Total No. of Questions : **08** Roll No. : 0701.....

B.Tech FIFTH SEMESTER EXAMINATION JUNE-2025

(Branch : Chemical Engineering)

CM 5301 MASS TRANSFER –I

Time : Three Hours ***Maximum Marks : 70***

Min. Pass Marks : 22

Note : Attempt any five questions. Each question carries equal marks.

1(a) Classify the mass transfer operations based on direct contact of two immiscible phases with examples.

(b) Distinguish plate and packed towers. Explain flooding and loading in packed towers.

2(a) Define mass transfer coefficient. Discuss in detail about two film theory of mass transfer.

(b) Give the relationship between mass transfer coefficient and diffusivity.

3(a) How the diffusivity of a multi component mixture can be estimated using the binary diffusivity values if all but one component is stagnant?

(b) Oxygen (A) is diffusing through carbon monoxide (B) under steady state conditions, with equimolar counter current diffusion. The total pressure is $1x10^5 N/m^2$, and the temperature 0^oC. The partial pressure of oxygen at two planes 2.0 mm apart is, respectively, 13000 and 6500 N/m^2. The diffusivity for the mixture is 1.87×10^{-5} m^2/s. Calculate the rate of diffusion of oxygen in kmol/s through each square meter of the two planes.

4(a) What is Relative Volatility? What is its significance? Give expression for a binary mixture.

(b) The vapor pressures of A and B are 200 mm Hg and 400 mm Hg. The total pressure is 760 mm Hg. Estimate the relative volatility?

5(a) Briefly explain the operation and principle of flash distillation.

(b) A liquid mixture containing 40 mole % n-heptane and 60 mole % n-octane is to be continuously flash vaporized at 1 atmospheric pressure to vaporize 50 mol% of the feed. What will be composition of the vapor and liquid that leaves the separator?

6(a) What are the assumptions made in McCabe Thiele method?

(b) A feed mixture of A and B (45 mole %A and 55 mol % B) is to be separated into a top product containing 96 mol %A and bottom product having 95 mol % B. The feed is 50% vapour and reflux ratio is 1.5 times the minimum. Determine the number of ideal trays required and the location of feed tray. Given $\alpha_{AB} = 2.8$.

7 An air-ammonia mixture containing 5% ammonia by volume is absorbed in water in a packed column operated at 20^oC and 1 atm pressure. So as to recover 98% NH_3. If the inert gas flow rate in the column is 1200 $kg/m^2.hr$. Calculate

(i) The minimum mass velocity of water from this column.

(ii) The number of transfer units in the column taking the operating liquid rate to be 1.25 times the minimum.

(iii) The height of the packed tower taking the overall transfer coefficient K_Ga to be 128 kg moles/ $m^3.hr.atm$. The relationship for equilibrium in the column is $y = 1.154 x$, where y and x are in mole fraction units.

8 Write short notes on **any three**:

(a) Define absorption factor. Give the significance of absorption factor.
(b) State characteristics of solvents used in absorption operation.
(c) Define HTU and NTU.
(d) Explain Minimum and Total reflux
(e) How is the slope of the feed line estimated?

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Total No. of Questions : **08** Roll No. : 0701.....

B.Tech FIFTH SEMESTER EXAMINATION JUNE-2025

(Branch : Chemical Engineering)

CM-5302 CHEMICAL REACTION ENGINEERING

Time : Three Hours ***Maximum Marks : 70***
Min. Pass Marks : 22

Note : Attempt any five questions. Each question carries equal marks.

1(a) Differentiate the following :-

(i) Molecularity and order of reaction
(ii) Elementary and non-elementary reactions
(iii) Single and Multiple reactions.

(b) Explain the advantages, disadvantages and application of batch, mixes flow and plug flow reactor.

2(a) Draw and discuss the comparison of performance of N equal size mixed flow reactor with a plug flow reactor.

(b) The reaction A + B ☒ C is believed to be first order with respect to each reactant. The following data are reported from batch reactor at 200°C using an initial concentration of B = 0.123 Kmol/m^3. Determine whether these data are constant with given rate equation if so find rate constant.

3(a) Develop expressions for optimum space time and maximum concentration of product R for a series reaction with first order kinetics $\left(A \overset{k_1}{\rightarrow} R \overset{k_2}{\rightarrow} S\right)$ in a CSTR. Assume that the feed contains no R & S. k_1 and k_2 are first order rate constants.

(b) Define E(t), F(t) and C(t) curves and derive relation between them.

4(a) A sample of the tracer hytane was injected as a pulse to a reactor and the effluent concentration measured as function of time, resulting in the following data :

t (min)	0	1	2	3	4	5	6	7	8	9	10	11	12
C (g/m^3)	0	1	5	8	10	8	0	4	3	2.2	1.5	0.6	0

The measurement represents the exact concentration at the times listed and not average values between the various sampling tests. Construct figure showing C(t) and Ef(t) as function of time and determine both the fraction of material leaving the reactor that has spent between 3 & 6 min in the reactor and the fraction of material leaving that has spent between 7.75 and 8.25 min.

(b) Explain pulse input method for the measurement of RTD.

5(a) Explain briefly optimal temperature progression for first order eversible reaction.

(b) Describe briefly effect of operating variables on the stability of CSTR.

P.T.O.

6(a) Derive the performance equation for reactors containing process catalyst particle.

(b) In a heterogeneous catalytic reaction, how can the catalyst's effectiveness be improved and what are the key factors that influence catalyst activity and selectivity?

7(a) Explain the effect of external transport processes on selectivity for consecutive isothermal reactions.

(b) How does catalyst affect the equilibrium of a reaction?

8(a) For a gas phase decomposition of azomethone $(CH_3)_2N_2 \rightarrow C_2H_6 + N_2$ with a rate expression $-r_{N_2} = \frac{K_1\left[C_{A_2o}^2\right]}{1+ k^1\, C_{A_2O}}$ where A_2O = azomethane. Devise a mechanism to explain this rate.

(b) What factors influence the design of a semi-batch reactor? How can we analyze the performance of a semi-batch reactor?

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Total No. of Questions : **06** Roll No. : 0701.....

B.Tech FIFTH SEMESTER EXAMINATION JUNE-2025

(Branch : Chemical Engineering)

CM-5303 PROCESS EQUIPMENT DESIGN (MECHANICAL ASPECT)

Time : Three Hours ***Maximum Marks : 70***
Min. Pass Marks : 22

Note : Attempt any four questions in which Q. No. 1 is compulsory. Use of data book, design codes, steam table are permitted. Assume suitable data wherever necessary.

1(a) Define : (i) Stress (ii) Strain (iii) Design pressure. ***06***

(b) A pressure vessel made up of steel (allowable design stress value - 165 MN/m^2) having diameter and length of 2.4 and 3.8 m, respectively is used to design maximum operating pressure of 750 kN/m^2. Compute the standard plate thickness to fabricate this vessel. Also determine the thickness of conical head having a half apex angle 30^0. ***13***

2 Determine the shell thickness for the entire tower height based on the following data : ***17***

Shell Id = 3500 mm,
Working pressure = 2.5 N/mm^2 gauge
Top disengagement space = 200 mm,
Specific gravity of material = 7.6,
Insulation density = 7800 N/mm^3,
$E = 1.95 \times 10^5$ N/mm^2,
Head Type = Elliptical,
Working temperature = 180 ˚C,
Design temperature = 200 ˚C,
Base chamber height = 3200 mm,
Permissible tensile stress = 85 N/mm^2,
$\mu = 0.3$,
Insulation thickness tins = 120 mm.
Weight = 2750 N

Attachment weights :

Pipe, ladders, platform etc. = 1500 N/m^2,
Wind pressure = 1400 N/m^2,
Weight of column = 3.1×10^6 N,
Weight of liquid and trays = 890 N/m^2,

Negligible Seismic load and Eccentricity.
Tray, numbers of trays, n = 60, tray spacing = 0.7.

3 Find the thickness of a straight cylindrical skirt support for extraction column based on following data. ***17***

- Diameter of column : 2500 mm
- Height of distillation column : 40 m
- Max. weight of vessel, its attachment & contents : 340000 kg,
- Diameter of skirt : 2500 mm
- Height of skirt : 5 m
- Wind pressure at the top of column : 32.5 kgf/m^2
- Material used for skirt support : IS-800 structural steel
- Max. allowable tensile stress : 1600 kgf/cm^2
- Max. allowable compressive stress : 690 kgf/cm^2
- Max. allowable bending stress : 1600 kgf/cm^2
- Seismic coefficient : 0.07
- Minimum wt of empty vessel : 250000 kg

P.T.O.

4 Design a ring flange based on given data : ***17***

- Internal design pressure : 10 kg_f/cm^2
- Design temperature : 150°C
- Shell O.D. : 800 mm
- Basic gasket seating width : 10 mm
- Shell thickness : 12 mm
- Maximum allowable stress of flange material at atmospheric temperature : 1345 kg/cm^2
- Maximum allowable stress of bolting material at design temperature : 825 kg/cm^2
- Maximum allowable stress of bolting material at atmospheric temperature : 1037 kg/cm^2
- Bolt size : 3/4”
- Root mean area of bolt : 0.302 in^2
- Gasket factor : 2.8
- Gasket seating stress : 254 kg/cm^2

Calculate gasket and flange dimensions with no. of bolts and every factor of flange design.

5 Design a fixed conical roof cylindrical tank with the help of following data : ***17***

Tank diameter (inside) = 22 m,
Tank height = 14 m,
Density of liquid = 990 kg/m^3,
Superimposed load = 1300 N/m^2,
Conical roof slope = 1 in 5,
MOC = carbon steel IS 2062,
Permissible stress = 170 N/mm^2,
Density of MOC = 7900 kg/m^3,
Modulus of elasticity = 2×10^5 N/mm^2

6 Attempt ***<u>any three</u>*** : ***17***

(i) Discuss about mechanical design of torishperical head
(ii) Write a note on role of vessel lining in chemical industries
(iii) Compare destructive and non-destructive testing
(iv) Why is reinforcement pad provided in process vessel? Outline its design method.

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Total No. of Questions : **08** Roll No. : 0701.....

B.Tech FIFTH SEMESTER EXAMINATION JUNE-2025

(Branch : Chemical Engineering)

CM-5304 PETROLEUM TECHNOLOGY

Time : Three Hours ***Maximum Marks : 70***
Min. Pass Marks : 22

Note : Attempt any five questions. All questions carry equal marks. Draw neat and labelled diagram whenever necessary.

1(a) Define petroleum along with its composition and occurrence. ***07***

(b) Discuss in detail the classification of crude oil. ***07***

2(a) Discuss in detail the effect of the presence of sulphur and oxygen in crude oil during refining operations. ***07***

(b) Mention the various informations that are required by refiners along with their physical significance. ***07***

3(a) Discuss in detail the classification of refinery products. ***07***

(b) Discuss the different refinery operation along with basic refinery flow sheet. ***07***

4(a) Define and explain the term hydro cracking and hydro treating. ***07***

(b) Discuss in detail the types of vacuum producing systems used in refinery. ***07***

5(a) Discuss the term dewaxing and deoiling along with its physical significance. ***07***

(b) Describe in detail along with flow sheet the process for the production of wax. ***07***

6(a) Discuss the term hydro finishing and sweetening process. ***07***

(b) Give a comparison between thermal cracking and catalytic cracking. ***07***

7(a) Describe in detail along with flow sheet the furfural solvent method for refining of lubricating oils. ***07***

(b) Discuss the term refinery gas and associated gas along with their applications. ***07***

8(a) Mention the properties of LPG and CNG along with their mode of applications. ***07***

(b) Discuss the various environmental issues related to the processing of lubricating oils. ***07***

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Total No. of Questions : **08** Roll No. : 0701.....

B.Tech FIFTH SEMESTER EXAMINATION JUNE-2025

(Branch : Chemical Engineering)

CE-5351 (OEL-I) BIO-CHEMICAL ENGINEERING

Time : Three Hours ***Maximum Marks : 70***
Min. Pass Marks : 22

Note : Attempt any five questions. Each question carries equal marks.

1(a) Discuss about the many historical advancements in biochemical engineering and its byproducts. ***07***

(b) Differentiate between the Prokaryotic and Eukaryotic cells. Take one examples from each of them and write their salient features. ***07***

2(a) Define and classify the enzyme. Describe the commercial applications of enzyme with examples. ***07***

(b) Starting from the basic relationship between substrate and enzyme, derive Machaelis-Menten equation stating all the assumptions. How do you evaluate the kinetic parameters of the above equation graphically? ***07***

3(a) Plot the graphical representation of cell number density versus time, for the growth cycle of microorganism in a batch cultivation medium and explain the graph. State the factors responsible for the change in cell number density with respect to time. ***07***

(b) Explain the thermal death cell kinetics of cells and spores and formulate the mathematical modeling for it. ***07***

4(a) Define Genetic Engineering. Write down the various applications of genetic engineering. ***07***

(b) Discuss the different mass transfer theories applied to oxygen transfer. ***07***

5(a) Discuss anaerobic digestion and biodegradation in context with biological waste water treatment. ***07***

(b) Describe the industrial procedure for the production of ethanol/antibiotic. ***07***

6(a) Define sterilization in bioprocess. Also make note on the different sterilization methods. ***07***

(b) Explain the factors influencing the enzyme activity. Also explain the techniques used for the immobilization of enzymes. ***07***

7(a) Write in details about design and operation of typical anaerobic fermentation process. ***07***

(b) With the help of proper assumptions, derive the performance of equation of an ideal batch fermenter during the exponential growth phase of microorganism. ***07***

8 Write a short note on **any three** : ***14***

(i) Genetic modified organism (ii) Polysaccharide & sugar
(iii) Bioreactor (iv) Gene therapy
(v) Biofertilizer

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