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10ME/AU33

Third Semester B.E. Degree Examination, July/August 2021
Basic Thermodynamics

Time: 3 hrs. Max. Marks:100

Note: 1. ***Answer any FIVE full questions.***
2. ***Use of steam table and thermodynamics data hand book is permitted.***

1 a. With suitable sketches/examples, distinguish between
i) System and control volume
ii) Point function and path function
iii) Intensive and Extensive properties
iv) Diathermic and adiabatic walls. **(08 Marks)**

b. Classify the following thermodynamic systems.
i) Pressure cooker ii) Wind Mill iii) Thermo flask filled with hot tea iv) Storage cell producing electricity **(04 Marks)**

c. Define Zeroth law of thermodynamics. 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 $e = 0.20t - 5\times10^{4} t^{2}$ 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? **(08 Marks)**

2 a. Starting from a common state point, draw the following processes on the P-V diagram and write expression for the work in each case : i) Isobaric process ii) Isochoric process iii) Isothermal process iv) Isentropic process v) Polytropic process. **(10 Marks)**

b. Distinguish between heat and work in thermodynamics. **(04 Marks)**

c. If a gas of volume 6000cm^3 and at a pressure of 100KPa is compressed quasi-statically according to PV^2 = constant, until the volume becomes 2000cm^3, determine the final pressure and the work transfer. **(06 Marks)**

3 a. Define first law of thermodynamics. What is PMM1? **(04 Marks)**

b. A gas undergoes a thermodynamic cycle consisting of the following processes :
i) Processes 1 – 2 : constant pressure, P = 1.4 bar, $V_1 = 0.028m^3$, $W_{1-2} = 10.5kJ$
ii) Process 2 – 3 : compression with P^v = constant, $U_3 = U_2$
iii) Process 3 – 1 : Constant volume $U_1 - U_3 = -26.4kJ$.
There are no significant changes in KE and PE. Sketch the cycle on P-V diagram. Calculate the network for the cycle in kJ and heat transfer for process 1 – 2. Show that $\sum_{cycle} Q = \sum_{cycle} W$. **(08 Marks)**

c. A turbine operates under steady flow conditions, receiving steam at the following state : Pressure 1.2MPa, temperature 188°C, enthalpy 2785kJ/kg, velocity 33.3m/s and elevation 3m. The steam leaves the turbine at the following state; Pressure 20KPa, enthalpy 2512 kJ/kg, velocity 100m/s, and elevation '0'm. Heat is lost to the surroundings at the rate of 0.29kJ/s. If the rate of steam flow through the turbine is 0.42Kg/s, what is the power output of the turbine in kW? **(08 Marks)**

4 a. Define the two statement of II law of thermodynamics. Show that violation of Clausius statement of II law of thermodynamics violates the Kelvin Plank statement. **(10 Marks)**

b. Define heat engine and heat pump and show that $[COP]_{H.P} = 1 + [C\ O\ P]_R$. **(06 Marks)**

c. A refrigerating plant for a food store operates as a reversed Carnot heat engine cycle. The store is to be maintained at a temperature of -5°C, and the heat transfer from the store to the cycle is at the rate of 5kW. If heat is transferred from the cycle to the atmosphere at a temperature of 25°C, calculate the power required to drive the plant. **(04 Marks)**

5 a. State and prove Clausius theorem. **(10 Marks)**

b. What do you understand by the entropy principle? **(02 Marks)**

c. Water is heated at a constant pressure of 0.7MPa. The boiling point is 164.97°C. The initial temperature of water is 0°C. The latent heat of evaporation is 2066.3kJ/kg. Find the increase of entropy of water, if the final state is steam. **(08 Marks)**

6 a. Draw enthalpy and entropy diagram for water and indicate the following o the same.
i) Saturated liquid line ii) Saturated vapour line iii) Critical point iv) Constant pressure line v) Constant temperature line vi) Constant Quality line. **(06 Marks)**

b. With a neat sketch, explain the measurement of dryness fraction of steam by using "Throttling Calorimeter". **(06 Marks)**

c. The following observations were recorded in an experiment with a combined separating and throttling calorimeter :

Pressure in the steam main	= 15bar
Mass of water drained from the separator	= 0.55kg
Mass of steam condensed after passed through the throttle valve	= 4.20kg
Pressure and temperature after throttling	= 1 bar, 120°C

Evaluate the dryness fraction of the steam in the main. **(08 Marks)**

7 a. Explain the following :
i) Maxwell's relations ii) Clausius – Clapeyron eqution. **(08 Marks)**

b. Derive the expression for ratio of heat capacities. **(04 Marks)**

c. Calculate under what pressure the ice would freeze at 272K, if the change in specific volume, when 1kg of water freezes is 91×10^{-6} m^3, given latent heat of ice = 3.36×10^5 J/kg. **(08 Marks)**

8 a. Write short notes on :
i) Vander walls equation of state
ii) Law of corresponding states
iii) Compressibility chart **(12 Marks)**

b. 0.5kg of air is compressed reversibly and adiabatically from 80KPa, 60°C to 0.4MPa and is then expanded at constant pressure to the original volume. Sketch these processes on the P-V and T-S planes. Compute the heat transfer and work transfer for the whole path. **(08 Marks)**

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