

Total No. of Questions : 08

Roll No. : 0701.....

B.Tech FOURTH SEMESTER EXAMINATION JUNE-2025

(Branch : *Chemical Engineering*)

CM-4401 / CM-4301 PARTICLE AND FLUID PARTICLE PROCESSING

Time : Three Hours

Maximum Marks : 70

Min. Pass Marks : 22

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

- 1(a) Define sphericity for both spherical and non-spherical particles. Evaluate the differential and cumulative methods for determining average particle size, and explain why cumulative screen analysis provides a more precise measurement of surface area than differential analysis.
- (b) One ton per hour of dolomite is produced by a ball mill operating in closed circuit with a 100 mesh screen. The screen analysis (weight %) is given below, calculate the screen efficiency :

Mesh	35	48	65	100	150	200	- 200	
Feed	7.07	16.60	14.02	11.82	9.07	7.62	33.80	100
Oversize	13.67	32.09	27.12	20.70	4.35	2.07	0	100
Undersize	0	0	0	2.32	14.32	13.34	70.02	100

- 2(a) Describe the fundamental laws of crushing and derive the equations. Specify the applicable feed size range for each law and highlight the limitations of these laws.
- (b) What is critical speed of a grinding mill? Deduce a relation between the critical speed and diameter of a ball mill. Why the operating speed of a ball mill should be less than the critical speed.
- 3(a) What are the different methods adopted for prevention of swirling in an agitated tank? What are the main types of impellers? Compare the performance, characteristics and applications of paddle, turbine and propeller type mixers.
- (b) A reaction is to be carried out in an agitated vessel. Pilot plant experiments were performed under fully turbulent condition in a tank 0.6 m in diameter, fixed with baffles and provided with flat bladed turbine. It was found that satisfactory mixing was obtained at a rotor speed of 4 Hz, when the power consumption was 0.15 kW and Reynolds number 160000. What should be rotor speed in order to remain the same mixing performance if the linear scale of the equipment is increased 6 times? What will be power consumption and Reynolds number?
- 4(a) Prove that power required for agitation of Newtonian liquids can be represented by the following relationships : $NP = f(NRe, NFr)$, where NP, NRe and NFr represent dimensionless groups.
- (b) A pair of rolls take a feed equivalent to 20 mm in diameter and crush them to spheres of 10 mm diameter. What should be the diameter of crushing rolls if the coefficient of friction is 0.25?

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- 5(a) Describe the different flow regimes in a fluidized bed using the relationship between pressure drop and Reynolds number. For a gas-solid system, define superficial velocity, soaring velocity and actual velocity.
- (b) Air flow through a packed bed of powder material of 1cm depth at a superficial gas velocity of 1 cm/sec. A manometer connected to unit, registered a pressure drop of 1 cm of water. The bed has porosity of 0.4. Assume that Kozeny-Carmon equation is valid for the range of the study. Estimate the particle size of the powder if density and viscosity of air is 1.23 kg/m^3 and 1.8×10^{-5} respectively.
- 6(a) What are the various types of conveyor systems utilized in industries and what key factors should be evaluated when choosing the most suitable conveyor system for a specific industrial application?
- (b) How do conveyor systems enhance automation and improve operational efficiency in industrial processes, and what innovations are emerging in conveyor technology for modern industries?
- 7(a) Summarize the roles of thickeners and clarifiers, emphasizing their operational functions, key differences and the critical factors influencing their selection for industrial use.
- (b) Explain the basic concepts and differences between constant-rate and constant-pressure filtration, focusing on their benefits and uses.
- 8(a) What is minimum fluidization velocity? Derive an expression for minimum fluidization velocity with the help of Ergun's equation.
- (b) In a plate and frame filter (no cloth resistance) it takes 2 hour 15 minutes to filter 18 m^3 of suspension. Filter cake is washed with 2 m^3 of water having viscosity of filtrate. If washing velocity is 1/4th of the filtration velocity at the final moment, calculate washing time.

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B.Tech FOURTH SEMESTER EXAMINATION JUNE-2025

(Branch : *Chemical Engineering*)

CM-4402 / CM-4302 HEAT TRANSFER

Time : Three Hours

Maximum Marks : 70

Min. Pass Marks : 22

Note : Attempt any five questions. Each question carries equal marks. Assume suitable data if requires.

- 1(a) Write Fourier's law of conduction and derive the expression for heat conduction in a hollow cylindrical vessel. State the necessary assumptions.
- (b) Calculate the rate of heat loss through the vertical walls of a boiler furnace of size 4 m × 3 m × 3m high. The walls are constructed from an inner fire brick wall 25 cm thick of thermal conductivity 0.4 W/mK, a layer of ceramic blanket insulation of thermal conductivity 0.2 W/mK and 8 cm thick, and a steel protective layer of thermal conductivity 55 W/mK and 2 mm thick. The inside temperature of the fire brick layer was measured at 600°C and the temperature of the outside of the insulation 60°C. Also find the interface temperature of layers.
- 2(a) Derive equation for overall heat transfer coefficient.
- (b) Calculate the heat transfer coefficient for water flowing in a tube of 30 mm diameter at a velocity of 3.2 m/s. the temperature of the tube is 310 K and the water enters at 380 K and leaves at 295 K. Use : (i) Dittus-Boelter equation and (ii) Sieder-Tate equation.
- Data : Properties of water at arithmetic mean bulk temperature (331 K) are
Density = 984.1 kg/m³, Cp = 4187 j/(kg.K), μ = 485×10⁻⁶ Pa.s,
k = 0.657 W/(m.K), μ_w of water at 300 K = 920×10⁻⁶ Pa.s.
- 3(a) State Kirchoffs laws of thermal radiation. Also differentiate between black body and grey body.
- (b) Calculate the net radiant heat exchange per m² area for two large parallel plates at temperatures of 427°C and 27°C. ε (hot plate) = 0.9 and ε (cold plate) = 0.6. If a polished aluminum shield is placed between them, find the % reduction in the heat transfer ε (shield) = 0.4.
- 4(a) Discuss briefly the difference between film-wise and drop-wise condensation. What are the methods employed to promote drop-wise condensation?
- (b) It is desired to concentrate 5000 kg/hr of a solution of sodium hydroxide from 12 % to 28 % solids in a single effect evaporator. Steam is available at 110°C and the vapor space is maintained at 410 mm of Hg (mercury). The boiling point of water corresponding to the vapor space pressure is 85°C. The solution has a boiling point elevation of 8°C. The enthalpies of the feed and thick liquor are 90 and 80 kcal/kg, respectively and the enthalpy of the vapor is 650 kcal/kg. The feed enters at its boiling point corresponding to the vapor space pressure. λ = 525 kcal/kg. Calculate the steam consumption per hour, if the available heat transfer area is 35 m² coefficient, estimate the heat transfer coefficient.

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- 5(a) Classify the heat exchanger. Also discuss in brief about shell and tube heat exchanger.
- (b) A heat exchanger tube of $D = 30$ mm diameter conveys 4.7 kg/min of water ($Pr = 4.3$, $k = 0.602$ W/m K, $\rho = 1000$ kg/m³, $\mu = 0.6 \times 10^{-3}$ kg/ms) on the inside which is used to cool a stream of air on the outside where the external heat transfer coefficient has a value of $h_o = 120$ W/m² K. Ignoring the thermal resistance of the tube walls, evaluate the overall heat transfer coefficient, U , assuming that the internal heat transfer coefficient is given by the Dittus-Boelter relation for fully developed turbulent pipe flow : $Nu = 0.023 Re^{0.8} Pr^{0.4}$.
- 6(a) Write the physical significance of :
- (i) Grashof number (ii) Prandtl number (iii) Boit number.
- (b) Discuss the various regimes of boiling heat transfer with the help of a boiling curve for water.
- 7(a) What do you understand by tube pitch and clearance? Differentiate between square pitch and triangular pitch arrangement in case of heat exchanger tubes.
- (b) "LMTD method is most suitable for heat exchanger design calculations" Comment.
- 8 Write short note on **any three** :
- (i) Fouling, Shape factor
(ii) Stefan Boltz man's law of radiation
(iii) Plate type Heat Exchanger
(iv) Critical thickness of insulation
(v) Feeding method of evaporator
(vi) Hydrodynamic and thermal boundary layer

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B.Tech FOURTH SEMESTER EXAMINATION JUNE-2025

(Branch : *Chemical Engineering*)

CM-4403 / CM-4303 MATERIAL TECHNOLOGY

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 types of materials used in the construction of chemical plants. **07**
(b) Discuss the thermal and electrical properties of two engineering materials. **07**
- 2(a) Discuss about the key parameters required for the selection of engineering materials related to chemical industries. **07**
(b) How solids are classified based on Bonding? **07**
- 3(a) Give a comparison between crystallization and crystallinity. **07**
(b) Discuss in detail about solid solution along with suitable example. **07**
- 4(a) Give a comparison between substitutional and interstitial solid solution. **07**
(b) What is an alloy and how does it relate to solid solution? Explain. **07**
- 5(a) Discuss the salient features of iron carbon diagram. **07**
(b) Mention the physical and chemical properties of cast iron and stainless steel. **07**
- 6(a) Mention in detail about types of corrosion. **07**
(b) Discuss in detail the key factors that influence the rate of corrosion. **07**
- 7(a) Explain in detail the types of stability of material in service. **07**
(b) What is the primary effect of annealing process on conducting materials. **07**
- 8(a) Discuss in detail about surface modification of equipments used in chemical industries. **07**
(b) Give a comparison between semiconductors and superconductors. **07**

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B.Tech FOURTH SEMESTER EXAMINATION JUNE-2025

(Branch : *Chemical Engineering*)

CM-4404 / CM4304 ORGANIC PROCESS TECHNOLOGY

Time : Three Hours

Maximum Marks : 70

Min. Pass Marks : 22

Note : Attempt any five questions. Each question carries equal marks. Draw process flow diagram if required.

- 1(a) Discuss utility of mixed acid in organic synthesis industry. 07
(b) Submit constructional and operational features of nitrator. 07
- 2(a) Enlist suitable raw materials for making ethyl-alcohol. 07
(b) Describe making of ethyl-alcohol on commercial scale. 07
- 3(a) Distinguish between soaps and detergents. 07
(b) Discuss water pollution aspects caused due to soaps and detergents industry. 07
- 4(a) Explain working of a paper industry with a process flow diagram. 07
(b) Propose suitable solution of “Noise Induced Hearing Losses” in a paper industry. 07
- 5(a) Write precisely about growth of petro chemicals in India. 07
(b) Enlist noticeable applications of benzene and its derivatives. 07
- 6(a) Comment on challenges of Indian sugar industry. 07
(b) How does concepts of ‘energy co-generation’ aid sugar industry to claim sustainable growth? 07
- 7(a) Describe making of azo dye with a neat flow diagram. 07
(b) “Intermediates and dyes go together” comment on the statement with facts and figures. 07
- 8 Write in short about **any two** of the following with regard to advancements in organic synthesis industry : 2*7
(i) Biodegradability of detergents
(ii) Quality control measures in paper industry
(iii) Challenges of Indian petrochemicals sector

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B.Tech FOURTH SEMESTER EXAMINATION JUNE-2025

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CM-4405 /CM-4305 NUMERICAL METHODS IN CHEMICAL ENGINEERING

Time : Three Hours

Maximum Marks : 70

Min. Pass Marks : 22

Note : Attempt any five questions. All questions Carry equal marks. Draw neat sketch and assume suitable data wherever you required.

- 1(a) Discuss the practical importance of interpolation in chemical engineering process problems.
(b) Write down purpose of graphical representation.

- 2(a) The table gives the distance in nautical miles of the visible horizon for the given heights in feet above the earth's surface :

X = height	: 100	150	200	250	300	350	400
Y = distance	: 10.63	13.03	15.04	16.81	18.42	19.90	21.27

Find the values of y when (i) $x = 410$ ft (ii) $x = 160$ ft.

- (b) Find Solution using Newton's Backward Difference formula :

x	1891	1901	1911	1921	1931
f(x)	46	66	81	93	101

$x = 1925$

- 3(a) The radius of a circle is $x = (4.0 \pm 0.4)$ cm. Find the circumference and its uncertainty.

- (b) Discuss different types of errors in data interpretation.

- 4(a) Explain Linear vs Non-Linear Differential Equations.

- (b) The concentration of salt x in a homemade soap maker is given as a function of time by $\frac{dx}{dt} = 37.5 - 3.5x$ at time $t = 0$, the salt concentration in the tank is 50 g/L. Using Euler's method and a step size of $h = 1.6$ min, what is the salt concentration after 4 minutes?

- 5(a) What is the law of Conservation of Mass and how does it apply to mixing in flow processes?

- (b) Initially a tank contains 1000 litres of brine with a salt concentration of 1 kg salt per 100 litres. Brine with 2 kg salt per 100 litres enters the tank at a rate of 15 litres per second. The well-stirred mixture leaves at the same rate. Find the concentration of salt as a function of time.

- 6(a) What is the Runge-Kutta 4th order method?

- (b) Use Runge-Kutta method to obtain an approximate solution to the differential equation $\frac{dy}{dx} = y - x + 5$ at the points $x = 2.4, 2.5, 2.6$ with initial condition $y(2) = 1$.

P.T.O.

- 7(a) Explain the significance of characteristic equations in solving linear ODEs.
- (b) Make a list of types of PDE's, corresponding problems and methods for their numeric solution.
- 8(a) Explain the significance of ordinary differential equations in modeling chemical engineering processes.
- (b) Solve the Laplace equation $u_{xx} + u_{yy} = 0$ given that


