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10ME/AU/PM/TL33

Third Semester B.E. Degree Examination, June 2012

Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer FIVE full questions, selecting at least TWO questions from each part.***
2. Use of steam tables/thermodynamic tables permitted.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

PART – A

1 a. Distinguish between following with an example for each :
i) Intensive and extensive property
ii) Point and path function
iii) Quasistatic and actual process. **(12 Marks)**

b. The readings t_A and t_B of two Celsius thermometers A and B agree at the ice point (0^oC) and steam point (100^oC), but elsewhere they are related by the equation $t_A = l + mt_B + nt_B^2$, where l, m and n are constants. When both the thermometers are immersed in a well stirred bath, A registers 51^oC whereas B registers 50^oC. Determine the reading on B when A registers 25^oC. **(08 Marks)**

2 a. Define thermodynamic heat and work. **(04 Marks)**

b. Derive an expression for displacement work for polytropic process. **(06 Marks)**

c. A spherical balloon has an initial diameter of 25cm and contains air at 1.2 bar. Because of heating, the diameter of the balloon increases to 30cm and during the heating process the pressure is found to be proportional to the diameter, calculate the work done during the process. **(10 Marks)**

3 a. State and derive an equation for steady state steady flow process. **(08 Marks)**

b. Show that energy is a property of system. **(06 Marks)**

c. Air flows steadily at the rate of 0.5 kg/s through an air compressor, entering at 7m/s velocity, 100 kpa pressure, and 0.95 m^3/kg volume and leaving at 5m/s, 700 kpa, and 0.19m^3/kg. The internal energy of the air leaving is 90 kJ/kg greater than that of the air entering. Cooling water in the compressor jackets absorbs heat from the air at the rate of 58 kW. Compute the rate of shaft work input to the air in kW. **(06 Marks)**

4 a. Give Kelvin-Plank and Clausius statements of second law of thermodynamics and show that they are equivalent. **(10 Marks)**

b. A reversible heat engine operates between two reservoirs at temperatures of 600^oC and 40^oC. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 40^oC and -20^oC. The heat transfer to the heat engine is 2000 kJ and the network output of the combined engine refrigerator plant is 360 kJ.
Evaluate the heat transfer to the refrigerant and net heat transfer to the reservoir at 40^oC. **(10 Marks)**

PART – B

5 a. State and prove "Clausius inequality". **(06 Marks)**

b. Define entropy and prove that it is a property of a system. **(06 Marks)**

c. 2 kg of water at 80°C are mixed adiabatically with 3 kg of water at 30°C in a constant pressure process of 1 atmosphere. Determine the increase in entropy due to the mixing process. Assume for water $c_p = 4.187$ kJ/kg. **(08 Marks)**

6 a. Sketch and explain separating and throttling calorimeter to find out the dryness fraction of pure substance. **(08 Marks)**

b. Draw the phase equilibrium diagram for water on P-T coordinates indicating triple and critical point. **(04 Marks)**

c. Steam initially at 1.5 MPa, 300°C expands reversibly and adiabatically in a steam turbine to 40°C. Determine the ideal work output of the turbine per kg of steam. **(08 Marks)**

7 a. Show that for reversible adiabatic process PV^{γ} = constant with usual notations. **(05 Marks)**

b. Explain the following :

i) Maxwell's relations.

ii) Clausius-Clapeyron equation. **(08 Marks)**

c. 2 kg of air undergoes a polytropic process from 330K and $0.15m^3$ to 550K and $0.02m^3$. Determine : i) work transfer ; ii) heat transfer ; iii) change in enthalpy ; iv) change in entropy. **(07 Marks)**

8 a. Write a brief note on compressibility factor and compressibility chart. **(04 Marks)**

b. State Gibb's Dalton law of partial pressures and hence derive an expression for the gas R of a mixture of gases. **(06 Marks)**

c. A mixture of ideal gases consists of 3kg of nitrogen and 5kg of carbon dioxide at a pressure of 300kpa and a temperature of 20°C. Find :

i) Mole fraction of each constituent.

ii) The equivalent molecular weight of the mixture.

iii) The equivalent gas constant of the mixture.

iv) The partial pressure and partial volume.

v) The volume and density of the mixture. **(10 Marks)**

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