CBCS SCHEME

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18MR33

Third Semester B.E. Degree Examination, Aug./Sept.2020
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. Use of Thermodynamic data handbook is permitted.

Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.
2. Any revealing of identification, appeal to evaluator and /or equations written eg, 42+8 = 50, will be treated as malpractice.

Module-1

1 a. Explain macroscopic and microscopic points of view in the study of thermodynamics. **(06 Marks)**

b. What is Thermodynamic equilibrium? Explain the conditions of thermodynamic equilibrium. **(07 Marks)**

c. The temperature on a Celsius scale is defined in terms of property 'P' by the relation $P = e^{\frac{(t-B)}{A}}$, where A and B are constants. Experiments give valve of 'P' is 1.86 and 6.81 at the ice point and steam point respectively. Obtain the relation for 't' and also find the temperature 't' for the reading P = 2.5. **(07 Marks)**

OR

2 a. Derive an expression for the displacement work in i) Isothermal process ii) Polytropic process. **(12 Marks)**

b. A cylinder contains 1kg of a certain fluid at an initial pressure of 20bar. The fluid is allowed to expand reversibly behind a piston according to law PV^2 = constant, until the volume is doubled the fluid is then cooled reversibly at constant pressure until the piston regains its original position. Heat is then supplied reversibly with the piston firmly locked in position until the pressure rises to original value of 20bar. Calculate the network done by fluid, for an initial volume of $0.05m^3$. **(08 Marks)**

Module-2

3 a. Show that energy is a property of system. **(06 Marks)**

b. State and explain the first law of thermodynamics for cycle and non cyclic (change of state) process. **(04 Marks)**

c. At the inlet to a certain nozzle, the enthalpy of the fluid passing is 3000kJ/kg and the velocity is 60m/s. At the discharge end the enthalpy is 2762kJ/kg. The nozzle is horizontal and there is negligible loss from it. Find:

i) The velocity at the exit from the nozzle.

ii) If the inlet area is $0.1m^2$ and specific volume at inlet is $0.187m^3/kg$ find the mass flow rate.

iii) If the specific volume at the nozzle exit is $0.498m^3/kg$, find the exit area of the nozzle. **(10 Marks)**

OR

4 a. State the Kelvin-Plank and Clausius statements of the second law of thermodynamics and prove they are equivalent. **(10 Marks)**

b. A reversible heat engine is supplied 900kJ of heat from a heat source at 500K. The engine develops 300kJ of network and rejects heat to two sink at 400K and 300K. Determine the engine thermal efficiency and magnitude of heat interaction with each of sink. **(10 Marks)**

Module-3

5 a. State and prove "Clausius inequality". (07 Marks)

b. Define entropy and prove that it is a property of system. (05 Marks)

c. A heat engine receives 420kJ/cycle of heat from a source at 327°C and rejects heat reversibly to sink to 27°C. There are no other heat transfer. For each of the three hypothetical amounts of heat rejection given below, compute the cyclic integral of $\frac{dQ}{T}$, from these results, classify the cycle. i) 210kJ/cycle is rejected ii) 105kJ/cycle is rejected iii) 315kJ/cycle is rejected. (08 Marks)

OR

6 a. Define the following: i) Subcooled liquid ii) Saturated liquid iii) Saturated vapour iv) Quality of steam (08 Marks)

b. Write a neat P-T diagram for the pure substance and define i) Tripple point ii) Critical point. (05 Marks)

c. A vessel having a volume of $0.6m^3$ contains 3kg of liquid water and water vapour mixture in equilibrium at a pressure of 0.5MPa. Calculate:
i) Mass and volume of liquid ii) Mass and volume of vapour. (07 Marks)

Module-4

7 a. Obtain four Maxwell relations for a simple compressible system in the form, $\left(\frac{\partial M}{\partial y}\right)_x = \left(\frac{\partial N}{\partial y}\right)_y$ (10 Marks)

b. Air expanded irreversibly and adiabatically in a turbine from 800K and 1.5MPa to 540K. If this process had been reversible, the final temperature would have been 485K for same discharge pressure. Calculate the work per kg of air and change in entropy. Assume for air $C_V = 0.718$kJ/kg K and $\gamma = 1.4$. (10 Marks)

OR

8 a. Write a note on: i) Helmholtz and Gibbs function ii) Ideal gas equation of state. (12 Marks)

b. Show that the entropy change for polytropic process is

$$\Delta S = mc_v\left(\frac{n-\gamma}{n-1}\right)\ell n\left(T_2/T_1\right)$$ (08 Marks)

Module-5

9 a. State and explain the following:
i) Dalton's law of partial pressures ii) Amagat's law of additive volumes. (06 Marks)

b. Derive an expression for molecular weight and gas constant interms of mass and molar fraction. (08 Marks)

c. A gaseous mixture contains 1kg of CO_2 and 1.5kg of N_2. The pressure and temperature of mixture are 3.5bar and 27°C. Determine: i) The mass and mole fraction of each gas ii) Average molecular weight iii) Gas constant. (06 Marks)

OR

10 a. Explain the following: i) Vander Waal's equation of state ii) Compressibility factor iii) Compressibility chart iv) Law of corresponding states. (10 Marks)

b. Determine the pressure exerted by CO_2 in a container of $1.5m^3$ capacity, when it contains 5kg at 27°C using i) Ideal gas ii) Vander Waal's equation. (10 Marks)

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