S.E. Sem. III [MECH/AUTO]

Thermodynamics

Time : 3 Hrs.] Prelim Question Paper **[Marks : 80**

N.B.: (1) Question No. **1** is **compulsory**.
(2) Solve any three questions from remaining four question.
(3) Assume suitable data.
(4) Use of Mollier Chart and Steam Table is permitted.

1. Explain any FOUR of the following: **[20]**
(a) State and explain Maxwell relations.
(b) Claussius inequality.
(c) Adiabatic flame temperature.
(d) Second law of thermodynamics.
(e) Joule's experiment.
(f) Second law efficiency.

2. (a) State and prove Clausius Theorem. **[8]**
(b) A power washer is being used to clean the walls of house. Water at the rate of 0.1 kg/s enters at 20°C and 1 atm, with the velocity 0.2 m/s. The jet of water exits at 23°C, 1 atm with a velocity 50 m/s at an elevation of 5 m. At steady state the magnitude of the heat transfer rate from power unit to the surrounding is 10% of the power input. Determine the power input to the motor in KW. **[12]**

3. (a) State and derive steady flow energy equation and apply it to a boiler condenser, nozzle and turbine. **[8]**
(b) Liquid Octane C_8H_{18} at 25°C is used as fuel. Air used is 150% of theoretical air and is supplied at 25 °C. Assume a complete combustion and the product leaves the combustion chamber at 1600K. Calculate heat transfer per kg mole of fuel. use the following data : **[12]**

Substance	h_f^0 (MJ/Kmole)	h_{298K} (MJ/Kmole)	h_{1500K} (MJ/Kmole)
C_8H_{18}	− 250	−	−
O_2	−	8.68	52.96
N_2	−	8.67	50.57
H_2O (gas)	−241.8	9.9	62.75
CO_2	−393.5	9.36	76.95

4. (a) Plot the Rankine cycle on T-S diagram and derive an expression for thermal efficiency of the cycle. List different methods of improving the performance of the cycle. Discuss any one method in brief. **[8]**

(b) Water at 40° C is continuously sprayed into a pipeline carrying 5 tons of steam per hour at 5 bar, 300° C. At a section downstream where the pressure is 3 bar, the quality is to be 95%. Find the rate of water spray in kg/hr **[6]**

(c) Derive an expression for ratio of Heat Capacities (γ) in terms of isothermal compressibility (k) and adiabatic compressibility (ks). **[6]**

5. (a) Explain: (i) Enthalpy of reaction (ii) Enthalpy of formation (iii) Heating value **[6]**

(b) How much of the 1200 KJ of thermal energy at 700 K can be converted to useful work if the environment is at 25°C **[4]**

(c) A turbo compressor delivers 2.33 m^3/s of air at 0.276 MPa, 43° C which is heated at this pressure to 430°C and finally expanded in turbine which delivers 860 kW. During expansion there is a heat transfer of 0.09 MJ/s to surroundings. Calculate the turbine exhaust temperature if changes in kinetic and potential energy are negligible. **[10]**

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