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06ME33

Third Semester B.E. Degree Examination, June/July 2013
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: ***Answer FIVE full questions, selecting at least TWO questions from each part.***

PART – A

1 a. What is a thermodynamic system? Explain various thermodynamic systems. **(05 Marks)**

b. Define thermodynamic equilibrium. Explain dfferent conditions that a system should satisfy to attain thermodynamic equilibrium. **(05 Marks)**

c. Explain zeroth law of thermodynamic. **(04 Marks)**

d. The emf in a thermocouple with the test junction at t°C on gas thermometer scale and reference junction at ice point is given by, $\in = 0.2t - 5\times10^{-4}t^2$ mV. The millivoltmeter is calibrated at ice and steam points. What will this thermometer read in a place where the gas thermometer reads 50°C? **(06 Marks)**

2 a. Starting from a convenient common state point, on a P-V diagram show the four expansion processes indicating their names. **(05 Marks)**

b. What is the difference between work transfer and heat transfer? **(05 Marks)**

c. A stationary mass of gas is compressed in a frictionless way from 1 bar and 0.1 m^3 to 5 bar and 0.03 m^3. Assuming that the pressure and volume are related by PV^n = constant. Find the work done on the gas. **(05 Marks)**

d. An engine cylinder of diameter 22.5 cm has a stroke length of 37.5 cm. The swept volume is 4 times the clearance volume. The pressure of the gas at the beginning of expansion stroke is 1569 KPa. Find the work done during expansion stroke assuming the process as reversible adiabatic. Take $\gamma = 1.4$. **(05 Marks)**

3 a. State Ist law of thermodynamic for a closed system undergoing cycle. Write steady flow energy equation identifying each term in the equation with its units. **(08 Marks)**

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

c. The internal energy of a certain substance is given by the following equation: u = 3.56pv+84, where u is in KJ/kg, P is in KPa and u is in m^3/kg. A system composed of 3 kg of this substance expands from initial pressure of 500 KPa and a volume of 0.22 m^3 to a final pressure 100 KPa in a process in which pressure and volume are related by $PV^{1.2}$ = constant. Determine Q, ΔV and W for the process. **(06 Marks)**

4 a. State Kelvin-Plank and Clausius statements of II^{nd} law of thermodynamics and prove that they are equivalent. **(10 Marks)**

b. List the factors that renders a system irreversible. **(03 Marks)**

c. Carnot engine A operates between temperatures T_1 and T_2 whose waste heat is utilized by another Carnot engine B operating between temperature T_2 and T_3. What is the efficiency of a third Carnot engine C that operates between temperature T_1 and T_3 in terms of the efficiency η_A and η_B of the engines A and B. **(07 Marks)**

PART – B

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

b. Explain entropy principles. **(04 Marks)**

c. A fluid undergoes a reversible adiabatic compression from 5 bar, 0.2 m^3 to 0.05 m^3 according to the law $PV^{1.3} = C$. Determine the change in enthalpy, internal energy and entropy and also the heat transfer and work transfer during the process. **(10 Marks)**

6 a. Define availability and obtain the availability of a non-flow process. **(08 Marks)**

b. Define i) second law efficiency ii) irreversibility. **(04 Marks)**

c. In a steam boiler, hot gases transfer heat to water which vaporizes at constant temperature of 220°C. The gases are cooled from 1100°C to 550°C. All the heat transferred from the gases gives to water. How much does the total entropy of the combined system of gas and water increases as a result of the irreversible heat transfer? Obtain the result on the basis of 1 kg of water evaporated. If the surrounding temperature is 30°C. Determine the increase in unavailable energy due to irreversible heat transfer. Take $C_{P_{gas}}$ = 1.005 kJ/K. Latent heat of water at 220°C = 1858 kJ/K. **(08 Marks)**

7 a. Define : i) Pure substance ii) Triple point iii) Critical point. **(06 Marks)**

b. Draw a neat P-T diagram of a pure substance, clearly indicating various phases. **(06 Marks)**

c. With a neat sketch, explain throttling calorimeter. **(08 Marks)**

8 a. Explain : i) generalized compressibility chart ii) Vander walls equation of state. **(08 Marks)**

b. Compute the pressure of argon for a temperature of 425°C and a specific volume of 0.0115 m^3/kg by means of Vander wall's equation. Take a = 0.1376 $(m^3/Kmol)^2$, b = 0.0320 $m^3/Kmol$, M = 40 **(06 Marks)**

c. 0.5 kg of Nitrogen is cooled in a rigid tank from 227°C to 27°C. The initial pressure is 15 bar. Calculate the final pressure and ΔU, ΔH, ΔS. Assume that nitrogen behaves as an ideal gas with Cp = 1.042 kJ/kgK and Cv = 0.745 kJ/kgK. **(06 Marks)**

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