U.S.N.										

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

Autonomous Institute Affiliated to VTU

June 2025 Semester End Main Examinations

Programme: B.E. | **Semester: III**

Branch: Chemical Engineering | **Duration: 3 hrs.**

Course Code: 23CH3PCTD1 / 22CH3PCTD1 | **Max Marks: 100**

Course: Process Engineering Thermodynamics -I

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Steam table permitted
3.Missing data, if any, may be suitably assumed.

			CO	*PO*	Marks
		UNIT - I			
1	a)	Discuss the different approaches to thermodynamics.	*CO1*	*PO1*	**04**
	b)	A man weighs 800 N on the earth's surface where the acceleration of gravity is 9.83 m/s^2. Calculate the weight of the man on the moon where the acceleration due to gravity is 3.2 m/s^2.	*CO1*	*PO1*	**08**
	c)	Compare and contrast steam point, ice point and absolute zero on Kelvin, Celsius, Fahrenheit and Rankine temperature scales. Present the appropriate relationship equations for the same.	*CO1*	*PO1*	**08**
		OR			
2	a)	Distinguish between state and path function with examples.	*CO1*	*PO1*	**06**
	b)	Discuss concept of stability in thermodynamics.	*CO1*	*PO1*	**04**
	c)	During the adiabatic compression of a gas in a cylinder, the temperature of the gas rises by 30^0 C. Express the rise in temperature in terms of the Fahrenheit, Kelvin and Rankine scales.	*CO1*	*PO1*	**10**
		UNIT - II			
3	a)	Draw a neat sketch and discuss mechanical equivalence of heat using Joule's experiment.	*CO2*	*PO2*	**05**
	b)	Derive the mathematical expression for first law of thermodynamics for the case of a closed system.	*CO2*	*PO2*	**05**
	c)	Water at 368K is pumped from a storage tank at the rate of 25 m^3/h. The motor for the pump supplies work at the rate of 2 hp. The water passes through a heat exchanger, where it gives up heat at the rate of 42,000 kJ/min and is delivered to a second storage tank at an elevation of 20 m above the first tank. What is the	*CO2*	*PO2*	**10**

			temperature of the water delivered to the second storage tank? Assume that the enthalpy of water is zero at 273 K and specific heat of water is constant at 4.2 kJ /kg K.			
			OR			
	4	a)	Distinguish between: (i) Intensive and extensive properties, (ii) Reversible and irreversible properties.	*CO2*	*PO2*	**04**
		b)	Show that for a steady state flow process, $\Delta H = Q - W_S$	*CO2*	*PO2*	**06**
		c)	A system consisting of a gas confined in a cylinder is undergoing the following series of processes before it is brought back to the initial conditions: *Step* 1: A constant pressure process when it receives 50 J of work and gives up 25 J of heat. *Step* 2: A constant volume process when it receives 75 J of heat. *Step* 3: An adiabatic process. Calculate heat, work, changes in internal energy, enthalpy for each step and for whole cycle.	*CO2*	*PO2*	**10**
			UNIT - III			
	5	a)	Discuss the PVT behavior of a pure fluid with the aid of a P vs V and P vs T diagram.	*CO4*	*PO3*	**08**
		b)	Calculate the molar volume of methane at 773 K and 15 bar using the following methods: i) Ideal gas equation of state. ii) Van der Waals equation of state with a = 0.2303 Nm^4/mol^2 and b = 4.3073.12 x 10^{-5} m^3/mol. iii) Virial equation of state, $Z = 1 + \frac{B}{V}$ iv) Redlich -Kwong equation of state, when For methane, T_C= 190.6 K, P_C= 45.99 bar, V_C= 98.6 cm^3/mol.	*CO4*	*PO3*	**12**
			OR			
	6	a)	Find the second, third and fourth virial coefficient of the Van der Waals equation of state.	*CO4*	*PO3*	**08**
		b)	Deduce Van der Waals equation in its reduced form.	*CO4*	*PO3*	**12**
			UNIT - IV			
	7	a)	Show that for an adiabatic process of an ideal gas: $P_1 V_1^{\gamma} = P_2 V_2^{\gamma} = P V^{\gamma}$	*CO5*	*PO3*	**08**
		b)	An ideal gas is changed from 1 atm and 22.4 m^3 to 10 atm and 2.24 m^3 by the following reversible process: i. Isothermal compression.	*CO5*	*PO3*	**12**

			ii. ii. Adiabatic compression followed by cooling at constant volume. iii. Heating at constant volume followed by cooling at constant pressure. Evaluate Q, W, ΔH and ΔU of the overall process in each case. Data; C_P= 20.94 kJ/kmol C and C_V= 12.6914kJ/kmol C.			
			OR			
	8	a)	Derive the equation for work done in a constant temperature and polytropic process of an ideal gas.	*CO5*	*PO3*	**08**
		b)	An ideal gas undergoes the following sequence of mechanically reversible processes in a cooled system. i. From an initial state of 343.15K and 1bar, it is compressed adiabatically to 423.15K. ii. It is then cooled from 423.15K to 343.15 K at constant pressure. iii. Finally, it is expanded isothermally to its original state. Evaluate Q, W, ΔH and ΔU for each of the three processes and for the entire cycle. Take, $C_v = \frac{3}{2}$ R and $C_P = \frac{5}{2}$ R.	*CO5*	*PO3*	**12**
			UNIT - V			
	9	a)	Derive the mathematical expression for the efficiency of a Carnot cycle with a neat sketch.	*CO6*	*PO3*	**10**
		b)	A reversible engine absorbs 250 kCal of heat at 260^0C and discards heat at 40^0C. Calculate: i. The work output of the engine. ii. The entropy changes of system, surrounding and total change in enthalpy. iii. The heat rejected. iv. The efficiency of the heat engine.	*CO6*	*PO3*	**10**
			OR			
	10	a)	Derive an expression for the change in entropy of an ideal gas.	*CO6*	*PO3*	**10**
		b)	One mole of an ideal gas is compressed isothermally at 400K from 100 kPa to 1000 kPa. The work required for this irreversible process is 20% more than that for a reversible compression. The heat liberated during the process of compression is absorbed by a thermal reservoir at 300k. Calculate: i. The entropy changes of the gas; ii. The entropy changes of the reservoir and iii. The total entropy change.	*CO6*	*PO3*	**10**

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