

**II Year B.E/B.Tech**  
**CHEMICAL ENGINEERING**



**MODEL QUESTION PAPERS**

*(Effective from 2005 admitted batch)*

**SCHOOL OF DISTANCE EDUCATION**  
**ANDHRA UNIVERSITY**  
**VISAKHAPATNAM - 530 003**

## II Year B.E./B. Tech Degree Examination

### MATHEMATICS-III

Chemical Engineering

Time: 3 hours

Max.Marks: 75

Question 1 is compulsory

Answer any four from Questions 2 to 8

All questions carry equal marks

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1.
    - a) What is the greatest rate of increase of  $u = y^2 + xz^2$  at the point  $(2, -1, 2)$ ?
    - b) Write down the law of transformation of the tensor  $A^{jk}$ .
    - c) Evaluate  $\int_c \frac{z^2 - z + 1}{z - 3} dz$  where C is the circle  $|z-1| = 1$
    - d) If the Fourier sine transform of  $f(x) = \frac{1 - \cos n\pi}{n^2 \pi^2}$  ( $0 < x < \pi$ ), find  $f(x)$ .
    - e) Find the z-transform of  $na^n$ .
  2.
    - a) Show that  $\nabla^2 r^n = n(n+1)r^{n-2}$ .
    - b) Use Green's theorem to evaluate  $\int_c (3x^2 - 8y^2) dx + (4y - 6xy) dy$  where c is the boundary of the region defined by  $x = 0$ ,  $y = 0$  and  $x + y = 1$ .
  3.
    - a) Find the constant 'a' such that the force field  $\vec{A} = (2xy + z^3)\vec{i} + x^2\vec{j} + axz^2\vec{k}$  is conservative. Find the scalar potential and the work done by the force in moving a particle from  $(1, -2, 1)$  to  $(3, 1, 4)$ .
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- b) Evaluate  $\int_s \vec{F} \cdot n \vec{d}s$  where  $\int_s \vec{F} = (2x+3z)\vec{i} - (xz+y)\vec{j} + (y^2+2z)\vec{k}$  and S is the surface of the sphere having centre at (3, -1, 2) and radius 3.
4. a) If  $x^i$  and  $x^{-i}$  are independent coordinates of point, show that  $\frac{\partial x^j}{\partial x^k} \frac{\partial x^{-k}}{\partial x^i} = \delta_i^j$ .
- b) A Covariant tensor has components  $2x - z, x^2y, yz$  in Cartesian coordinate system. Find its components in cylindrical coordinates.
5. a) Find the analytic function whose imaginary part is  $e^{-x} (x \sin y - y \cos y)$
- b) Represent the function  $f(z) = \frac{4z+3}{z(z-3)(z+2)}$  in Laurent's series (i) within  $|z|=1$  (ii) in the annular region between  $|z|=2$  and  $|z|=3$ .
6. a) Show that the image of  $|z| < 1$  in z-plane is the entire right half plane in w-plane under the mapping  $w = \frac{1+iz}{1-iz}$ .
- b) Using Residue theorem, evaluate  $\int_0^{2\pi} \frac{\cos 2\theta d\theta}{5+4\cos \theta}$ .
7. a) Find the Fourier cosine transform of  $f(x) = \frac{1}{1+x^2}$

b) Solve the integral equation

$$\int_0^{\infty} f(\theta) \cos \alpha \theta d \theta = \begin{cases} 1-\alpha, & 0 \leq \alpha \leq 1 \\ 0, & \alpha > 1 \end{cases}$$

Hence evaluate  $\int_0^{\infty} \frac{\sin^2 t}{t^2} dt$ .

8. a) Form the difference equation generated by  $y_n = a2^x + b3^x$ .
- b) Using Z-transform, solve  $u_{n+2} - 5u_{n+1} - 6u_n = 2^n$ .

II Year B.E./B.Tech Degree Examination

**MATHEMATICS-IV**

(Chemical Engineering)

Time: 3 hours

Max.Marks: 75

Question 1 is compulsory

Answer any four from Questions 2 to 8

All questions carry equal marks

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1. a) Write down the formula for Simpson's  $\frac{1}{3}$  rule.
- b) What is the condition for convergence of Gauss Seidel iterative method for solution of linear algebraic equations.
- c) Solve  $\frac{\partial u}{\partial x} = 4 \frac{\partial u}{\partial y}$ .
- d) Write down the diagonal 5-point formula for solving Laplace's equation.
- e) Write down the properties of  $\chi^2$  - distribution.
2. a) Find by Newton's method, a root of the equation  $x^3 - 3x + 1 = 0$  correct to 3 decimal places.
- b) Solve the equations by using Gauss Seidel method.
- $$\begin{aligned} 2x + y + 6z &= 9 \\ 3x + 3y + 2z &= 13 \\ x + 5y + z &= 7 \end{aligned}$$
3. a) Find by power method, the largest eigen value of the matrix  $\begin{bmatrix} 4 & 1 \\ 1 & 3 \end{bmatrix}$ .

- b) Find the value of  $\int_1^2 \frac{dx}{x}$  by Simpson's rule. Hence obtain approximate value of  $\log_e 2$ .
4. a) Solve  $(y + z)p - z + x)q = x - y$ .
- b) Solve  $\frac{\partial^2 y}{\partial t^2} - a^2 \frac{\partial^2 y}{\partial x^2} = E \sin pt$
5. a) Given that  $\frac{dy}{dx} = x + y^2$  and  $y = 1$  at  $x = 0$ . Find an approximate value of  $y$  at  $x = 0.5$  by modified Euler's method.
- b) Using Runge-Kutta method of fourth order compute  $y(x)$ , given  $10 \frac{dy}{dx} = x^2 + y^2$ ,  $y(0) = 1$ , taking  $h=0.1$
6. a) Solve by the method of separation of variables  $\frac{\partial u}{\partial n} = \frac{2\partial u}{\partial l} + y$  given that  $u(x,0) = 6e^{3x}$ .
- b) A tightly stretched string with end points  $x = 0$  and  $x = 1$  is initially in a position given by  $y = y_0 \sin^3 \left( \frac{\pi x}{\ell} \right)$ . If it is released from rest from this position, find the displacement  $y(x, t)$ .
7. Solve  $\nabla^2 u = 0$  under the conditions  $(h = 1, k = 2) u(0, y) = 0$ ,  $u(4, y) = 12 + y$  for  $0 \leq y \leq 4$ ,  $u(x, 0) = 3x$   $u(x, 4) = x^2$  or  $0 \leq x \leq 4$ .

8. a) A machine is supposed to produce washers of mean thickness 0.12 cm. A sample of 10 washers was found to have a mean thickness of 0.128cm and S.D. 0.008. Test whether the machine is working in proper order at 5% level of significance.
- b) Fit a normal distribution to the data given below and test the goodness of fit.

Interval mid pts	50	55	60	65	70	75	80	85	90	95	100
Frequency	2	3	5	9	10	12	7	2	3	1	0

II Year B.E./B.Tech Degree Examination

**ORGANIC CHEMISTRY**

Chemical Engineering

Time: 3 hours

Max.Marks: 75

Question 1 is compulsory

Answer any four from Questions 2 to 8

All questions carry equal marks

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1. a) What is the optical activity? Give the criteria. 3M
- b) Why it is more difficult to nitrate nitrobenzene than benzene? 3M
- c) What is Diazotization? Explain the coupling reaction with an example. 3M
- d) How do you synthesise tertiary alcohols through Grignard's method? 3M
- e) Fructose reduces Fehling's solution. Being a ketohexose. Explain. 3M
2. a) A compound A, molecular formula  $C_{11}H_{11}NO_4$ , on treatment with aqueous NaOH yields. Ethanol and compound B gives C,  $C_9H_1NO_4$  which is soluble in aqueous sodium carbonate with effervescence. Catalytic reduction of B gives C,  $C_9H_{11}NO_2$ , which can be diazotized. Vigorous oxidation of B gives a compound which can be prepared by the action of nitric acid and sulphuric acids on benzoic acid. Discuss their reactions. 10M
3. a) At low temperature, the 1, 2-addition product of the reaction of HBr and 1,3-butadiene is. major product of the reaction. At higher temperature, the 1,4-addition

- product is the major product. Write a complete explanation. 8M
- b) Write a note on Wurtz reaction.
4. a) Classify amines giving examples. Discuss the effect of substituents on the basicity of aromatic amines. 8M
- b) Write a note on sulpha drugs. 7M
5. a) Illustrate with examples, how in aromatic compounds further substitution is governed by the nature of substituent already present in the ring. 9M
- b) Write a note on Friedel Crafts alkylations and its limitations. 6M
6. Write notes on:
- a) Perk inconsideration 5M
- b) Wiliamson Synthesis 5M
- c) Fries rearrangement. 5M
7. a) How Primary, Secondary and Tertiary alcohols are distinguished from one another? 9M
- b) Discuss the industrial preparation of phthalic acid. 6M
8. a) Describe the ring structure of D-glucose. 7M
- b) How will you convert D-glucose into Fructose and Vice-Versa? 8M

II Year B.E./B.Tech Degree Examination

**MECHANICAL OPERATIONS**

Chemical Engineering

Time: 3 hours

Max.Marks: 75

Question 1 is compulsory

Answer any four from Questions 2 to 8

All questions carry equal marks

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1. a) What do you understand by sphericity of a particle?  
(5 x 3 = 15)
- b) Toothed roll crusher is not used for size reduction of hard solids - why?
- c) Differentiate between agitation and mixing.
- d) Define drag and drag coefficient.
- e) What are filter aids? Give an example.
2. a) State and explain the three laws of crushing 9 + 6
- b) A set of crushing rolls of 100 cm. diameter by 50 cm breadth. The gap between the rolls is 1.25 cm and they are being run at a speed of 100 rpm. If the angle of nip is  $29^\circ$ , calculate the maximum size of speed and actual capacity in tons per hour if the rolls operate at 12% of the theoretical capacity. Take sp. gr. of the feed as 2.35.
3. a) Capacity and effectiveness of screens are two opposite factors - Explain. 7 + 8
- b) Calculate the effectiveness of 14 mesh screen from the following data:

Mesh	Mass % retained		
	Feed	Overflow	underflow
6	2.5	7.1	-
8	12.5	35.9	-
10	32.1	42.1	20.0
14	25.7	12.0	38.0
20	15.9	3.0	25.0
28	7.4	-	14.0
35	3.9	-	3.0
	100	100	100

4. a) With a neat sketch explain the working of a rotary drum filter. 9 + 6
- b) A rotary filter of filtering area  $0.7\text{m}^2$  has been found to deliver 250 liters of filtrate per minute operating with a speed of 2 rpm. Another filter is to be designed to handle the same slurry with a delivery of  $2.5\text{ m}^3$  of filtrate per minute operating with a speed of 1.5 rpm. Estimate the filtering area of the filter assuming all the other factors to be the same.
5. a) Derive an expression for the terminal velocity of a spherical particle settling in Stoke's law region. 9 + 6
- b) Estimate the settling velocity of the drops of oil (sp. gr. 0.90) of 15 microns in diameter settling through air at 1 atm. pressure and at  $20^\circ\text{C}$ . Assume viscosity of air = 0.018 cP and settling is in Stoke's law region.

6. Suggest suitable conveyors for the following situations and explain their working. 6 + 9
- i) Transportation of lumps of ore over long distances of the order of 1 km.
  - ii) Transportation of an irritating material like soda ash.
7. Explain the froth flotation technique for separating two components in a mixture. 15
8. Write short notes on any three of the following. 3 x 5 = 15
- a) Trommels.
  - b) Dorr thickener.
  - c) Open and closed circuit grinding.
  - d) Sink and float method of separation.
  - e) Magnetic separator.

II Year B.E./B.Tech Degree Examination  
**CHEMICAL PROCESS CALCULATIONS**  
(Chemical Engineering)

Time: 3 hours

Max.Marks: 75

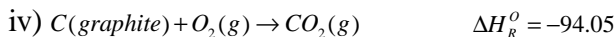
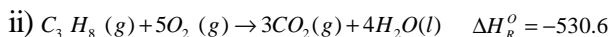
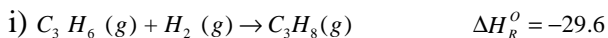
Question 1 is compulsory  
Answer any four from Questions 2 to 8  
All questions carry equal marks

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1.
  - a) Distinguish between molarity, molality and normality
  - b) Define Dalton's law and Amagat's law.
  - c) Distinguish between absolute humidity, relative humidity and % saturation.
  - d) Draw the ternary diagram for a system when all the three pairs are partially miscible and indicate various regions.
  - e) Define heat of formation, heat of combustion, heat of solution and heat of reaction.
  
2. The flue gas out of a burner at  $800^{\circ}\text{C}$  and high pressure 2.5 atmosphere has the following composition by weight  
 $\text{N}_2 = 65\%$ ,  $\text{CO}_2 = 15\%$ ,  $\text{H}_2\text{O} = 12\%$ ,  $\text{O}_2 = 7\%$  and the rest CO  
Find
  - a. the composition by volume
  - b. the density of gas mixture in g/L at exit temperature and at NTP
  - c. Mole Fraction of the components
  - d. Change in composition (by weight) when it is passed through a moisture absorbing bed.

3. The gas from a sulfur burner has the following composition by volume :
- $\text{SO}_3 - 0.8\%$ ;  $\text{O}_2 - 12.2\%$ ;  $\text{SO}_2 - 7.8\%$ ;  $\text{N}_2 - 79.2\%$
- Calculate the volume of gases ( $\text{m}^3$ ) at  $316^\circ\text{C}$  and  $1.02 \text{ kg/cm}^2$  pressure formed per kg of sulfur burnt.
  - Calculate the percentage excess oxygen supplied for the combustion above that required for complete oxidation to  $\text{SO}_3$ ?
4. One thousand kg of a solution containing 30% by weight of sodium carbonate in water is cooled slowly to  $20^\circ\text{C}$ . During the cooling, 10% of the water originally present is evaporated. The carbonate precipitated is crystals of  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ . If the solubility of anhydrous sodium carbonate at  $20^\circ\text{C}$  is  $21.5 \text{ gm/100 gms}$  of water. What weight of  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  crystallizes out.
5. The waste acid from a nitrating process contains 21%  $\text{HNO}_3$ , 55%  $\text{H}_2\text{SO}_4$  and 24%  $\text{H}_2\text{O}$  by weight. This acid is to be concentrated to contain 28%  $\text{HNO}_3$  and 62%  $\text{H}_2\text{SO}_4$  by the addition of concentrated sulfuric acid containing 93%  $\text{H}_2\text{SO}_4$  and concentrated nitric acid containing 90%  $\text{HNO}_3$ . Calculate the weight of waste and concentrated acids that must be combined to make 1500 kg of the desired mixture.
6. a) An approximate equation for  $C_p$  ( $\text{cal/gmol } ^\circ\text{K}$ ) of gaseous  $\text{HCl}$  is  $C_p = 6.6 + 9.6 \times 10^{-3} T$ .  
Calculate the heat required to raise the temperature of one g.mole of gas from  $100$  to  $200^\circ\text{C}$ .
- b) The following enthalpy changes are known from experiments for the reaction given below at  $25^\circ\text{C}$  in standard state. Calculate the standard heat of formation

$(\Delta H_f^0)$  of propylene gas. Heats of reaction given in kcal/g.mol



7. a) Write a note on theoretical flame temperature
- b) In an experiment methane is burnt with theoretical quantity of air for complete combustion. Because of faulty construction and operation of the equipment, the reaction does not go to completion. If the methane and air are originally at 25°C and the total products leave at 400°C. What percent of methane is burnt?

Date : Heat of combustion at 25°C when water is in gaseous state is – 191760 cal per gm.mole of methane burnt. Mean CP values in cal/g.mol) oC

$O_2 = 7.4, N_2 = 7.09, CH_4 = 10.88, CO_2 = 10.48, H_2O = 8.35$

8. A solution of 45 mole % benzene, 40 mole % toluene and the rest o-xylene is stored in a vessel at 122°C. What is the minimum pressure for which the vessel must be designed? What is the composition of the first vapor evolved from the vessel? Vapor pressures of benzene, toluene and o-xylene are 2400, 1050 and 400 mmHg respectively at 122°C.

II Year B.E./B.Tech Degree Examination

**FLUID MECHANICS**

(Chemical Engineering)

Time: 3 hours

Max.Marks: 75

Question 1 is compulsory

Answer any four from Questions 2 to 8

All questions carry equal marks

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1. Write briefly about the following : (5 x 3 = 15)
  - a) Similarity
  - b) Types of turbulence
  - c) Boundary layer separation
  - d) Drag
  - e) Valves
  
2.
  - a) Derive an expression for the estimation of pressure drop in a centrifuge.
  - b) A centrifuge bowl 250 mm internal diameter is turning at 4000 rpm. It contains a layer of chlorobenzene 50 mm thick. If the density of chlorobenzene is  $1109 \text{ kg/m}^3$  and the pressure is exerted on the wall of the centrifuge bowl?
  
3.
  - a) Define boundary layer and discuss its formation.
  - b) With the help of neat sketches, explain the laminar and turbulent flows in boundary layers.
  - c) Discuss boundary layer separation and wake formation.
  
4.
  - a) Explain the difference between a fan, a blower and a compressor.
  - b) Describe with a neat diagram, the working principle of a rotary pump.

5. Benzene at  $38^{\circ}\text{C}$  is pumped from a reservoir at a rate of  $9\text{ m}^3/\text{h}$  and discharged against a gauge pressure of  $345\text{ kPa}$ . The discharge line is made with  $1.5\text{ inch ID}$  pipe. The discharge point is  $10\text{ ft}$  and the pump suction is  $4\text{ ft}$  above the level in the reservoir. The friction in the suction line is  $3.5\text{ kPa}$  and in the discharge line is  $38\text{ kPa}$ . The density of benzene is  $865\text{ kg}/\text{m}^3$  and its vapor pressure is  $26\text{ kPa}$ . Calculate the developed head of the pump and the total power input assuming the efficiency of the pump to be  $60\text{ percent}$ .
6. a) What are the advantages and disadvantages of venturi meter over orifice meter?
- b) A sharp edged orifice having a diameter of  $0.0566\text{ m}$  is installed in a  $0.1541\text{ m}$  diameter pipe through which oil having a density of  $878\text{ kg}/\text{m}^3$  and a viscosity of  $4.1\text{ cP}$  is flowing. The pressure difference is  $93\text{ kPa}$ . Calculate the volumetric flow rate in  $\text{m}^3/\text{s}$ ? Assume  $C_0 = 0.61$ .
7. a) What is terminal velocity? Differentiate between hindered settling and free settling.
- b) Urea pellets are made by spraying drops of molten urea into cold gas at the top of a tall tower and allowing the material to solidify as it falls. Pellets  $6\text{ mm}$  in diameter are to be made in a tower  $25\text{ m}$  high containing air at  $200^{\circ}\text{C}$ . The density of urea is  $1330\text{ kg}/\text{m}^3$ . What would be the terminal velocity of the pellets, assuming free-settling conditions?
8. Explain in detail various pipe fittings employed in chemical process industries.

II Year B.E./B.Tech Degree Examination

**MATERIAL SCIENCE & ENGINEERING**

(Chemical Engineering)

Time: 3 hours

Max.Marks: 75

Question 1 is compulsory

Answer any four from Questions 2 to 8

All questions carry equal marks

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1. Answer the following: (5 x 3 = 15)
- a) Explain  $\Delta H_{\text{Crystal}}$  and  $\Delta H_{\text{Lattice}}$ . What do they signify in bonding?
  - b) What is configurational entropy? How would you estimate it?
  - c) What are slip systems? Give slip planes and slip systems of HCP and FCC structures.
  - d) Explain the mechanism of fatigue failure of materials.
  - e) Show the heat treatment cycles for Quenching and Annealing.
2. a) Obtain an expression for the Bond Energy of an AX type of crystal in which the anion and cation both are monovalent.
- b) First three lines from powder pattern of a Cubic Crystal have the following  $S$  values, 2.495 $\text{\AA}$ , 4.09 $\text{\AA}$ , 4.805 $\text{\AA}$ . On stretching the cassette film the distance between the entrance and exit slits of the film is 180mm. Molybdenum  $K\alpha$  radiation is used to obtain the pattern and the Wave length of the radiation is 0.71 $\text{\AA}$ . Determine the structure and the lattice parameter of the material.

3. a) Derive Bragg's Law of X-ray diffraction. Show that for any order of reflection  $n = 1$ . Briefly analyze the data obtained in X-ray diffraction technique using the metal specimen in the form of powder.
- b) Titanium has HCP structure below  $880^{\circ}\text{C}$  with  $a = 2.965^{\circ}\text{A}$  and  $c/a$  ratio of 1.584. If the atomic weight of titanium is 47.9 g/g atom calculate the density of Titanium. If Titanium reverts to BCC at a temp above  $880^{\circ}\text{C}$  ( $a = 3.32 \text{ A}^{\circ}$ ), calculate the change in the Density during such transformation from HCP to BCC.
4. a) What are line defects? With the help of a neat sketch draw edge dislocation. Show the Burgers circuit and Burgers vector in the diagram. List the characteristics of an edge dislocation. Explain the motion of an Edge dislocation under the influence of Shear stress.
- b) An FCC crystal of Aluminium is stressed in  $[101]$  direction, under a stress of  $4.24 \text{ MN/m}^2$  in tension. On which of the following systems does slip occur and what is Critical Resolved shear Stress? The planes and directions are :

$$(111) [101] ; (101) [111] ; \text{ and } (111) [110]$$

5. a) Explain the Anelastic property (Elastic - After-effect) of materials with suitable examples. Give the reasons for Anelastic behaviour of materials atomic point of view. Sketch the Strain Vs time diagram both for loading the unloading conditions and explain what is relaxation time?
- b) An empirical equation which represents the Strain-Hardening of behaviour of many engineering materials is:

$$\sigma_1 = A(B + \epsilon_t)_n$$

Show that for uniform elongation of such a material

$$\epsilon_t = (n - B)$$

6. a) Obtain Griffith's criterion for brittle failure. Summarise with suitable example the characteristics of brittle failure. Compare this with ductile failure.
- b) Enumerate the factors improving the Fatigue resistance for materials. Using S-N diagram compare the Fatigue behaviour of Ferrous and non-Ferrous materials.
7. a) Draw Iron-Iron Carbide diagram, label all the Phase fields. Indicate (i) Eutectic point (ii) Eutectoid point in the phase diagram. Write the appropriate phase transformation reactions at these points.
- b) The phase diagram of a Binary system of A and B has a three phase equilibrium at  $250^{\circ}\text{C}$  with composition of  $\alpha$ , Liquid and  $\beta$  phases equal to 10%, 55% and 95% respectively. Just below  $250^{\circ}\text{C}$  find the compositions which proeutectic phase is 1.5 times the Eutectic Mixtures.
8. Write detailed notes on any **Three** from the following.  $3 \times 5 = 15$
- a) Electron microscopy for observing the micro-structure
- b) Role of dislocation in improving mechanical properties
- c) Creep in metals - Creep curve
- d) Requirements of use of a material in shipping industry
- e) Non-destructive testing of materials used in ship building industry
- f) Heat treatment and its objectives

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