CBCS SCHEME

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18MR33

Third Semester B.E. Degree Examination, Jan./Feb. 2023
Basic Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. With the help of a neat sketch, explain the working principle of a constant volume gas thermometer. **(08 Marks)**

b. Differentiate between the following:
(i) Intensive and extensive property
(ii) Homogeneous and heterogeneous system
(iii) Macroscopic and microscopic point of view **(06 Marks)**

c. The temperature 'T' on a thermometric scale is defined as $T = a \ln K + b$, where a and b are constants. The values of K are found to be 1.83 and 6.78 at 0°C and 100°C respectively. Calculate the temperature for a value of K = 2.42. **(06 Marks)**

OR

2 a. Explain the concept of the path function and point function with the help of a relevant diagram. **(04 Marks)**

b. Derive the expression for displacement work of the following process:
(i) Constant pressure process (ii) Process in which PV^n = constant **(10 Marks)**

c. The following data refer to a 12-cylinder, single acting, two-stroke marine diesel engine:
Speed = 150 rpm Cylinder diameter = 0.8 m
Stroke of the piston = 1.2 m Area of the indicator diagram = 5.5×10^{-4} m
Length of the diagram = 0.06 m Spring value = 147 MPa per m
Find the value of net rate of work transfer from the gas to the piston in KW. **(06 Marks)**

Module-2

3 a. Define internal energy and prove that it is a property. **(06 Marks)**

b. Derive an expression for work done in steady flow process. **(08 Marks)**

c. A fluid flows steadily through a rotary device. For a kg of fluid, the heat transfer out of the device is 25 kJ. The fluid properties at the entry are 5 bar, 50 m/s and 0.78 m^3/kg. The corresponding properties at the exit are 1 bar, 100 m/s and 0.97 m^3/kg. The inlet is 5 m above the exit and the internal energy at the entry is greater than that of exit by 119 kJ. Find the output work. **(06 Marks)**

OR

4 a. Mention the statements of second law of thermodynamics and establish the equivalence of Kelvin Plank and Clausius statement. **(10 Marks)**

b. A direct heat engine operating between two reservoirs at 327°C and 27°C drives a refrigerator operating between 27°C and 13°C. The efficiency of the heat engine and the COP of the refrigerator are each 70% of their maximum values. The heat transferred to the direct heat engine is 500 kJ. The net heat rejected by the engine and the refrigerator to the reservoir at 27°C is 400 kJ. Find the net work output of the engine-refrigeration combination. **(10 Marks)**

Module-3

5 a. State and explain Clausius theorem. **(06 Marks)**

b. Prove that the entrophy is property of the system. **(06 Marks)**

c. A fluid undergoes a reversible adiabatic compression from 0.5 MPa, 0.2 m^3 to 0.05 m^3. According to the law, $PV^{1.3}$ = constant. Determine the change in enthalpy, internal energy and entropy and the heat transfer and work transfer during the process. **(08 Marks)**

OR

6 a. With reference to the following process derive the expression for amount of heat transferred 'Q'.

(i) Constant volume process

(ii) Constant pressure process **(12 Marks)**

b. Steam at 10 bar and 200°C undergoes a reversible adiabatic pressure to 1 bar in a turbine. Determine the final specific volume, the final temperature and the final specific entropy. If the mass flow rate of steam through the turbine is 2 kg/s, determine the work output from the turbine. **(08 Marks)**

Module-4

7 a. Correlate the relationship between specific heat (C_p and C_v). **(10 Marks)**

b. Give the detailed explanation on Clausius-Clayperon's equation. **(10 Marks)**

OR

8 a. A cylinder contains 1 kg of certain fluid at an initial pressure of 20 bar. The fluid is allowed expand reversibly behind a piston according to the 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 the original value of 20 bar. Calculate the work done by the fluid, for an initial volume of 0.5 m^3. **(10 Marks)**

b. An ideal gas cycle consisting of three processes uses Argo (molecular weight = 40) as working substance. Process 1-2 is reversible adiabatic process from 0.014 m^3, 700 kPa and 280°C to 0.0056 m^3. Process 2-3 is a reversible isothermal process. Process 3-1 is an isobaric process. Sketch the cycle on P-V and T-S diagram and find:

(i) The work transfer in process 1-2.

(ii) Work transfer in processes 2-3.

(iii) Net work output from the cycle. Assume $\gamma = 1.67$.

(iv) Change in enthalpy for each processes. **(10 Marks)**

Module-5

9 a. State and explain:

(i) Gibb's Daltons law of partial pressure (ii) Amagat's law of additive volume **(10 Marks)**

b. A gaseous mixture consists of 1 kg of oxygen and 2 kg of Nitrogen is initially at a pressure of 150 kPa and a temperature of 20°C. It is heated at constant pressure until its temperature reaches 100°C. Calculate: (i) Change in enthalpy (ii) Change in entropy (iii) Change in internal energy **(10 Marks)**

OR

10 Explain the following :

a. Compressibility factor b. Law of corresponding states

c. Compressibility chart d. Van-der Waal's equation **(20 Marks)**

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