CBCS SCHEME

USN

18MR33

Third Semester B.E. Degree Examination, Dec.2019/Jan.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 allowed.***

Module-1

1 a. Distinguish between :
i) Open system and Isolated system
ii) Intensive and extensive properties
iii) Macroscopic and microscopic approaches. **(06 Marks)**

b. What is Thermodynamic equilibrium? Explain mechanical, chemical and thermal equilibrium by means of examples. **(06 Marks)**

c. The temperature't' on a thermometric scale is defined in terms of a property 'K' by the relation t = a ln K + b where 'a' an 'b' are the constants. The valves of 'K' are found to be 1.83 and 6.78 at ice point and steam points the temperature of which are assigned as 0ºC and 100ºC respectively. Determine the temperature corresponding to the reading of K = 2.42 on the thermometer. **(08 Marks)**

OR

2 a. Derive an expression for displacement work for isentropic process. **(08 Marks)**

b. In Mass of 1.5kg of a substance is compressed in a quasistatic process from 0.1MPa to 0.7MPa. The initial density of the substance is 1.16 kg/m^3. Determine magnitude of workdone on the substance.
i) Process is according to law PV = Constant
ii) Process is according to law $PV^{1.4}$ = Constant **(12 Marks)**

Module-2

3 a. State first law of thermodynamics as applied to a cycle an as applied to a process. **(04 Marks)**

b. State the assumption and derive an equation for steady state steady flow process. **(08 Marks)**

c. A gas undergoes a thermodynamic cycle consisting of following processes.
Process 1-2 ; Constant pressure, P = 1.4 bar ; $V_1 = 0.028m^3$; $W_{1.2}$ = 10.5kJ
Process 2-3 ; Compression with PV = C ; $U_3 = U_2$
Process 3-1 ; Constant Volume $(U_1 - U_3) = -26.4$kJ
There is no significance changes in KE and PE
i) Sketch the cycle in PV diagram
ii) Calculate the net work for the cycle in kJ
iii) Calculate the heat transfer for process 1-2
iv) Show that $\sum Q_{cycle} = \sum W_{cycle}$. **(08 Marks)**

OR

4 a. Give Kelvin plank and Clausius statement of second law of thermodynamics and show that they are equivalent. **(10 Marks)**

b. Two reversible heat engines A and B are arranged in series. 'A' rejects heat to 'B' through an intermediate reservoir. Engine 'A' receives 200kJ at a temperature of 421ºC from hot source while engine 'B' is in equilibrium with a cold sink at a temperature of 4.4ºC. If the work output of 'A' is twice that of 'B' find :
i) Intermediate temperature between A and B.
ii) The efficiency of each engine
iii) Heat rejected to be clod sink. **(10 Marks)**

Module-3

5 a. State and prove Clausics in equality. **(08 Marks)**

b. One kg of water at 273K is brought into contact with a heat reservoir at 373K.

i) When the water has reached 373K find the entropy change of the water, reservoir and the universe.

ii) If water is heated from 273K to 373K by first brining it in contact with a reservoir at 323 K and then with a reservoir at 373K what will be the entropy change of the universe. **(12 Marks)**

OR

6 a. Draw a neat sketch of separating and throttling Calorimeter and explain how dryness fraction of steam is determined. **(10 Marks)**

b. A pressure cooker contains 1.5kg of saturated steam at 5 bars. Find the quality of steam which must be rejected so as to reduce the quality to 60% dry. Determine the pressure and temperature. **(10 Marks)**

Module-4

7 a. Explain the following :

i) Helmholtz and Gibbs function

ii) Maxwell relation **(10 Marks)**

b. Show that internal energy and enthalpy of an Ideal gas are function of temperature only. **(10 Marks)**

OR

8 a. Derive an expression for change in entropy for an ideal gas undergoing.

i) Isobaric process

ii) Isochoric process

iii) Isothermal process **(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 $C_V = 0.718$kJ/kg K and $\gamma = 1.4$. **(10 Marks)**

Module-5

9 a. Explain the following :

i) Dalton's Law of partial pressure

ii) Amagat's Law of additive volumes. **(06 Marks)**

b. Derive the expression for gas constants and molecular weight of a mixture of the ideal gases A, B and C. **(08 Marks)**

c. A mixture of gases contains 1kg of CO_2 and 1.5kg of N_2. The pressure and temperature of the mixture are 3.5bar and 27ºC. determine for the mixture

i) Mass and mole fraction for each constituent gas

ii) Gas constant of mixture

iii) Average molecular weight. **(06 Marks)**

OR

10 a. Explain the following :

i) Compressibility factor

ii) Law of corresponding states

iii) Generalized compressibility chart

iv) Vander Waals Equation of state

v) Redlich kwong equation. **(10 Marks)**

b. Determine the pressure exerted by CO_2 in a container of 1.5m^3 capacity when it contains 5 kg at 27ºC. i) Using idealgas equation ii) using Vander Waal' equation.
Given : for CO_2 : a = 365.6KPa, b = 0.0428m^3 kg/mole. **(10 Marks)**