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

Autonomous Institute Affiliated to VTU

October 2024 Supplementary Examinations

Programme: B.E. **Semester: III**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 23CH3PCTD1 **Max Marks: 100**
Course: Process Engineering Thermodynamics-I

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

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.

			CO	PO	Marks
		UNIT - I			
1	a)	Write about extensive property, path function, homogeneous and heterogeneous systems with example.	CO1	PO1	**10**
	b)	Nitrogen gas is confined in a cylinder and the pressure of the gas is maintained by a weight placed on the piston. The mass of the piston and the weight together is 50 kg. The acceleration due to gravity is 9.81 m/s^2 and the atmospheric pressure is 1.01325 bar. Assume frictionless piston. Determine: i. The force exerted by the atmosphere, the piston, and the weight on the gas if the piston is 100 mm in diameter. ii. The pressure of the gas. iii. If the gas is allowed to expand pushing up the piston and the weight by 400 mm, what is the work done by the gas in J?	CO1	PO1	**10**
		UNIT - II			
2	a)	Derive the equation for first of thermodynamic for an open system	CO2	PO2	**12**
	b)	Liquid water at 25°C flows in a straight horizontal pipe, in which there is no exchange of either heat or work with the surroundings. Its velocity is 12 m/s in a pipe with an inner diameter of 2.5 cm until it flows into a section where the pipe diameter increases to 7.5 cm. What is the Enthalpy change per kg mass.	CO2	PO2	**08**
		OR			
3	a)	With a neat sketch, explain laboratory flow calorimeter process system designed for enthalpy with suitable equation.	CO2	PO2	**12**
	b)	Iron filings are contained in a cylinder in an atmosphere of oxygen. It combines with oxygen according to the following reaction. $4\ Fe + 3\ O_2 \rightarrow 2Fe_2O_3$ The pressure inside the cylinder is maintained at 101 kPa. The temperature is kept constant at 298 K by removing heat. For 2 moles of iron reacted; calculate Q, W, and ΔU given that 831.08 kJ of heat is liberated in the process.	CO3	PO2	**08**

			UNIT - III			
	4	a)	With a neat graphical representation describe the "Pressure-Volume-Temperature" phase behavior of pure water.	CO2	PO2	**08**
		b)	The following equation proposed by van der Waals to explain the P-V-T behavior of real gases. $\left(P + \frac{a}{V^2}\right)(V - b) = RT$ Where, a and b are called van der Waals constants. Prove that $\left(a = +\frac{27R^2T_C^2}{64P_C}\right)$	CO3	PO3	**12**
			UNIT - IV			
	5	a)	Derive an expression to estimate the work done in an adiabatic process.	*CO5*	*PO2*	**08**
		b)	20 kg of air is compressed from 1 bar, 300 K to 5 bar in a single stage compressor. The process is considered as polytropic with n = 1.25. The specific heat of air at constant pressure in kJ/kmol is given below, $C_P = 27.4528 + 6.1839 \times 10^{-3}T - 8.9932 \times 10^{-7}T^2$ Estimate the following i. The work done by the compressor per cycle ii. The amount of heat transferred to the surroundings	*CO5*	*PO2*	**12**
			OR			
	6	a)	Derive equations for the calculation of internal energy change, heat and work interactions during isothermal, and isobaric reversible processes	CO4	PO2	**10**
		b)	An ideal gas is undergoing a series of three operations: Step1: The gas is heated at constant volume from 300 K and 1 bar to a pressure of 2 bar. Step2: It is expanded in a reversible adiabatic process at 492 K and the work done is 2262 kJ/kmol. Step3: It is cooled at constant pressure of 1 bar to 300 K. Determine the heat and work effects for each step. Assume C_P = 29.3 kJ/kmol K.(1bar= 1x 10^5 Pa).	CO5	PO3	**10**
			UNIT - V			
	7	a)	Oil at 500 K is to be cooled at a rate of 5000 kg/h in a counter-current exchanger using cold water available at 295 K. A temperature approach of 10 K is to be main-trained at both ends of the exchanger. The specific heats of oil and water are respectively 3.2 and 4.2 kJ/kg K. Determine the total entropy change in the process.	CO6	PO3	**10**
		b)	Write about the Carnot principle for a cyclic operations that describe the second law of thermodynamics.	CO6	PO2	**10**

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