3 m above the exhaust. The turbine develops 35 kW and heat loss over the surface of the turbine is 20 kJ/kg. Determine the steam flow rate. (8)

(OR)

(b) In a reheat Rankine cycle, steam enters the steam turbine at 30 bar and 400°C and expands in a high pressure steam turbine to an intermediate pressure of 3 bar at which it is reheated to 400°C before entering the low pressure turbine. The condenser pressure is 0.08 bar. If the mass flow rate of steam is 60 kg/s, calculate (i) the specific steam consumption, (ii) the net work per kg, (iii) the power output and (iv) the thermal efficiency. (8)

15) (a) (i) Describe the sensible heating and dehumidification process with suitable sketches. (8)

(ii) The condition of air in the room of 6 m x 7 m x 8 m is temperature 30°C and 60 % relative humidity. Calculate the specific humidity, dew point temperature, wet bulb temperature, mass of air and total enthalpy of air. State the assumptions made. (8)

(OR)

(b) A stream of air at 1atm pressure, 18°C and 40 % relative humidity flowing at 550 m^3/h adiabatically mixes with another stream at 1 atm, 38°C and 60 % relative humidity, flowing at 250 m^3/h to form a third stream at 1 atm pressure. Determine the temperature, specific humidity, specific enthalpy and the relative humidity of the mixed stream. (16)