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MMTP-102

M.E./M.Tech., I Semester

Examination, December 2014

Thermodynamics and Combustion

Time : Three Hours

Maximum Marks : 70

Note: Attempt any five questions out of eight questions. Draw suitable diagram and assume suitable data wherever required.Use of steam table is permitted.

1. a) State first law of thermodynamics. Explain PMM1 and its converse.
   b) In a gas turbine the gas enters at the rate of 4 Kg/s with a velocity of 50 m/s and enthalpy of 900 KJ/Kg; and leaves the turbine with a velocity of 150 m/s and enthalpy of 400 kJ/kg. The loss of heat from the gases to the surroundings is 25 kJ/Kg. Assume for real gas R= 0.287 kJ/kg K and Cp= 1.005 kJ/kg K. The inlet conditions to be at 100KPa and 27°C. Determine the power output of the turbine and the diameter of the inlet pipe.

2. a) Explain different types of thermodynamic equilibrium.
   b) Explain local equilibrium conditions viz $(\delta s)_{u,v} = 0$.

3. a) Find the enthalpy and internal energy of steam when the pressure is 2 MPa and the specific volume is 0.11 m^3/Kg.
   b) Explain the law of corresponding states. With the help of this compute the value of R in terms of critical properties (Pc, Vc and Tc).

4. a) Draw the phase equilibrium diagram for water on T-S plot and show the following: liquid, two phase and superheated region; critical point; water line; saturated vapour line and dryness fraction lines.
   b) 10 Kg of water at 45°C is heated at a constant pressure of 10 bar until it becomes superheated vapour at 300°C. Find the change in volume, enthalpy and internal energy.

5. a) Determine minimum quantity of air required for complete combustion of 1Kg of fuel, whose mass analysis is known and volumetric analysis of dry flue gases are also known to us.
   b) Convert the mass analysis of dry flue gases into volumetric analysis: CO= 1%, CO_2 = 15%, O_2= 8% and N_2 = 76%.

6. a) A fluid is confined in a cylinder by a spring loaded, frictionless piston so that the pressure in the fluid is a linear function of the volume (P = a+bV). The internal energy of the fluid is given by the following equation: U = 34+3.15pV, where U is in KJ,p in KPa and V in m^3. If the fluid changes from an initial state of 170KPa, 0.03 m^3 m^3 to a final state of 400 KPa, 0.06 m^3, with no work other than that done on the piston. Find the direction and magnitude of the work and heat transfer.
   b) A vessel of volume 0.05 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 8Kg. Find the pressure, the mass, the specific volume and the internal energy .

7. a) Draw the phase equilibrium diagram on P-T coordinates for a pure substance and show the following on the diagram: solid, liquid and vapour region; critical and tripal points; fusion, sublimation and vaporization curve.
   b) An unknown hydrocarbon has the following Orsat analysis: CO_2 = 13%, CO = 0.3%, O_2 = 3.1% and N_2 = 83.6%. Determine the fuel composition on mass basis, A:F and stoichiometric A:F.

8. Attempt any four of the following:
   i) Show that for isothermal process change in internal energy is zero.
   ii) Define steady state and steady flow
   iii) Write different statements of second law of thermodynamics.
   iv) Define latent heat of vaporization and latent heat of sublimation.
   v) Define triple point. Write properties (P, V and T) of water at this point.

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