B.E. / B.Tech (FT) DEGREE END SEMESTER EXAMINATIONS, APRIL / MAY 2014

MECHANICAL ENGINEERING BRANCH

III Semester

Regulation : 2012

ME 8301 ENGINEERING THERMODYNAMICS

INSTRUCTIONS

Use of Standard Steam Tables, Mollier, Compressibility and Psychrometric Chart permitted
Assume any data required suitably with proper justification

Answer All Questions

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

PART A (10 X 2 = 20 Mark)

1. Differentiate macroscopic approach from microscopic approach?
2. What is meant by thermodynamic equilibrium?
3. Draw reversed Carnot cycle and label the processes properly.
4. Give 2 examples each for low and high grade energy.
5. What is latent heat of fusion?
6. What is economiser?
7. Write a equation of state for a real gas.
8. What is reduced property?
9. What is the relationship between the molar and mass fractions?
10. What is relative humidity?

PART B (5 x 16=80 Mark)

11) (i) Establish the relationship between the Celsius and Fahrenheit scale through zeroth law of thermodynamics. (6)

(ii) Carbon dioxide contained in a piston-cylinder device is compressed from 0.3 to 0.1m^3. During the process, pressure and volume are related by $p = aV^{-2}$ where a = 8 kPa.m^6, calculate the magnitude of work transfer and its direction. (10)

12) a) (i) Prove that Kelvin Planck statement is equivalent to Calusius statement of Second law. (6)

(ii) 50 kg of water at 40°C and enough ice at –5°C are mixed together in an adiabatic container, find the mass of ice used and the total entropy change in the process if at the end of the process all the ice melts and both water and ice are left at 0°C. Also calculate the change in entropy of water and ice to prove the principle of increase in entropy (10)

(OR)

b) (i) Define second law efficiency of the heat engine and refrigerator. (6)

(ii) A lead storage battery is able to deliver 5.2MJ of electrical energy. This energy is available for starting the car. Suppose we wish to use compressed air for doing an equivalent amount of work in starting the car. The compressed air is stored at 7 MPa, 25°C. What volume of tank would be required to have the compressed air having availability 5.2MJ? Take, p_0 = 101325 Pa, T_0= 298 K as atmospheric conditions. (10)

13) a) (i) Draw the p – v - T surface for water. (6)

(ii) An ideal Rankine cycle operates between the pressures 30 bar and 0.5 bar. The temperature of the steam at the turbine inlet is 400°C. The mass flow rate of the steam is 40 kg/s. Plot the cycle on h-s diagram and calculate the power output and the thermal efficiency. (10)

(OR)

b) (i) Briefly describe the merits of combined cycles. (6)

(ii) In a regenerative Rankine cycle, 100 kg/s of steam enters the steam turbine at 30 bar and 400°C and expands in a steam turbine to a condenser pressure of 0.5 bar. If steam is extracted at 4 bar for open feed water heating such that the boiler feed water reaches the saturation temperature in the heater, calculate the network per kg, the power output and the thermal efficiency. (10)

14) a) (i) Explain the principle of corresponding states and compressibility factor. (6)

(ii) The pressure and volume of certain air is found to obey the rule $\left(p+\frac{a}{V^2}\right)(V-b)=mRT$. Obtain an expression for displacement work during isothermal process, where volume changes from initial volume, V_1 to final volume, V_2. If m = 10 kg, V1 = 1m^3, V2 = 10 m^3 at 293 K. Take a = 15.7 Nm^4, b = 1.07 x 10^{-2} m^3 and R =287 J/kg.K. (10).

(OR)

b) (i) Derive Tds equation in terms of volume and temperature. (6)

(ii) Derive the relationship for the Joule Thomson Coefficient and deduce its value for an ideal gas.(10)

15) a) (i) State Dalton's and Amagat's law. (6)

(ii) A gas mixture consists of 7 kg nitrogen and 2 kg oxygen, at 4 bar and 27°C. Calculate the mole fraction, partial pressures, molar mass, gas constant, volume, and density. (10)

(OR)

b) (i) Explain the sensible heating process (6)

(ii) A stream of air at 1atm pressure, 20°C and 40 % relative humidity flowing at 400 kg/h adiabatically mixes with another stream at 1 atm, 33°C and 75 % relative humidity, flowing at 200 kh/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..(10)