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Question Paper Code : 57539

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Third Semester

Mechanical Engineering

ME 6301 – ENGINEERING THERMODYNAMICS

(Common to Automobile Engineering and Mechanical and Automation Engineering)

(Regulations 2013)

Time : Three Hours **Maximum : 100 Marks**

(Use of approved Thermodynamics Tables, Mollier diagram, Psychrometric chart and Refrigerant property tables permitted in the Examinations)
Answer ALL questions.

PART – A (10 × 2 = 20 Marks)

1. Write down the equation for first law for a steady flow process.

2. Give the energy equation applicable for an adiabatic nozzle and an adiabatic turbine.

3. A reversible heat engine operates between a source at 800 °C and a sink at 30 °C. What is the least rate of heat rejection per KW network output of the engine. ?

4. Define Irreversibility ?

5. State the phase rule for pure substance.

6. Mention the two working fluids used in binary vapour cycle.

7. What are reduced properties ? Give their significance ?

8. What is the importance of Joule-Thomson coefficient ?

9. State Dalton's law of partial pressure. On what assumptions this law is based ?

10. What is adiabatic mixing and write the equation for that ?

PART – B (5 × 16 = 80 Marks)

11. (a) A mass of air is initially at 260 °C and 700 kPa, and occupies 0.028 m^3.The air is expanded at constant pressure to 0.084 m^3. A polytropic process with n = 1.5 is then carried out followed by a constant temperature process which completes a cycle. All the process are reversible.

(1) Sketch the cycle in T-S and P-V planes

(2) Find the heat received and heat rejected in the cycle.

(3) Find the efficiency of the cycle. **(16)**

OR

(b) (i) A room for four person has 2 fans ,each consuming 0.18 kW power, and three 100 W lamps. Ventilation air at the rate of 80 kg/hr enters with an enthalpy of 84 kJ/kg and leaves with an enthalpy of 59 kJ/kg. If each person puts out heat at the rate of 630 kJ/hr. Determine the rate at which heat is removed by a room cooler, so that a steady state is maintained in the room. **(8)**

(ii) An insulated rigid tank of 1.5 m^3 of air with a pressure of 6 bar and 100 °C discharges air in to the atmosphere which is at 1 bar through a discharge pipe till its pressure becomes 1 bar.

(1) Calculate the velocity of air in the discharge pipe.

(2) Evaluate the work that can be obtained from the frictionless turbine using the kinetic energy of that air. **(8)**

12. (a) A heat engine operating between two reservoirs at 1000 k and 300k is used to drive a heat pump which extracts heat from the reservoir at 300 k 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 ? **(16)**

OR

(b) (i) 50 kg of water is at 313 K and enough ice at –5 °C is mixed with water in an adiabatic vessel such that at the end of the process all the ice melts and water at 0 °C is obtained. Find the mass of ice required and the entropy change of water and ice. Given C_p of water = 4.2 kJ/kgK, C_p of ice = 2.1 kJ/kgk and latent heat of ice= 335 kJ/kg. **(10)**

(ii) A heat engine receives 800 kJ of heat from the reservoir at 1000 K and rejects 400 kJ at 400k. If the surrounding is at 300 K, calculate the first and the second law efficiency, and the relative efficiency of the heat engine. **(6)**

13. (a) A large insulated vessel is divided into two chambers, one containing 5 kg of dry saturated steam at 0.2 MPa and the other 10 kg of steam, 0.8 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. **(16)**

OR

(b) (i) Why is Carnot cycle not practicable for a steam power plant ? **(4)**

(ii) In a steam power plant the condition of steam at inlet to the steam turbine is 20 bar and 300 °C and the condenser pressure is 0.1 bar. Two feed water heaters operate at optimum temperatures. Determine: (1) The quality of steam at turbine exhaust, (2) network per kg of steam, (3) cycle efficiency, (4) the steam rate. Neglect pump work. **(12)**

14. (a) (i) A vessel of volume 0.28 m^3 contains 10 kg of air at 320 K. Determine the pressure exerted by the air using a) perfect gas equation b) Vander walls equation c) Generalised compressibility chart.(Take critical temperature of air as 132.8 K and critical pressure of air as 37.7 bar). **(10)**

(ii) Draw a neat schematic of a compressibility chart and indicate its salient features. **(6)**

OR

(b) What is meant by phase change process ? Derive Clausius-Clapeyron equation for a phase change process. Give the significance of this equation. **(16)**

15. (a) A rigid tank of 5 m^3 contains gas mixture comprising 3 kg of O_2, 4 kg of N_2 and 5 kg of CO_2 at 290 K. Calculate the molar specific volume, initial pressure of the gas. If it is heated to 350 K, calculate the heat transfer and change in enthalpy. Also verify the Gibbs theorem for entropy. **(16)**

OR

(b) A room 7m*4m*4m is occupied by an air-water vapour mixture at 38 °C. The atmospheric pressure is 1 bar and the relative humidity is 70%. Determine the humidity ratio, dew point, mass of dry air and mass of water vapour. If the mixture of air-water vapour is further cooled at constant pressure until the temperature is 10°C. Find the amount of water vapour condensed. **(16)**
