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B.E / B.Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS, APRIL / MAY 2013

Mechanical Engineering
III Semester

(6)

ME 9202 Engineering Thermodynamics

(Regulation 2008)

Instructions
Use of Standard Steam and Refrigeration Tables with Charts Permitted

Time: 3 Hours   Answer ALL Questions   Max. Marks 100

PART-A (10 x 2 = 20 Marks)

1. Compare microscopic approach with the macroscopic approach.
2. Why is specific heat at constant pressure greater than that at constant volume?
3. List the major reasons for irreversibility in a system.
4. State Clausius Inequality.
5. Differentiate High Grade energy from Low Grade Energy.
6. What is meant by energy dissipation?
7. What is triple and critical point of a pure substance?
8. State the Phase Rule.
9. What is the condition of water vapour in atmospheric air?
10. What is adiabatic saturation temperature?

Part – B (5 x 16 = 80 marks)

11. In a steady flow process, the fluid flows through a machine at the rate of 15 kg/min between the entrance and exit of the machine, the relevant data regarding the working fluid is

Parameter	inlet	outlet
Velocity	5 m/s	8 m/s
Pressure	100 kPa	700 kPa
Specific volume	0.45 m^3/kg	0.125 m^3/kg

The working fluid leaves the machine with internal energy 200 kJ/kg greater than that at entrance and during the process 7200 kJ/min of heat is lost to the surroundings. Assuming entrance and exit pipes to be at the same level, calculate the shaft work and the ratio of inlet pipe diameter to outlet pipe diameter. (16)

12. a) (i) State Carnot theorem and explain its implications (6)

(ii) Two Carnot refrigerators A and B operates in series. The refrigerator A absorbs energy at the rate of 1 kJ/s from a body at 300 K and rejects energy as heat to a body at T. The refrigerator B absorbs same quantity of energy which is rejected by the refrigerator A from the body at T, and rejects energy as heat to a body at 1000K. If both refrigerators have the same COP, calculate: (i) the temperature T of the body, (ii) The COP of the refrigerators and (iii) the rate at which energy is rejected as heat to the body at 1000K and (iv) total power consumed (10)

OR

b) (i) What do you understand by thermodynamic temperature scale? What are its features. (6)

(ii) A lump of steel of mass 8 kg at 1000 K is dropped in 100 kg of oil at 300 K. Make calculations for the entropy change of steel, the oil and the universe. Also identify the nature of the process. Take specific heat of steel and oil as 0.5 kJ/kg K and 3.5 kJ/kg K, respectively. (10)

13. a) Air expands in a turbine adiabatically from 500 kPa, 400 K and 150 m/s to 100 kPa, 300 K and 70 m/s. The environment is at 100 kPa, 17°C. Calculate per kg of air (i) the max work output (ii) the actual work output and (iii) irreversibility. (16)

OR

b) Air enters a centrifugal compressor at 101 kPa, 30°C, from the atmosphere with negligible kinetic and potential energy. If it leaves at 4.5 bar, 177°C and 100 m/s. Determine (i) the index of compression, (ii) the type of the process, (iii) the minimum work input required and (iv) the irreversibility. (16)

14. a) Steam initially at 10 bar pressure and 400°C expands isentropically in a steam turbine to 0.1 bar. (i) Determine the final condition of steam and the ideal work produced per kg, (ii) If the entropy increases by 10% due to irreversibility, identify the final condition of steam and the actual work produced per kg, and (iii) Find the isentropic efficiency of the steam turbine, taking it as the ratio of actual to ideal work. (16)

OR

b) In a Rankine cycle, steam enters the turbine at 30 bar and 400°C and expands at 90% isentropic efficiency to the condenser pressure of 0.5 bar. The isentropic efficiency of the pump is 80%. If the mass flow rate of steam is 40 kg/s, (i) calculate the specific steam consumption, (ii) the network per kg, (iii) the power output and (iv) the thermal efficiency. (16)

15. a) (i) Compare relative humidity with specific humidity. (6)

(ii) A room of 300 m^3 capacity is filled with air at 38°C DBT and 70 % RH at 100 kPa pressure. Find the specific humidity, the dew point temperature, mass of dry air and water vapour in the room (10)

OR

b) In an air stream of 12000 m^3/h at 25°C dry bulb temperature and 12°C wet bulb temperature, 72 kg/h of saturated steam at 100°C is added. If the whole process takes place at 1 atm pressure, find the specific humidity, specific enthalpy, dry bulb temperature, wet bulb temperature, and relative humidity of the final air. (16)