U.S.N.										

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

Autonomous Institute Affiliated to VTU

April 2024 Semester End Main Examinations

Programme: B.E. **Semester :IV**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 22BT4ESPET **Max Marks: 100**
Course: Process Engineering Thermodynamics

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

		UNIT - I	CO	PO	Marks
1	a)	How would you define extensive and intensive properties? State whether the following properties are intensive or extensive: (a) volume, (b) density, (c) specific volume, (d) heat capacity, (e) specific heat, (f) potential energy, (g) pressure, (h) temperature.	*CO1*	*PO 1*	**04**
	b)	A reversible process is never attained in practice. It can only be approached'. Comment on this statement.	*CO1*	*PO1*	**06**
	c)	Derive the equation for first law of thermodynamics for open system. Hydrogenation of an oil is carried out in a reactor at a pressure of 136.8 kPa and a temperature of 453 K. The hydrogen gas at 293 K is heated to 453 K by passing through a coil where it experiences a pressure drop of 300 kPa. Hydrogen behaves like an ideal gas and its heat capacity at constant pressure is 29.4 kJ/kmol. Neglecting the kinetic energy effects determine the heat transfer rate in the coils per 1000 kg hydrogen.	*CO1*	*PO1*	**10**
		OR			
2	a)	Prove that a Carnot engine has the maximum efficiency, and that efficiency is independent of working fluid.	*CO1*	*PO1*	**10**
	b)	Why is the concept of entropy essential to explain the direction of spontaneous process? Elaborate.	*CO1*	*PO1*	**06**
	c)	Calculate the absolute entropy of water vapor at 473 K and 101.3 kPa above 273 K base temperature. Compare this with the value reported in steam tables (S=7.829 kJ/kg K). The average heat capacity of water =4.2 kJ/kg K and that of water vapor between 373 K and 473 K = 1.9 kJ/kg K. The latent of vaporization at 373 K = 2257 kJ/kg.	*CO1*	*PO 1*	**04**

			UNIT - II			
	3	a)	How is the real gas different from ideal gas? Write van der Waal equation.	*CO2*	*PO2*	**04**
		b)	Distinguish between vapor and gas. Show the regions of vapor and gas in PV diagram by explaining the characteristics.	*CO2*	*PO2*	**06**
		c)	Calculate the pressure developed by 1 mol of gaseous ammonia contained in a vessel of $0.6x10^{-3}$ m^3 capacity at a constant temperature of 473 K by the following methods: 1) using ideal gas equation 2) using Vander Waals equation given that a=0.4233 Nm^4/mol^2 b=3.73 x 10^{-5} m^3/mol 3) using Redlich Kwong equation given that P_c=112.8 bar T_c=405.5 K.	*CO1*	*PO1*	**10**
			UNIT - III			
	4	a)	Formulate the general equations for the changes in enthalpy and internal energy in terms of measurable quantities.	*CO1*	*PO1*	**06**
		b)	Derive Gibbs Helmholtz equation from the fundamental property relation.	*CO1*	*PO1*	**06**
		c)	A 30% by mole methanol-water solution is to be prepared. How many cubic metres of pure methanol (molar volume, 40.727 x 10^{-6} m^3/mol) and pure water (molar volume, 18.068 x 10^{-6} m^3/mol) are to be mixed to prepare 2 m^3 of the desired solution? The partial molar volumes of methanol and water in a 30 percent solution are 38.632 x 10^{-6} m^3/mol and 17.765 x 10^{-6} m^3/mol, respectively.	*CO1*	*PO1*	**08**
			OR			
	5	a)	Distinguish between molar volume and partial molar volume. Does the partial molar volume of a substance vary with the concentration of substance in the solution?	*CO1*	*PO1*	**06**
		b)	Explain in detail about the effect of temperature and pressure on fugacity.	*CO1*	*PO1*	**07**
		c)	Determine the fugacity and fugacity coefficient of steam at 623 K and 1000 kPa using enthalpy and entropy values from steam tables. Assume that steam behaves ideally at 101.3 kPa. Data from steam tables: At 1000 kPa and 623 K, H = 3159 kJ/kg; S = 7.3 kJ/kg K. At 101.3 kPa and 623 K, H = 3176 kJ/kg; S = 8.38 kJ/kg K.	*CO1*	*PO1*	**07**
			UNIT - IV			
	6	a)	Distinguish between bubble point and dew point temperatures.	*CO2*	*PO2*	**05**
		b)	The mixture of n-Heptane (A) and n-Octane (B) are expected to behave ideally. The total pressure over the system is 101.3kPa. Using the vapor pressure data given below, i) Construct the boiling point diagram ii) The Equilibrium diagram	*CO2*	*PO2*	**10**

		iii) Deduce an equation for equilibrium diagram using an arithmetic mean of value.				

T, K	371.4	378	383	388	393	398.6
P_A, kPa	101.3	125.3	140	160	179.9	205.3
P_B, kPa	44.4	55.6	64.5	74.8	86.6	101.3

	c)	Explain non-ideal solution with suitable example.	*CO2*	*PO1*	**05**
		UNIT - V			
7	a)	Derive Van't Hoff equation by stating suitable assumptions	*CO2*	*PO2*	**06**
	b)	Derive criteria for biochemical reaction equilibrium.	*CO2*	*PO2*	**10**
	c)	Comprehend the importance of oxygen consumption and heat generation in microbial growth.	*CO2*	*PO1*	**04**

****

U.S.N.										

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

Autonomous Institute Affiliated to VTU

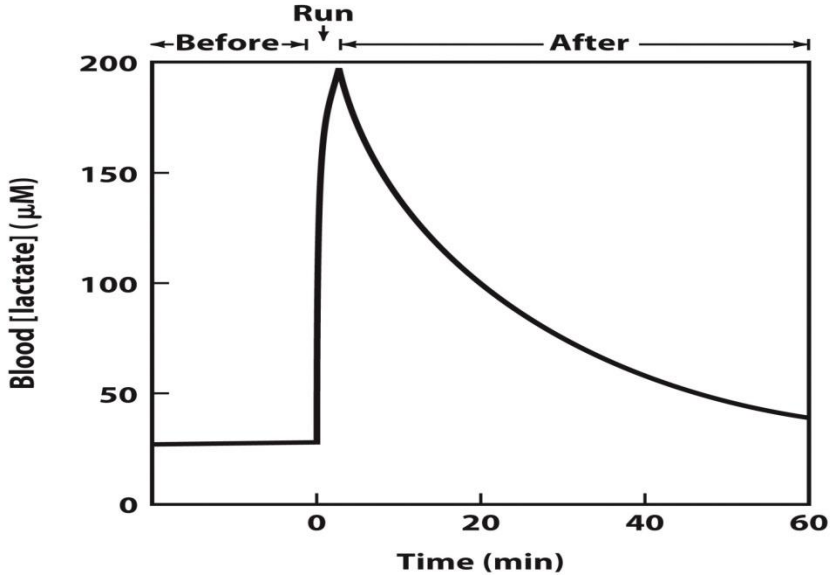
April 2024 Semester End Main Examinations

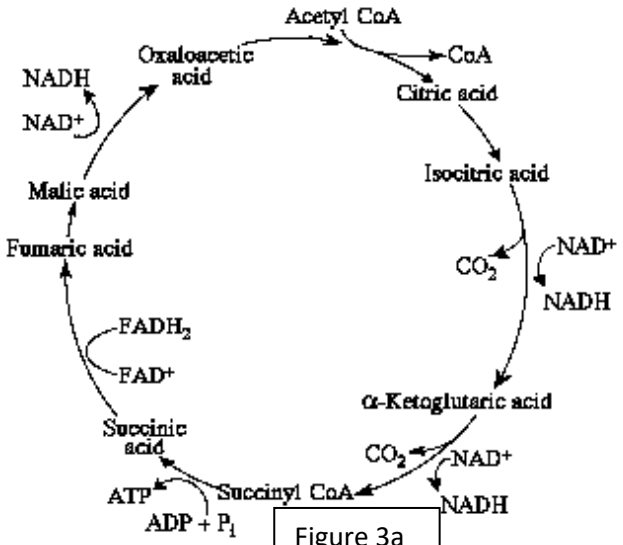
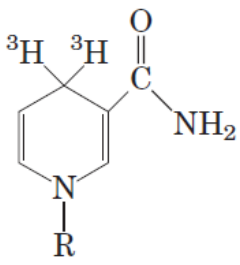
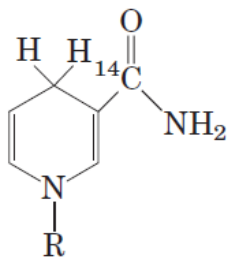
Programme: B.E. **Semester: IV**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 22BT4PCBAB **Max Marks: 100**
Course: Biochemistry and Bioenergetics

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

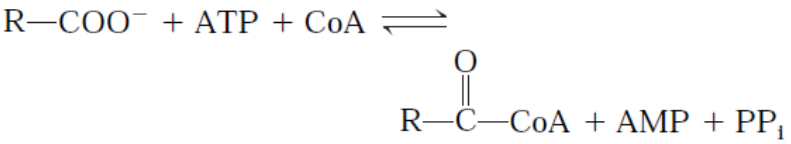
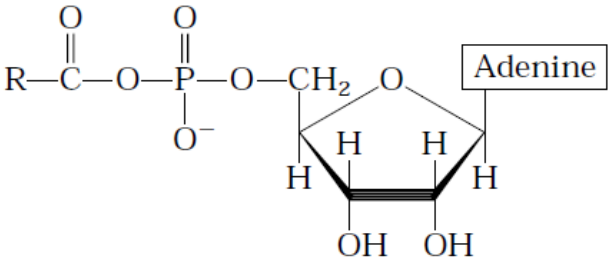
Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

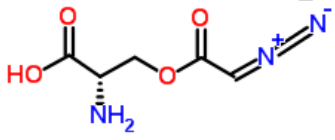
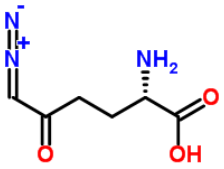
			UNIT - I	CO	PO	Marks
1	a)		Considering the following reaction Acetaldehyde + NADH + H^+ → Ethanol + NAD^+ with $E'^0_{NAD^+/NADH}$ = -0.32 V and $E'^o_{Acetaldehyde/Ethanol}$ = -0.197 V. i. Which redox pair has the greater tendency to lose electrons? Explain. ii. Which pair is the stronger oxidizing agent? Explain. iii. Beginning with 1 M concentrations of each reactant and product at pH 7 and 25 °C, in which direction will the above reaction proceed? iv. What is the standard free-energy change ($\Delta G'^0$) for the reaction? v. What is the free-energy change (ΔG) for the reaction at 37 °C if [acetaldehyde] and NADH are 1.0 M, and [ethanol] and [NAD^+] are 0.1 M? vi. What is the standard equilibrium constant (K'^0_{eq}) for this reaction?	*CO 1*	*PO 1*	**15**
	b)		The phosphorylation of glucose in the cell is coupled to the hydrolysis of ATP; that is, part of the free energy of ATP hydrolysis is used to phosphorylate glucose: (1) Glucose + Pi ⟶ Glucose 6-phosphate + H_2O $\Delta G'^0$ = 13.8 kJ/mol (2) ATP + H_2O ⟶ ADP + Pi $\Delta G'^0$ = − 30.5 kJ/mol Sum: Glucose + ATP ⟶ Glucose 6-phosphate + ADP Calculate K'^0_{eq} at 37 °C for the overall reaction. For the ATP-dependent phosphorylation of glucose, what concentration of glucose is needed to achieve a 250 µM intracellular concentration of glucose 6-phosphate when the concentration of ATP and ADP are 3.38 mM and 1.32 mM, respectively? Does this coupling process provide a feasible route, at least in principle, for the phosphorylation of glucose in the cell? Explain.	*CO 1*	*PO 1*	**05**

			UNIT - II			
	2	a)	The degree of reduction of each carrier in the respiratory chain is determined by conditions in the mitochondrion. For example, when NADH and O_2 are abundant, the steady-state degree of reduction of the carriers decreses as electrons pass from the substrate to O_2. When electron transfer is blocked, the carriers before the block become more reduced and those beyond the block become more oxidized. For each of the conditions below, predict the state of oxidation of ubiquinone and cytochrome b, c_1, c, and $a + a_3$. i. Abundant NADH and O_2, but cyanide added ii. Abundant NADH and O_2 exhausted iii. Abundant O_2, but NADH exhausted iv. Abundant NADH and O_2	*CO 3*	*PO 3*	**08**
		b)	Why would it be disadvantageous to the organism to have Glycolysis and Gluconeogenesis operating simultaneously within a cell? Briefly describe one example of reciprocal regulation of Glycolysis and Gluconeogenesis, involving an allosteric regulator. For the example chosen, write out the reaction catalyzed by the enzyme in each pathway, and indicate the nature of the effect of the regulator (e.g., inhibition or activation).	*CO 2*	*PO 2*	**07**
		c)	 The concentrations of lactate in blood plasma before, during, and after a 400 m sprint are shown in the graph. i. What causes the rapid rise in lactate concentration? ii. What causes the decline in lactate in lactate concentration after completion of the sprint? iii. Why does the decline occur more slowly than the increase? iv. Why is the concentration of lactate not zero during the resting state?	*CO 2*	*PO 2*	**05**
			OR			

	3	a)	Refer the figure 3a given below as a guide to answer the following questions.  Figure 3a i. What is substrate-level phosphorylation? Starting with citric acid and ending with fumeric acid in Figure 3a, what is the maximum number of ATP molecules that could be made through substrate-level phosphorylation? ii. Refer to Figure 3a. Carbon skeletons for amino acid biosynthesis are supplied by intermediates of the Krebs cycle. Which intermediate would supply the carbon skeleton for synthesis of a 5-carbon amino acid? iii. Refer to Figure 3a. Starting with citric acid and ending with oxaloacetic acid, how many ATP molecules can be formed from oxidative phosphorylation? iv. How many ATP molecules can be made through substrate-level phosphorylation and oxidative phosphorylation if you started with succinyl CoA and ended with oxaloacetate? v. What are anaplerotic reactions? Write any two anaplerotic reactions and comment on their significance.	*CO 2*	*PO 2*	**10**
		b)	Under aerobic conditions, extramitochondrial NADH must be oxidized by the mitochondrial electron-transfer chain. Consider a preparation of rat hepatocytes containing mitochondria and all the cytosolic enzymes. If [4-^{3}H]NADH is introduced, radioactivity soon appears in the mitochondrial matrix. However, if [7-^{14}C]NADH is introduced, no radioactivity appears in the matrix. What do these observations reveal about the oxidation of extra mitochondrial NADH by the electron-transfer chain?  [4-^{3}H]NADH  [7-^{14}C]NADH	*CO2*	*PO2*	**05**

		c)	If the oxidation of glucose 6-phosphate via the pentose phosphate pathway were being used primarily to generate NADPH for biosynthesis, the other product, ribise 5-phosphate, would accumulate. What problems might this cause?	*CO2*	*PO2*	**03**
		d)	Chemical compound 2, 4-dinitrophenol (DNP), when added to intact mitochodria can uncouple oxidation from phosphorylation. What seems the reason for this uncoupling?	*CO3*	*PO3*	**02**
			UNIT - III			
	4	a)	Outline the reductive pentose phosphate pathway giving names and structures of substrates and products, and the name of each enzyme.	*CO2*	*PO2*	**10**
		b)	In typical C_4 plants, the initial capture of CO_2 occurs in one cell type, and the Calvin cycle reactions occur in another. Voznesenskaya and colleagues have described a plant, *Bienertia cycloptera*-which grows in salty depressions of semidesert in Central Asia-that shows the biochemical properties of a C_4 plant but unlike typical C_4 plants does not segregate the reactions of CO_2 fixation into two cell types. PEP carboxylase and rubisco are present in the same cell. However, the cells have two types of chloroplasts, which are localized differently, as shown in the micrograph. One type, relatively poor in grana (thylakoids), is confined to the periphery; the more typical chloroplasts are clustered in the center of the cell, separated from the peripheral chloroplasts by large vacuoles. Thin cytosolic bridges pass through the vacuoles connecting the peripheral and central cytosol.  In this plant, where would you expect to find (i) PEP carboxylase, and (ii) Rubisco? Explain your answers for CO_2 fixation in these C_4 cells.	*CO2*	*PO2*	**04**
		c)	The light used by vascular plants for photosynthesis has a wavelength of about 600 nm. Calculate the energy in a "mole" of photon (an einstein) of light of this wavelength, and compare this with the energy needed to synthesize a mole of ATP. (Given h= 6.626×10^{-34} J . s)	*CO1*	*PO1*	**03**
		d)	The extent to which an electron carrier is oxidized or reduced during photosynthetic electron transfer can sometimes be observed directly with a spectrophotometer. When chloroplasts are illuminated with 700 nm light, cytochrome *f*, plastocyanin, and plastoquinone are oxidized. When chloroplasts are illuminated	*CO2*	*PO2*	**03**

			with 680 nm light, however, these electron carriers are reduced. Explain.			
			UNIT - IV			
	5	a)	Fatty acids are converted to their coenzyme A esters in a reversible reaction catalyzed by acyl-CoA synthetase:  The enzyme-bound intermediate in this reaction has been identified as the mixed anhydride of the fatty acid and adenosine monophosphate (AMP), acyl-AMP:  i. Write two equations corresponding to the two steps of the reaction catalyzed by acyl-CoA synthetase ii. The acyl-CoA synthetase reaction is readily reversible, with an equilibrium constant near 1. How can this reaction be made to favor formation of fatty acyl–CoA? iii. Describe four basic steps of β-oxidation of saturated fatty acid.	*CO2*	*PO2*	**10**
		b)	Using your knowledge of fatty acid biosynthesis, provide an explanation for the following experimental observations: i. Addition of uniformly labeled [^{14}C]acetyl-CoA to a soluble liver fraction yields palmitate uniformly labeled with ^{14}C. ii. However, addition of a *trace* of uniformly labeled [^{14}C]acetyl-CoA in the presence of an excess of unlabeled malonyl-CoA to a soluble liver fraction yields palmitate labeled with ^{14}C only in C-15 and C-16.	*CO2*	*PO2*	**05**
		c)	Cholesterol in humans can be obtained from the diet or synthesized de novo. An adult human on a low-cholesterol diet typically synthesizes 600 mg of cholesterol per day in the liver. If the amount of cholesterol in the diet is large, de novo synthesis of cholesterol is drastically reduced. How is this regulation brought about?	*CO 2*	*PO2*	**05**
			UNIT - V			
	6	a)	Oxidative degradation of amino acids makes a significant contribution to the generation of metabolic energy.	*CO2*	*PO2*	**08**

			i. Name and draw the structure of the α-keto acid resulting from Alanine and Aspartate when these amino acids undergo transamination with α-ketoglutarate. ii. Explain the significance of oxidative deamination in the catabolism of amino acids. iii. Name the coenzyme involved in the transamination reaction.			
		b)	Describe the major pathways of purine catabolism in animals.	*CO2*	*PO2*	**08**
		c)	Appraise the role of tetrahydrofolate in the biosynthesis of dTMP.	*CO2*	*PO2*	**04**
			OR			
	7	a)	In a study conducted some years ago, cats were fasted overnight then given a single meal complete in all amino acids except arginine. Within 2 hours, blood ammonia levels increased from a normal level of 18 µg/L to 140 µg/L, and the cats showed the clinical symptoms of ammonia toxicity. A control group fed with a complete amino acid diet or an amino acid diet in which arginine was replaced by ornithine showed no unusual clinical symptoms. i. What was the role of fasting in the experiment? ii. What caused the ammonia levels to rise in the experimental group? iii. Why did the absence of arginine lead to ammonia toxicity? iv. Is arginine an essential amino acid in cats? Why or why not? v. Why can ornithine be substituted for arginine?	*CO 2*	*PO2*	**10**
		b)	Azaserine (O-diazoacetyl-L-serine) and 6-diazo-5-oxo-L-norleucine (DON) are glutamine analogs.  **Azaserine**  **6-diazo-5-oxo-L-norleucine** They form covalent bonds to nucleophiles at the active sites of enzymes that bind glutamine, thereby irreversibly inactivating these enzymes. Identify any three of these enzymes involved in the nucleotide biosynthesis and intermediates that accumulate in the presence of either of these glutamine antagonists.	*CO 3*	*PO 3*	**06**
		c)	How is the rate of pyrimidine nucleotide synthesis regulated through aspartate transcarbamoylase (ATCase)? Explain briefly.	*CO 2*	*PO 2*	**04**

******

U.S.N.										

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

Autonomous Institute Affiliated to VTU

April 2024 Semester End Main Examinations

Programme: B.E. **Semester: IV**
Branch: Biotechnology **Duration: 3 hrs.**
Course Code: 22BT4PCHMT **Max Marks: 100**
Course: Heat and mass transfer

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.

		UNIT - I	CO	PO	Marks
1	a)	Explain the different modes of heat transfer with examples.	CO 1	PO 1	**06**
	b)	What is thermal conductivity? Compare thermal conductivity in solids, liquids and gases.	CO1	PO1	**04**
	c)	An exterior wall of house may be approximated by a 100 mm layer of a common brick with thermal conductivity 0.7 W/m K followed by a 40 mm layer of gypsum plaster with thermal conductivity 0.48 W/m K. What thickness of loosely packed rockwool insulation with thermal conductivity 0.065 W/m K should be added to reduce the heat loss through the wall by 25%.	CO3	PO2	**10**
		OR			
2	a)	Explain the construction and working principle of double pipe heat exchanger with a neat diagram. Name any 10 major parts.	CO1	PO1	**10**
	b)	Ethylene glycol at 273K enters a 40 mm diameter pipe at a velocity of 5 m/s. The tube wall is maintained at a temperature of 353K. Determine the heat transfer coefficient using Sieder-Tate equation. Exit temperature is 313K. Properties of ethylene glycol at 293K are as follows : $\rho = 1117$ kg/m^3 , Cp = 2.39 kJ/(kg·K), $\nu = 19.18 \times 10^{-6}$ m^2 /s, k = 0.249 W/(m·K), μ_w = viscosity at 353 K = 3.21×10^{-3} kg/(m·s)	CO3	PO2	**10**
		UNIT - II			
3	a)	Differentiate between dropwise and filmwise condensation.	CO2	PO1	**06**
	b)	Derive equation for individual and overall heat transfer coefficients.	CO2	PO1	**08**
	c)	With a neat diagram, explain the working of backward feed type triple effect evaporator.	CO1	PO 1	**06**

			UNIT - III			
	4	a)	Derive relationship between different k type mass transfer coefficients in gases and liquids.	*CO2*	*PO1*	**10**
		b)	Hydrochloric acid (A) at 283K diffuses through a thin film of water (B). The film is 4 mm thick. The concentration of A at location 1, on one boundary of the film, is 12 weight % (density ρ_1 = 1060.7 kg/m^3) and at location 2, on the other boundary, is 4 weight % (density ρ_2 = 1020.15 kg/m^3). The diffusivity of HCl in water is 2.5 × 10^{-9} m^2 /s. Calculate the flux of diffusion of A assuming water to be stagnant (i.e., non-diffusing).	*CO3*	*PO2*	**10**
			UNIT - IV			
	5	a)	Explain aqueous two phase extraction with suitable examples. Give its applications.	*CO2*	*PO 1*	**08**
		b)	A rectification column is fed with 100 kmol/h of a mixture containing 50 mole% hexane and 50 mole% octane at 101.325 kPa absolute pressure. The feed is at its boiling point. The distillate is to contain 90 mole% hexane and the bottoms 10 mole% hexane. The reflux ratio is 3:1. Calculate the kmol/h distillate and kmol/h bottoms, and the number of theoretical trays needed for this separation. The equilibrium data for this system is given below:	*CO3*	*PO2*	**12**

Mole fraction of hexane in liquid, x	1	0.69	0.4	0.192	0.045	0
Mole fraction of hexane in vapour, y	1	0.932	0.78	0.538	0.1775	0

			OR			
	6	a)	Derive material balance equation for simple distillation with a neat diagram.	*CO 2*	*PO1*	**10**
		b)	A liquid mixture containing 35 mole% n-heptane and 65 mole% n-octane (average relative volatility of 2.16) is subjected to a differential distillation at atmospheric pressure (101.325 kPa), with 65 mole% of the liquid distilled. Estimate the composition of the composited distillate and residue. Heptane is the more volatile component.	*CO3*	*PO2*	**10**
			UNIT - V			
	7	a)	Explain any three types of physical adsorbents.	*CO1*	*PO1*	**06**
		b)	With a neat diagram, explain the drying rate curve.	*CO1*	*PO1*	**08**
		c)	Explain the principle of crystallization.	*CO 1*	*PO1*	**06**

****