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10ME/AU33

Third Semester B.E. Degree Examination, Dec.2018/Jan.2019
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. ***Use of Thermodynamic data hand books and steam tables are permitted.***

PART – A

1 a. With suitable examples, distinguish between
 (i) Closed, open and Isolated system.
 (ii) Point function and path function.
 (iii) Intensive and extensive properties. **(06 Marks)**

b. Briefly explain quasi-static process. **(04 Marks)**

c. A certain thermometer is calibrated using ice and steam points as fixed points designating them as 0°C and 100°C respectively. The thermodynamic function choosen to establish the scale is $t = a\ln x + b$. Determine the constants 'a' and 'b' in terms of x_S and x_I and show that new scale is given by, $t = 100\left[\frac{\ln\left(x/x_I\right)}{\ln\left(x_S/x_I\right)}\right]$ **(10 Marks)**

2 a. Derive the expression for displacement work or work done during quasistatic process. **(06 Marks)**

b. Differentiate between work and heat. **(04 Marks)**

c. A Gas is enclosed in a cylinder with a frictionless piston at 3 bar as shown in Fig. Q2 (c). The spring force exerted through the piston is proportional to the volume of the gas. The atmospheric pressure on the spring side of the piston is 1 bar. Gas is expanded from 0.2 m^3 to 1 m^3. Calculate the work done by the gas. **(10 Marks)**

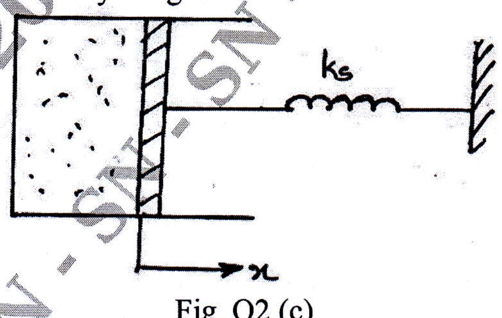

Fig. Q2 (c)

3 a. State first law of thermodynamics and illustrate with Joule's paddle wheel experiment. **(06 Marks)**

b. Show that $h_2 - h_1 = mCp(T_2 - T_1)$ using applications of first law of thermodynamics for constant reversible pressure process. **(06 Marks)**

c. A steam turbine developing 400 kW receives a flow of 20,000 kg/hour of steam. The inlet and outlet velocities of steam are 100 m/s and 320 m/s respectively. The inlet pipe is 4 m above the exhaust. Determine the change in enthalpy assuming adiabatic flow. **(08 Marks)**

4 a. Show that COP of the heat pump is greater than COP of refrigerator by unity. **(04 Marks)**

b. Prove that violation of Clausius statement leads to violation of Kelvin Planck's statement. **(06 Marks)**

c. Two Carnot engines A and B are connected in series between two thermal reservoirs maintained at 1000°K and 100°K. Engine A receives 1680 kJ of heat from High Temperature reservoir and rejects heat to engine B. The engine B takes in heat rejected by engine A and rejects heat to low temperature reservoir. If efficiencies of engine A and B are same. Determine

(i) Heat rejected by engine B.
(ii) The temperature at which heat rejected by engine A.
(iii) Work done during the process by A and B. **(10 Marks)**

PART – B

5 a. State and prove Clausius inequality. **(08 Marks)**

b. Apply the Clausius inequality for a system undergoing an irreversible cyclic change and show that the entropy change of the system is given by $dS \geq \frac{\delta Q}{T}$. **(06 Marks)**

c. A heat engine is supplied with 278 kJ/s of heat at a constant fixed temperature of 283°C and heat rejection takes place at 5°C, the following results were reported.

(i) 208 kJ/s of heat rejected.
(ii) 139 kJ/s of heat rejected.
(iii) 70 kJ/s of heat rejected

Classify which of the results are reversible, irreversible and impossible. **(06 Marks)**

6 a. Define the following with respect to steam formation,
(i) Sub cooled liquid. (ii) Dryness fraction. (iii) Latent heat of vaporization
(iv) Degree of superheat. **(08 Marks)**

b. Describe with neat sketch working of throttling calorimeter. **(06 Marks)**

c. In a throttling calorimeter, the steam is admitted at a pressure of 10 bars. If it is discharged at atmospheric pressure and 110°C after throttling, determine the dryness fraction of steam. Assume specific heat of steam as 2.2 KJ/kgK. **(06 Marks)**

7 a. Write a note on Maxwell equations and Clausius – Clayperon's equations. **(10 Marks)**

b. Derive an energy equation for ideal gas and show that internal energy is a function of temperature alone. **(10 Marks)**

8 a. Derive Vander Waal's constants in terms of critical properties. **(10 Marks)**

b. Define compressibility factor and explain its significance. **(04 Marks)**

c. A cylinder of 0.01 m^3 volume is filled with 0.727 kg of n-octane (C_8H_{18}) at 427.85 K. Assuming that n octane obeys the Vander Waal's equation of state, calculate the pressure of gas in the cylinder. Take the constants a and b as 3.789 Pa $(m^3/mol)^2$ and 2.37×10^{-4} m^3/mol respectively. **(06 Marks)**

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