U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

May 2023 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 22ME3PCETD **Max Marks: 100**
Course: Engineering Thermodynamics **Date: 12.05.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may suitably be assumed.
3. Use of steam tables and Mollier chart, Thermodynamics data hand book is permitted.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

UNIT - I

1	a)	What do you understand the term (i) state, (ii) path, (iii) process, and (iv) cycle, as applied to thermodynamics?	**04**
	b)	Derive an expression for the displacement work in a polytropic process.	**06**
	c)	A perfect gas undergoes a process in which $P \propto V^{\frac{2}{5}}$. Calculate the work done by the gas in going from state 1 with pressure 100 bar, volume 4 m^3 to state 2 in which the volume is 2 m^3. Also calculate the final pressure.	**10**

UNIT - II

2	a)	State and explain first law of thermodynamics.	**04**
	b)	Prove that energy is a property of a thermodynamic system.	**06**
	c)	(i) 1.5 kg of liquid having a constant specific heat of 2.5 kJ/kgK is stirred in a well-insulated chamber causing the temperature to rise by 15^0C. Find the change in energy and work transfer for the process. (ii) The same liquid is stirred with same amount of stirring work in a conducting chamber. During the process 1.7 kJ of heat is transferred from the liquid to the surroundings, while the temperature of the liquid rises. Find the change in temperature and change in energy during the process.	**10**

UNIT - III

3	a)	Explain briefly the causes of irreversibility.	**04**
	b)	Show that the entropy is a property of a thermodynamic system.	**06**
	c)	Two reversible refrigerators are connected in series. The first refrigerator removes heat from a cold reservoir at T_L and discharges heat at 10^0C. The second refrigerator absorbs heat from the first at 10^0C and discharges heat to the ambient at 25^0C. If the two refrigerators have the same COP, what should be the value of T_L? What would be value of T_L if both the refrigerators have the same work output?	**10**

OR

4 a) Write the statements of Kelvin-Planck and Clausius with reference to the second law of thermodynamics. **04**

b) Show that all reversible heat engines operating between the same two reservoirs of different temperatures have the same efficiency. **06**

c) One kg of ice at -5^0C is exposed to the atmosphere, which is at 20^0C. The ice melts and comes to thermal equilibrium with the atmosphere. Determine the entropy increase of the universe. Take C_p of ice = 2.093 kJ/kgK and latent heat of fusion of ice = 334 kJ/kg. **10**

UNIT - IV

5 a) Explain the generalized compressibility chart with a neat schematic sketch. **04**

b) With usual notations, prove that the hat transfer for an ideal gas undergoing a polytropic process is given by $Q_{1-2} = W_{1-2}\left(\frac{\gamma-n}{\gamma-1}\right)$. **06**

c) Determine the pressure exerted by CO_2 in a container of 1.5 m^3 with 5 kg mass at 27^0C using (i) ideal gas equation (ii) Van der Waal's equation, taking a = 3.6285 x 10^5 J^4/kg-mol^2 and b = 0.0422 m^3/kg-mol. **10**

UNIT - V

6 a) Define, (i) superheated vapour state, (ii) critical point, (iii) triple point, and (iv) dryness fraction, as applied to a pure substances. **04**

b) With a neat schematic sketch and T-s diagram, explain the working of an ideal Rankine cycle. **06**

c) A rigid vessel contains 1 kg of a mixture of saturated water and saturated steam at a pressure of 0.15 MPa. When the mixture is heated, the state passes through the critical point. Determine, (i) the volume of the vessel, (ii) the mass of liquid and of vapour in the vessel initially, (iii) the temperature of the mixture when the pressure has risen to 3 MPa, and (iv) the heat transfer required to produce the final state of the critical point. **10**

OR

7 a) Draw T-s and h-s diagrams for a pure substance and indicate the salient points on the diagrams. **04**

b) With a neat schematic sketch and T-s diagram, explain the working of a reheat Rankine cycle. **06**

c) Two streams of steam, one at 2 MPa, 300^0C and the other at 2 MPa, 400^0C mix in a steady flow adiabatic process. The rates of flow of the two streams are 3 kg/min and 2 kg/min respectively. Evaluate the final temperature of the emerging stream, if there is no pressure drop due to the mixing process. **10**

****