2023-24

B.TECH. (AUTUMN SEMESTER) EXAMINATION
CHEMICAL/PETROCHEMICAL ENGINEERING
MASS TRANSFER OPERATIONS
CHC3080/PKC3050

Maximum Marks: 60 **Credits: 04** **Duration: Two Hours**

Answer all the questions.

Q No	Question	Marks	CO covered
1(a)	Define diffusive flux and convective flux of mass transfer. Show that the molar diffusive and convective fluxes are related as $N_i = x_i \sum_i N_i + J_i$ Hence show that $\sum_i J_i = 0$	[06]	CO-1
1(b)	At a particular section of an equipment for absorption of a solute A in a liquid, the bulk gas phase contains 9.5 mol% A and the liquid contains 2 mol% of A. The gas-film coefficient is $k_y = 10$ kmol/(h)(m^2)(Δy) and 60% of the mass transfer resistance occurs in the liquid-film. The equilibrium is described by Henry's law, $y_A = 0.85x_A$. Calculate (a) the overall mass transfer coefficient, K_x; (b) the molar flux of A; and (c) the interfacial concentrations of the solute, x_{Ai} and y_{Ai}.	[09]	CO-1
	OR		
1'(a)	Penetration theory interprets the mass transfer rate at the interface as given by: $N_{Ax}\big\|_{x=0} = (c_{Ai} - c_{Ab})\sqrt{\frac{D_{AB}}{\pi t}}$ Using Danckwerts' age distribution function $\phi(t) = se^{-st}$, show that the Danckwets' surface renewal model gives the average liquid side mass transfer coefficient as: $k_{L,\text{av}} = \sqrt{sD_{AB}}$; where s is the surface renewal rate.	[06]	CO-1
1'(b)	The gas-phase mass transfer coefficient for the evaporation of a drop of ethyl alcohol in a stream of air at 300 K and 1.2 bar pressure is $k_G = 2.4\times10^{-6}$ kmol/s·m^2·mm Hg. Calculate the value of the mass transfer coefficient if the driving force is expressed in terms of difference in: (i) mole fraction of alcohol in the gas phase, (ii) concentration of alcohol in kmol/m^3. Also calculate F_G.	[09]	CO-1

contd.... 2

If the diffusivity of ethyl alcohol in air is 0.102 cm^2/s at 0 °C and 1 atm., estimate the thickness of the stagnant gas-film. Vapor pressure of alcohol = 0.0877 bar at 300 K.

2 A packed tower 4.0 m tall is used to absorb ethyl alcohol from an inert gas by 90 kmol/h of pure water at 30 °C and 1 atm. The total gas stream flow rate of 100 kmol/h contains 2.0 mol% alcohol and the exit concentration is 0.2 mol%. The equilibrium relationship is $y = 0.68x$. Using the analytical equations, calculate the number of theoretical stages, N, number of overall gas transfer unit, N_{tOG}, height of overall gas transfer unit, H_{tOG}, and height equivalent to theoretical plate, HETP. [15] CO-2

OR

2' A relatively nonvolatile hydrocarbon oil contains 4.0 mol% propane and is being stripped by direct superheated steam in a stripping tray tower to reduce propane content to 0.2 mol%. A total of 11.42 kmol of direct steam is used for 300 kmol of total entering liquid. Under the prevailing conditions in the tower, the vapor liquid equilibria is described as $y = 25x$. Determine the number of theoretical staged required both graphically and using Kremser's equation. [15] CO-2

3(a) A mixture of air and benzene vapor at 800 mmHg has a dry bulb temperature and wet bulb temperature as 50 °C and 31 °C respectively. Determine the absolute humidity of the mixture in kg/kg dry air. The psychrometric ratio of benzene vapor-air system is 1.72 kJ/kg°C and the latent heat of vaporization of benzene at 30 °C is 428.02 kJ/kg. The vapor pressure of benzene is given by [05] CO-3

$$\log p^*[mmHg] = 8.15 - \frac{1842.2}{T[K]}$$

3(b) A cooling tower receives warm water at 43 °C at a mass flow rate of 7000 $kg/m^2 \cdot h$. A cooling range of 13 °C is achieved by countercurrent contact with air. The air enters at a rate of 4200 $kg/m^2 \cdot h$ at a dry bulb temperature of 31 °C and a humidity of 0.01516 kg/kg DA. The overall volumetric mass transfer coefficient is $K_Y a = 250$ $kg/m^3 \cdot h \cdot \Delta Y'$. Determine the height of the packing. [10] CO-3

4(a) A batch of wet solid was dried on a tray dryer using constant drying conditions and a thickness of material on the tray of 25.4 mm. Only the top surface was exposed. The drying rate during the constant-rate period was N_c = 2.05 kg water/$h \cdot m^2$. The ratio S_S / A used was 24.4 kg dry solid/m^2 exposed surface. The initial free moisture was X_1 = 0.55 and the critical moisture content X_c = 0.22 kg free moisture/kg dry solid. Calculate the time [09] CO-4

Contd....3.

required to dry the batch of this material from $X_1 = 0.45$ to $X_2 = 0.30$ using the same drying conditions but a thickness of 50.8 mm, with drying from both the top and bottom surfaces.

4(b) A salt solution weighing 10000 kg with 30 wt% is cooled to 20 °C. the salt crystallizes as the dehydrate. If 3% of the total weight of the solution is lost by evaporation of water in cooling, Calculate the yield of $Na_2CO_3.10H_2O$ crystals. The solubility is 21 kg Na_2CO_3/100 kg of total water. **[06]** **CO-4**

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contd...4.

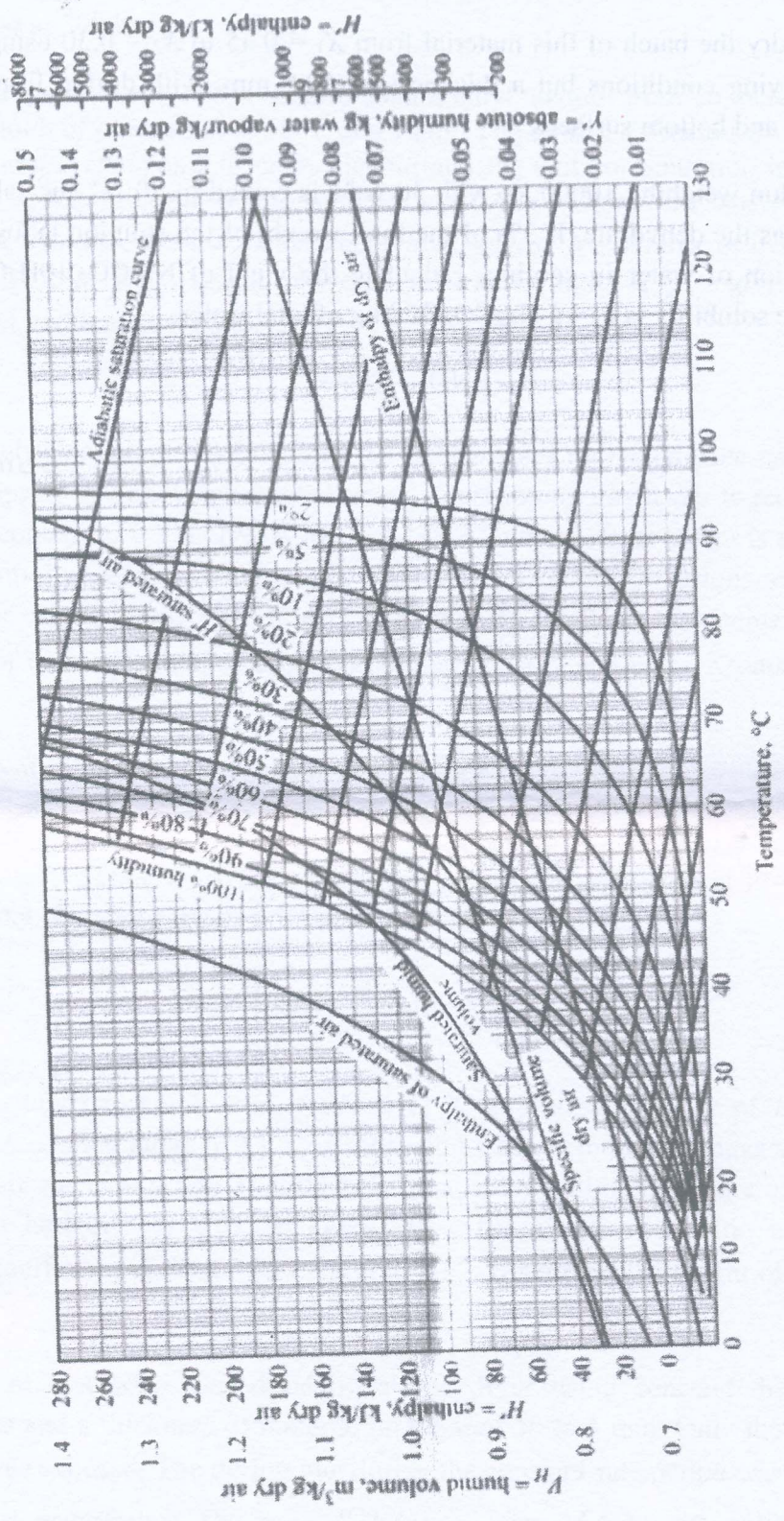


Figure 10.6 (a) Psychrometric chart for the air–water system at 1 atm total pressure.

2023-2024
B.TECH. (V SEMESTER) EXAMINATION
(CHEMICAL ENGINEERING)
PROCESS INSTRUMENTATION
(CHC-3090)

Maximum Marks: 60 **Credits : 03** **Duration: Two Hours**

Q.No.			M.M.	
1.	(a)	Explain various types of errors encountered during measurement process. What are the typical sources for these types of error? In what ways can the act of measurement cause a disturbance in the system being measured? What steps can be taken to minimize the effect of environmental inputs in measurement systems?	(09)	[CO1]
		OR		
	(a')	What do you understand by static and dynamic characteristic of instruments? List and explain in detail the static characteristic of instruments.	(09)	[CO1]
1.	(b)	Give a detailed classification of instrument types used in process industries.	(06)	[CO1]
2.	(a)	Discuss the working of (i) optical sensor (air path and fibre-optic), (ii) piezoelectric and piezoresistive sensor, and (iii) ultrasonic transducer.	(09)	[CO2]
2.	(b)	Explain the process of digital to analog conversion of measuring instruments. What are the approaches to improve the accuracy of A/D conversion? Explain the role of data acquisition in instrumentation.	(06)	[CO2]
3.		Write detailed notes on any five different types of instruments used for pressure and vacuum measurement mentioning their working principle, operating range, application etc. Draw neat and well labelled diagrams.	(15)	[CO3]
		OR		
3'.		With the help of a neat diagram explain in detail the working of Capacitive Hygrometer, Psychrometer, Dew Point Meter, Induction Hydrometer, and Thermohydrometer.	(15)	[CO3]

Contd....2.

4. (a) Explain the significance of letters and symbols in piping and instrumentation diagram with the help of two examples. Draw the piping and instrumentation diagram of a distillation column in which following conditions are required to be measured/ controlled: (09) [CO4]

(i) Flowrate of feed, distillate, and bottom product.

(ii) Temperature of distillation column, condenser, and reboiler.

(iii) Pressure in the distillation column.

4. (b) Describe the construction and working of (i) gas chromatography and, (ii) ultraviolet visible spectroscopy. (06) [CO4]

2023-24

B. TECH. (AUTUMN SEMESTER) EXAMINATION

CHEMICAL ENGINEERING/FOOD TECHNOLOGY

Chemical Reaction Engineering I

CHC-3100

Maximum Marks: 60 **Credits: 03** **Duration: Two Hours**

Answer all questions.
Assume suitable data if missing.
Notations and symbols used have their usual meaning.

Q. No.	Question	M.M.
1(a)	A gaseous phase reaction is carried out in constant volume batch reactor under isothermal condition where number of moles of material changes with time. Develop the general expression which relates the total pressure of the system to the concentration or partial pressure of any of the reaction components.	[08] [CO1]
	OR	
1(a')	A reversible type first order reaction $A \leftrightarrow 2R$ takes place in a batch reactor. k_1 and k_2 are the rate constants for forward and backward reaction respectively. Find out the equilibrium conversion of A. Explain the procedure and evaluate the expression to determine the rate constant.	[08] [CO1]
1(b)	The maximum allowable temperature for a reactor is 800 K. At present our operating set point is 780 K. Now, with a more sophisticated control system we would be able to raise our set point to 792 K. By how much can the reaction rate, hence, production rate, be raised by this change if the reaction taking place in the reactor has an activation energy of 175 kJ/mol?	[04] [CO1]
1(c)	The decomposition of nitrous oxide is found to proceed as follows: $$N_2O \rightarrow N_2 + \frac{1}{2}O_2, \qquad -r_{N_2O} = \frac{k_1[N_2O]^2}{1 + k_2[N_2O]}$$ What is the order of this reaction with respect to N_2O, and overall?	[03] [CO1]
2(a)	Liquid A decomposes in a batch reactor by zero order kinetics. The initial concentration of A is 0.5 kmol/m^3 and for a reaction time of 1200 s, the conversion is 40%. Assume isothermal conditions. Determine the rate constant for this reaction and what will be the conversion for a reaction time of 3600 s?	[5] [CO2]

contd ....2.

2(b) A first order liquid phase reaction is carried out in an ideal continuous stirred tank reactor. What will happen to the conversion if a part of the outlet stream is recycled back to the reactor? [02] [CO2]

2(c) The elementary second-order, liquid phase reaction A+B→ C +D is conducted in an isothermal plug flow reactor of $1m^3$ capacity. The inlet volumetric flow rate is 10 m^3/h and $C_{A0}=C_{B0}=2$ $kmol/m^3$. At these conditions, conversion of A is 50%. Now, if a stirred tank reactor of 2 m^3 capacity is installed in series, upstream of the plug flow reactor, then what conversion can be expected in the new system of reactor? [08] [CO2]

3(a) The reversible first order gas phase reaction [15] [CO3]

$$A \rightleftarrows R \begin{cases} \Delta G^{\circ}_{298} = -14\,130 \text{ J/mol} \\ \Delta H^{\circ}_{298} = -75\,300 \text{ J/mol} \end{cases}$$

is to be carried out in a batch reactor, starting with a mixture of C_{A0} = 4 mol/liter to C_{R0} = 0 mol/liter. Reaction gives 50% conversion in 1 min at 60°C and 60% conversion in 12 min at 25°C. Assuming first order kinetics, determine the equilibrium conversion at 60°C and also find the reaction rate at 60°C for 60% conversion of A. Data given: $C_{PA}=C_{PR}$ = 25 J/mol.K

OR

3(a') Explain optimum temperature progression. Develop the relationship between conversion and heat of reaction for adiabatic operations. Also explain the graphical representation of energy balance equation for adiabatic operations. [15] [CO3]

4(a) Develop the output concentration profile (mathematical function) of tracer in an ideal CSTR for an impulse input. Compare it with non-ideal CSTR reactor. [04] [CO4]

OR

4(a') How does the F curve obtain from a RTD experiment? Establish the relationship between F and E curve. [04] [CO4]

4(b) Briefly explain the governing equation of unsteady state tubular reactor. Simplify it for steady state plug flow reactor with axial mixing. Explain the significance of dispersion number. [05] [CO4]

Contd....3.

4(c) The concentration reading in the table represent a continuous response to a pulse input into a closed vessel. [06] [CO4]

Time, t (min)	Tracer Output Concentration, C_{pulse} (gm/liter fluid)
0	0
5	2
10	4
15	5
20	4
25	3
30	2
35	0

The vessel is to be used as a chemical reactor for a liquid decomposing with rate $r_A = -kC_A$, k=0.421 min^{-1}. Find the fraction of reactant unconverted in the real reactor and compare this with the fraction unconverted in a plug flow reactor of the same size.

2023-24

B.TECH. (WINTER SEMESTER) EXAMINATION

Chemical Engineering

Equillibrium Stage Processes

CHC3110

Maximum Marks: 60 **Credits: 04** **Duration: Two Hours**

Answer all the questions.
Use of graph papers is allowed.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.	Question	M.M.
1(a)	Discuss the effect of increasing pressure on vapor liquid equilibria with diagrams.	[5] [CO1]
1(b)	A liquid containing 50 mol % n-heptane, and 50mol% n-octane were subjected to a differential distillation at atmospheric pressure, with 60mol% of the liquid distilled. Compute the average composition of the distillate and the composition of remaining liquid. Equilibrium data are given as:	

x	0.50	0.46	0.42	0.38	0.34	0.32
y	0.689	0.648	0.608	0.567	0.523	0.497

[10]

Where x and y are mole fractions of n-heptane. [CO1]

OR

1'(a)	With the help of diagrams define overall tray efficiency, Murfree tray efficiency, and point efficiency in a distillation column.	[5] [CO1]
1'(b)	A rectification column is fed with 100 kg mol/h of a mixture of 45 mol% benzene and 55 mol % toluene at 101.32 kPa abs pressure. The feed is liquid at the bubble point. The distillate is to contain 90 mol % benzene and the bottoms 10 mol % benzene. The reflux ratio is 2.5:1. Calculate the amounts of distillate and bottoms and the number of theoretical trays needed using the McCabe-Thiele method.	

Contd.....2.

Equilibrium data are given below at 101.3 kPa for the mole fraction benzene x_B and y_B.

Temperature °C	80.1	85	90	95	100	105	110.6
x_B	1.00	0.78	0.58	0.41	0.258	0.13	0.00
y_B	1.00	0.90	0.77	0.63	0.456	0.261	0.00

[10]

[CO1]

2. The following mixture must be separated by distillation so that 95% of the propane charged is recovered in the distillate and 90% of the butane charged is recovered in the bottoms. Estimate the other components at total reflux and number of stages at the given condition:

Component	K values	kgmoles
Ethane	4.9	5
Propane	1.9	20
Butane	0.85	30
Pentane	0.35	20
Hexane	0.17	20
Heptane	0.08	5

[15]

[CO2]

3 Pure isopropyl ether of 450kg/h is being used to extract an aqueous solution of 150 kg/h with 25wt% acetic acid by countercurrent multistage extraction. The exit acid concentration in the aqueous phase is 10wt%. Calculate the number of stages required. For acetic acid-water-isopropyl ether system, equilibrium data is given below:

Water layer (wt%)			isopropyl ether layer(wt%)		
0	98.8	1.2	0	0.6	99.4
0.69	98.1	1.2	0.18	0.5	99.3

Contd .... 3.

1.41	97.1	1.5	0.37	0.7	98.9
2.89	95.5	1.6	0.79	0.8	98.4
6.42	91.7	1.9	1.93	1.0	97.1
13.3	84.4	2.3	4.82	1.9	93.3
25.5	71.1	3.4	11.4	3.9	84.7
36.7	58.9	4.4	21.6	6.9	71.5
44.3	45.1	10.6	31.1	10.8	58.1
46.4	37.1	16.5	36.2	15.1	48.7

[15]
[CO3]

OR

3'(a) Write in brief about the preparation of solids for leaching. [5]
[CO3]

3'(b) In a single stage leaching of soya bean oil from flaked soya beans with hexane, 100 kg of soya bean containing 30 wt% oil is leached with 100 kg of fresh hexane solvent. The value of N for the slurry underflow is essentially constant at 2.5 kg insoluble solid / kg solution retained. Calculate the amount and composition of the overflow and underflow slurry leaving the stage. [10]
[CO3]

4(a) Write short notes on

(i) Effect of temperature and pressure on adsorption [5]

(ii) Adsorption hysteresis [CO4]

4(b) State Freundlich law for the adsorption of solutes from dilute solution. Deduce the relation for the determination of least total amount of adsorbent for two stage cross current operation. [10]
[CO4]

(6508)

2023-24

B.TECH. (AUTUMN SEMESTER) EXAMINATION

CHEMICAL ENGINEERING

BIOPROCESS ENGINEERING

CHE3210

Maximum Marks: 60 **Credits: 04** **Duration: Two Hours**

Answer all the questions.
State assumptions clearly for full marks.
Choose suitable value with justification for any missing data.

Q No	Question	Marks	CO
1(a)	Plant cells are cultured in a bioreactor using sucrose ($C_{12}H_{22}O_{11}$) as the carbon source and ammonia (NH_3) as the nitrogen source. The vessel is sparged with air. Biomass is the major product formed; however, because the cells are subject to lysis, significant levels of excreted by-product with the same molecular composition as the biomass are also produced. Elemental analysis of the plant cells gives a molecular formula of $CH_{1.63}O_{0.80}N_{0.13}$ with negligible ash. Yield measurements show that 0.32 g of intact cells is produced per g of sugar consumed, while 0.2 g of by-product is formed per g of intact biomass. If 10 kg sugar is consumed per hour, at what rate must oxygen be provided to the reactor in units of gmol min^{-1}?	(8)	[CO1]
1(b)	*Azotobacter vinelandii* is investigated for production of alginate from sucrose. In a continuous fermenter at 28°C with ammonia as nitrogen source, the yield of alginate was found to be 4 g g^{-1} oxygen consumed. It is planned to produce alginate at a rate of 5 kg h^{-1}. Since the viscosity of alginate in aqueous solution is considerable, energy input due to mixing the broth cannot be neglected. The fermenter is equipped with a flat bladed disc turbine; at a satisfactory mixing speed and air flow-rate, power requirements are estimated at 1.5 kW. Estimate the cooling water requirement if the water is available at 25°C and the environmental considerations impose an upper bound of 45°C on the water discharge temperature.	(7)	[CO1]

Contd.....2.

2(a) Describe the simple dynamic method of k_La measurement using appropriate graph. Obtain the relationship for estimating k_La from the data measured using the dynamic method. Clearly define the variables appearing in the above relationship. (6) [CO2]

2(b) The simple dynamic method is used to measure k_La in a fermenter operated at 30°C and 1 atm pressure. Data for the dissolved oxygen concentration as a function of time during the reoxygenation step are as follows.

Time (s)	C_{AL} (% air saturation)
10	43.5
15	53.5
20	60.0
30	67.5
40	70.5
50	72.0
70	73.0
100	73.5
130	73.5

(i) Calculate the value of k_La. (6) [CO2]

(ii) What additional experiments are required to check the reliability of this kLa result? (3) [CO2]

OR

2'(a) Whole gutted fish are dried to make a protein paste. In a batch drier, the rate at which water is removed from the fish is roughly proportional to the moisture content. If a batch of gutted fish loses half its initial moisture content in the first 20 min, how long will the drier take to remove 95% of the water? (7) [CO2]

2'(b) Aqueous two-phase extraction is used to recover α-amylase from solution. A polyethylene glycol-dextran mixture is added and the solution separates into two phases. The partition coefficient is 4.2. Calculate the maximum possible enzyme recovery when the volume ratio of the upper to lower phase is 5.0. Given that the yield of A in the upper phase, Y_{Au}, is defined as:

Contd.....3.

$$Y_{Au} = \frac{V_{u}}{V_u + \frac{V_l}{K}}$$

Where V_u is the volume of upper phase, V_l is the volume of lower phase, and K is the partition coefficient. (4) [CO2]

2'(c)

What are the three main types of downstream processing operations? Enumerate the major steps involved for these three types of downstream processing operations. (4) [CO2]

3(a) Lactase, also known as β-galactosidase, catalyses the hydrolysis of lactose to produce glucose and galactose from milk and whey. Experiments are carried out to determine the kinetic parameters for the enzyme. Initial rate data are listed below.

Lactose concentration (mol L^{-1} x 10^2)	*Initial reaction velocity* (mol L^{-1} min^{-1} x 10^3)
2.50	1.94
2.27	1.91
1.84	1.85
1.35	1.80
1.25	1.78
0.730	1.46
0.460	1.17
0.204	0.779

Evaluate v_{max} and K_m by linearization of the Michaelis-Menten equation using **Langmuir plot**. What is the drawback of this method over the Langmuir method? (7) [CO3]

3(b) The following figure shows a continuous stirred tank reactor (CSTR) for the production of a hormone. The growth of the hormone in each vessel in the steady state is given by the Monod equation,

Contd.....4

$$\mu = \frac{\mu_{max} c_s}{K_s + c_s}$$

Where

μ = the specific growth rate, h^{-1}

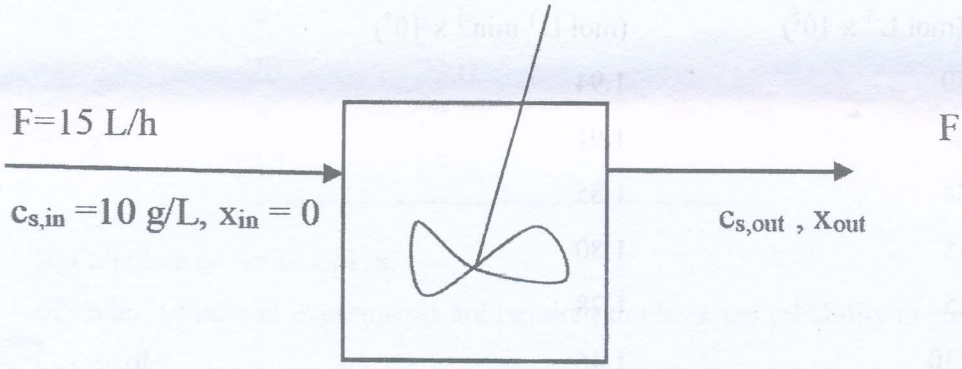
μ_{max} = maximum specific growth rate, h^{-1}

c_s = nutrient concentration in the vessel, g nutrient/L substrate

K_s = Monod constant, g nutrient/L substrate

The substrate is the liquid containing water, nutrients, and cells. The biomass yield coefficient, $Y_{X/S}$ (g dry cell formed/g nutrients consumed) is given. The reactor has a volume of 100 L. Calculate the concentration of biomass in the reactor exit stream, x_{out} for the following data. [CO3] (8)

Data: The substrate flow rate into the vessel is 15 L/h, and contains no cell, but contains a nutrient with a concentration of 10 g/L. $Y_{X/S}$ is equal to 0.2 g cells/g nutrient consumed. Monod constant is 2 g/L, and μ_{max}=0.4/h.



OR

3'(a) What are different mechanisms of reversible enzyme inhibition kinetics? Describe each giving detailed reaction sequence. (5) [CO3]

3'(b) Growth and nutrient uptake in batch cultures of the freshwater diatom, *Cyclotella meneghiniana*, are studied under silicate-limiting conditions. Unbuffered freshwater medium containing 25 µM silicate is inoculated with cells. Samples are taken over a period of 4 days for measurement of cell and silicate concentrations. The results are as follows.

Contd.....5.

Time (days)	Cell Concentration (cells l^{-1})	Silicate Concentration (μM)
0	4.41×10^5	8.00
0.5	5.53×10^5	7.97
1.0	1.31×10^6	7.72
1.5	3.00×10^6	7.59
2.0	4.82×10^6	6.96
2.5	1.12×10^7	5.33
3.0	1.67×10^7	4.63
4.0	2.57×10^7	1.99

(a) Does this culture exhibit exponential growth? **(4) [CO3]**

(b) What is the value of μ_{max}? **(4) [CO3]**

(c) Is there a lag phase? **(2) [CO3]**

4(a) The concentration profile for the substrate in an isothermal spherical biocatalyst pellet for the case of zero order reaction with internal mass diffusion is given by,

$$C_A = C_{As} + \frac{k_0 R^2}{6D_{Ae}}\left(\frac{r^2}{R^2} - 1 + \frac{2R_0^3}{rR^2} - \frac{2R_0^3}{R^3}\right), \quad for\ 0 < r \leq R_0,\ C_A = 0$$

where symbols have their usual meaning.

(i) Obtain the differential equation by writing shell mass balance over a spherical biocatalyst pellet and write down the appropriate boundary conditions in order to obtain above solution for the substrate concentration distribution. **(4) [CO4]**

(ii) Derive the expression for the maximum particle radius for which C_A remains greater than zero throughout the particle volume. **(3) [CO4]**

4(b) L-Lactate 2-monooxygenase from *Mycobacterium smegmatis* is immobilised in spherical agarose beads. The enzyme catalyses the reaction:

$$\underset{\text{lactic acid}}{C_3H_6O_3} + O_2 \longrightarrow \underset{\text{acetic acid}}{C_2H_4O_2} + CO_2 + H_2O$$

Cont....6.

Agarose beads 4 mm in diameter are immersed in a well-mixed solution containing 0.5 mM oxygen. A high lactic acid concentration is provided so that oxygen is the rate-limiting substrate. The effective diffusivity of oxygen in agarose is 2.1×10^{-9} m^2/s. K_m for the immobilised enzyme is 0.015 mM and v_{max} is 0.12 mol s^{-1} per kg of enzyme. The beads contain 0.012 kg of enzyme m^{-3} of gel. External mass transfer effects are negligible. [CO4]

(a) Plot the oxygen concentration profile inside the beads. (5) [CO4]

(b) What fraction of the catalyst volume is active? (1)

(c) Determine the largest bead size that allows the maximum overall rate of conversion. (2)

THE END OF QUESTIONS

IMPORTANT DATA AND EQUATIONS:

Atomic weights: C=12, O=16, S=16, N=14, H=1

Valence of elements for calculating available electron:

C=4, H=1, O= -2, P=5, S=6, N= -3 (if ammonia is the reference state)

1 cal = 4.187 J

Gas constant R =82.057×10^{-6} m^3 atm K^{-1} gmol^{-1} = 8.312 J gmol^{-1} K^{-1}

Heat of reaction for aerobic fermentation = - 460 kJ/mol O_2 consumed

Heat capacity of water = 75.4 kJ kgmol^{-1} °C^{-1} =4.2 kJ kg^{-1}°C^{-1}

Air composition at low pressure: 21% O_2 and 79% N_2 by volume.

Michaelis-Menten equation:

$$r_A = \frac{v_{max} C_A}{K_m + C_A}$$

Monod equation:

$$\mu = \frac{\mu_{max} s}{K_S + s}.$$

The rate of cell growth in a batch culture may be given as:

$$r_x = \frac{dx}{dt} = \mu x$$

The zero-order kinetics may be given as:

$r_A = k_0' e$, where e is the concentration of enzyme

Catalytic efficiency = $v_{max}\, e_a / K_m$

2023-2024

B.TECH. (AUTUMN SEMESTER) EXAMINATION

MEH-3450: ENGINEERING ECONOMY & MANAGEMENT

(COMPUTER/ARTIFICIAL INTELLIGENCE/CHEMICAL/PETROCHEMICAL ENGINEERING AND FOOD TECHNOLOGY)

Maximum Marks: 60 **Duration: Two Hours**

All questions are compulsory.
Assume data suitably, if required.

1(a) Write one practical implication of the Equilibrium Point on the supply-demand curve. [CO1] [01]

1(b) On the Cost-Revenue Curve, show the regions of Profit and Loss. [CO1] [01]

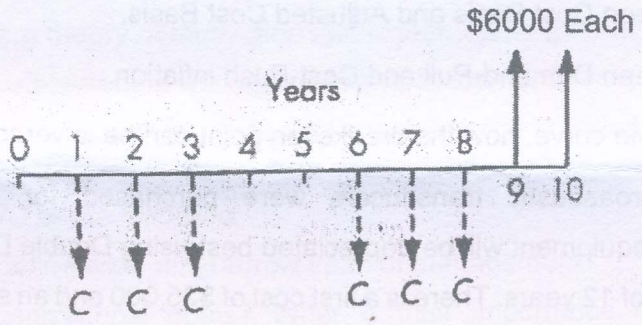
1(c) Write in brief, how the equilibrium point changes if variable cost is decreased. [CO1] [02]

OR

1(c') Differentiate between Monopoly and Oligopoly. [CO1] [02]

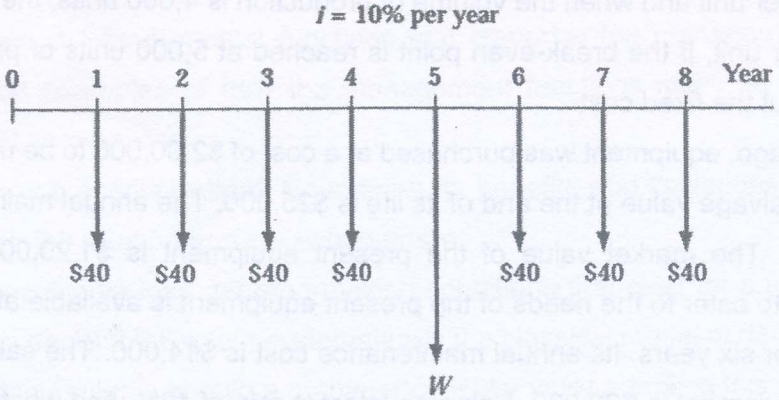
1(d) Differentiate between Nominal and Effective Interest Rates. [CO1] [02]

1(e) From the cash flow diagram, find the value of C (in $) that will establish the economic equivalence between the deposit series and the withdrawal series at an interest rate of 8% compounded annually. [CO1] [04]



OR

1(e') For the cash flow diagram shown, determine the value of *W* that will render the equivalent future worth in 8 years equal to $500 at an interest rate of 10% per year. [CO1] [04]



Contd....2.

1(f)	Two alternative machines are being considered for a manufacturing process. Machine 'A' has a first cost of $75,200 and its salvage value at the end of 6 years of estimated service life is $21,000. The operating costs of this machine are estimated to be $6,800 per year. Extra income taxes are estimated at $2,400 per year. Machine 'B' has a first cost of $44,000 and its estimated salvage value at the end of 6 years' of service is estimated to be negligible. The annual operating costs will be $11,500. Compare these two alternatives by the present worth method at i=13% per year.	[CO1]	[05]
	OR		
1(f')	The purchase of a truck with an operator's platform on a telescoping hydraulic boom will reduce labour costs for sign installations by $15,000 per year. The price of the boom truck is $ 93,000 and its operating costs will exceed those of present equipment by $250 per month. The resale value is expected to be $18,000 in 8 years. Should the boom truck be purchased when the current available interest rate is 7%?	[CO1]	[05]
2(a)	Define "Profitability Index" in the context of B/C Analysis.	[CO2]	[01]
2(b)	Define Debt-Equity Ratio.	[CO2]	[01]
2(c)	Differentiate between Cost Basis and Adjusted Cost Basis.	[CO2]	[01]
2(c)	Differentiate between Demand-Pull and Cost-Push inflation.	[CO2]	[02]
2(d)	On the Cost-Volume curve, how the breakeven point can be lowered?	[CO2]	[02]
2(e)	Underwater electroacoustic transducers were purchased for use in SONAR applications. The equipment will be depreciated best using Double Declining Balance Method over a life of 12 years. There is a first cost of $25,000 and an estimated salvage of $2500. Calculate the depreciation and book value for 1st & 4th years.	[CO2]	[03]
	OR		
2(e')	For a manufacturing firm, when the volume of production is 3,000 units, the average cost is $4 per unit and when the volume of production is 4,000 units, the average cost is $3.50 per unit. If the break-even point is reached at 5,000 units of production and sale, find out the fixed cost.	[CO2]	[03]
2(f)	Two years ago, equipment was purchased at a cost of $2,00,000 to be useful for eight years. Its salvage value at the end of its life is $25,000. The annual maintenance cost is $25,000. The market value of the present equipment is $1,20,000. Now, new equipment to cater to the needs of the present equipment is available at $1,50,000 to be useful for six years. Its annual maintenance cost is $14,000. The salvage value of the new equipment is $20,000. Using an interest rate of 12%, find whether it is worth replacing the present equipment with the new equipment.	[CO2]	[05]
	OR		

Contd.... 3.

2(f) In the past, the Afram Foundation has awarded many grants to improve the living and medical conditions of people in war-torn and poverty-stricken countries throughout the world. In a proposal for the foundation's board of directors to construct a new hospital and medical clinic complex in a deprived central African country, the project manager has developed some estimates. These are developed in a manner that does not have a major negative effect on prime agricultural land or living areas for citizens. [CO2] [05]

Award amount: $20 million (end of) first year, decreasing by $5 million per year for 3 additional years; local government will fund during the first year only.

Annual costs: $2 million per year for 10 years, as proposed.

Benefits: Reduction of $8 million per year in health-related expenses for citizens.

Disbenefits: $0.6 million per year for the removal of arable land and commercial districts.

Use the conventional and modified B/C methods to determine if this grant proposal is economically justified over a 10-year study period. The foundation's discount rate is 6% per year.

3(a) *Fill in the blanks* [CO3] [1x3]

i) The Herzberg theory of motivation states that.....

ii) .....is a statement of the organization's fundamental purpose.

iii) Power granted through the organizational hierarchy is called .....

3(b) *Answer any **TWO** of the following:* [CO3] [2x2]

i) Draw and define wide and narrow span of management.

ii) Define organizational goals? What is their importance in the management process?

iii) Differentiate between line and staff authority with suitable examples.

3(c) *Answer any **TWO** of the following:* [CO3] [4x2]

i) What are the fundamental functions that comprise the management process? Describe examples of how the management functions might be performed in different sequences.

ii) What is job specialization? Enumerate its benefits and limitations. Differentiate between job rotation and job enlargement.

iii) What are the various decision-making conditions that exist for a manager while taking a decision? Explain systematically the classical model of decision-making. What assumptions should a manager consider while adopting this model?

Contd ....4.

4(a) *Fill in the blanks:* [CO4] [1x3]

i) A list of important managerial positions in the occupation, who occupies it, how long he/she will remain in position and who is/will be a qualified replacement is known as .....

ii) The four P's of marketing mix are .....

iii) .....is a business that transcends national boundaries and is not committed to a single host country.

4(b) *Answer any **TWO** of the following:* [CO4] [2x2]

i) Differentiate between Q/R inventory system and periodic inventory system.

ii) Demand for part number 1012 was 210 in January, 100 in February and 150 in March. The forecast for January was 140 units. With a smoothing constant of 0.30 and using first order exponential smoothing, what is the April forecast?

iii) What is a "Market"? List the types of markets that are used by sellers and buyers in a modern exchange economy.

4(c) *Answer any **TWO** of the following:* [CO4] [4x2]

i) What procedures do the human resource managers adopt while planning for human resources? How are the forecast and human resource demand and supply matched? Explain.

ii) Describe the four basic levels of international business activity. Do you think any organization will achieve the fourth level? Why?

iii) Define Quality. Discuss the two aspects of quality. Name some quality control tools and explain any one of them in detail.

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