CBCS SCHEME

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17ME33

Third Semester B.E. Degree Examination, Jan./Feb. 2021
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 book, steam tables are permitted.

Module-1

1 a. What is thermodynamics? Differentiate between the classical and statistical approaches to thermodynamics. **(06 Marks)**

b. Classify the following into intensive and extensive properties.
i) Enthalpy specific entropy
ii) Viscosity
iii) Quality of steam
iv) Refractive index
v) Roll strength of class. **(06 Marks)**

c. A new scale N of temperature is devised in such a way that the freezing point of ice is 100°N and the boiling point of water is 400°N. What is the temperature reading on this new scale when the temperature is 150°C? At what temperature both the Celsius and the new scale reading would be the same? **(08 Marks)**

OR

2 a. Distinguish between:
i) Point function and path function
ii) Intensive and extensive property. **(08 Marks)**

b. What is flow work? Is it different from displacement work? **(04 Marks)**

c. To a closed system 150kJ of work is supplied. If the initial volume is $0.6m^3$ and pressure of the system changes as $P = 8\text{-}4V$, where P is in bar and V is in m^3, determine the final volume and pressure of the system. **(08 Marks)**

Module-2

3 a. State the first law of thermodynamics for a closed system undergoing change of state. Explain the property introduced by this law. **(04 Marks)**

b. What are the limitations of first law of thermodynamics? **(04 Marks)**

c. A stationary fluid system goes through a following cycle:
Process 1-2 isochoric heat addition of 235kJ/kg
Process 2-3 adiabatic expansion to its original pressure with loss of 70kJ/kg in internal energy.
Process 3-1 isobaric compression to its original volume with heat rejection of 200kJ/kg
Prepare a balance sheet of energy quantities. **(12 Marks)**

OR

4 a. Define the following:
   i) Thermal Energy Reservoir (TER)
   ii) Mechanical Energy Reservoir (MER). **(04 Marks)**

b. Show that efficiency of a reversible engine is independent of the nature or amount of the working substance going through the cycle. **(06 Marks)**

c. An inventor claims that his engine has the following specifications:

Heating value of the fuel	: 74500kJ/kg
Temperature limits	: 750°C and 25°C
Power developed	: 75kW
Fuel burnt	: 0.07kg/min

State whether claim is valid or not. **(10 Marks)**

Module-3

5 a. Explain the conditions for reversibility. **(06 Marks)**

b. Show that heat transfer through a finite temperature difference is irreversible. **(06 Marks)**

c. Determine the entropy change of 4kg of a perfect gas whose temperature varies from 127°C to 227°C during a constant volume process. The specific heat varies linearly with absolute temperature and is given by the relation $C_v = (0.48 + 0.0096T)$kJ/kg K. **(08 Marks)**

OR

6 a. Define entropy and show that entropy is a property of system. **(06 Marks)**

b. Write the criteria of reversibility, irreversibility and impossibility to a thermodynamic cycle. **(06 Marks)**

c. A Carnot engine absorbs 200J of heat from a reservoir at the temperature of the normal boiling point of water and rejects heat to a reservoir at the temperature of the triple point of water. Find the heat rejected, the work done by the engine and the thermal efficiency. **(08 Marks)**

Module-4

7 a. Define the following:
   i) Thermodynamic dead state
   ii) Energy
   iii) Second law efficiency. **(06 Marks)**

b. Energy is always conserved, but its quality is always degraded. Explain. **(04 Marks)**

c. Prove that, $\eta_{II} = \frac{\eta_I}{\eta_{carnot}}$ **(10 Marks)**

OR

8 a. Draw the phase equilibrium diagram on P-V coordinate for a pure substance, whose volume decreases on melting. **(04 Marks)**

b. State whether the following samples of steam are wet, dry or superheated: Justify your answer.
   i) Temperature = 200°C, pressure = 1.2MPa
   ii) Pressure = 1MPa volume = 0.235m^3/kg
   iii) Pressure = 500kPa enthalpy = 2530kJ/kg
   iv) Temperature = 100°C entropy = 7.35kJ/kg K **(08 Marks)**

c. What is dryness fraction of steam? Explain the method of estimating quality of wet steam by a combined separating and throttling calorimeter. **(08 Marks)**

Module-5

9 a. State 'Dalton's law of partial pressure' **(04 Marks)**

b. Define the following terms:
   i) Saturated air
   ii) Wet bulb temperature
   iii) Specific humidity
   iv) Dew point temperature. **(04 Marks)**

c. A mixture of gas has the following volumetric analysis. $O_2 = 30\%$, $CO_2 = 40\%$, $N_2 = 30\%$. Determine:
   i) The analysis on a mass base.
   ii) The partial pressure of each component if the total pressure is 100kPa and temperature is 32°C.
   iii) The molecular weight of mixture. **(12 Marks)**

OR

10 a. What is the generalized compressibility chart? Explain. **(04 Marks)**

b. Write the Vander Waal's equation of state. In what ways, it is an improvement over the ideal gas equation of state. **(04 Marks)**

c. One kg-mol of oxygen undergoes a reversible non-flow isothermal compression and the volume decreases from $0.2m^3/kg$ to $0.08m^3/kg$ and the initial temperature is 60°C. If the gas obeys Vander Waal's equation find: i) the work done during the process ii) the find pressure. **(12 Marks)**

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