Total No. of Questions—8] [Total No. of Printed Pages—3

Seat No.	

[4657]-564

S.E. (Chemical) (First Sem.) EXAMINATION, 2014

CHEMICAL ENGINEERING MATERIALS

(2012 PATTERN)

Time : Two Hours **Maximum Marks : 50**

N.B. :— (*i*) Attempt *All* questions.

(*ii*) Neat diagrams must be drawn wherever necessary.

(*iii*) Figures to the right indicate full marks.

(*iv*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(*v*) Your answers will be valued as a whole.

1. (*a*) Define the following terms : [6]

(*i*) Creep

(*ii*) Fatigue

(*iii*) Hardness

(*iv*) Resilience

(*v*) Toughness

(*vi*) Malleability.

(*b*) Write the difference between destructive and non-destructive testing of materials. [3]

P.T.O.

(c) Define the following terms : [3]

(i) Lattice points

(ii) Unit Cell

(iii) Atomic Packing Factor.

Or

2. (a) Define Material and explain the classification of materials. [6]

(b) Define Hardness. What are the different hardness tests ? Explain any *one* in brief. [6]

3. (a) Write short notes on the following : [8]

(i) Rolling

(ii) Bending

(iii) Central punching

(iv) Welding.

(b) Define Nanotechnology. State the applications of Nanomaterials in chemical industry. [5]

Or

4. (a) Explain in detail about Fullerenes and Bucky Balls. [7]

(b) Write short notes on the following : [6]

(i) Welding

(ii) Rolling

(iii) Riveting.

5. (a) Explain in brief about Scanning Tunneling Microscopy. [6]

(b) Write a short note on X-ray diffraction. [6]

Or

6. Explain principle and working of Transmission Electron Microscope (TEM). [12]

7. (a) Explain crystalline and non-crystalline ceramics with examples and state their applications. [7]

(b) Discuss Thermal, Electrical and Mechanical properties of ceramic materials. [6]

Or

8. (a) Write a short note on Organic Protective Coatings. [6]

(b) Discuss in detail applications of ceramic materials. [7]

Total No. of Questions—8] [Total No. of Printed Pages—3

Seat No.	

[4657]-562

S.E. (Chem.) (I Sem.) EXAMINATION, 2014

CHEMISTRY—I

(2012 PATTERN)

Time : Two Hours **Maximum Marks : 50**

N.B. :— (*i*) Answer *four* questions.

(*ii*) Neat diagrams must be drawn wherever necessary.

(*iii*) Figures to the right indicate full marks.

(*iv*) Use of calculator is allowed.

(*v*) Assume suitable data, if necessary.

1. (*a*) What is aromaticity ? Discuss Huckel's rule to explain the aromaticity of benzenoid and non-benzenoids. [6]

(*b*) Derive the integrated rate expression for first-order reaction. [6]

Or

2. (*a*) Give reasons : [6]

(*i*) Pyridine is a weaker base than pyrrole.

(*ii*) Acetic acid is weaker than monochloroacetic acid.

(*iii*) *p*-methoxy phenol is weaker acid than phenol.

(*b*) Explain activated complex theory for reaction rates. [6]

P.T.O.

3. (*a*) Give the important parts of a gas chromatograph. [6]

(*b*) Give the experiment and equation for molar mass of solute in elevation in boiling point. An aqueous solution of a non-volatile solute boils at 100.17°C. At what temperature would it freeze ?

For water k_b = 0.52 KKgmol^{-1} and k_f = 1.86 KKgmol^{-1}. [7]

Or

4. (*a*) Derive the equations relating degree of dissociation for solution of electrolyte. A 0.5% aqueous solution of KCL was found to freeze at –0.24°C. Calculate the Vant Hoff factor. [7]

(*b*) Write a short note on Thin layer chromatography. [6]

5. (*a*) Give mechanism of Favorskii rearrangement. [6]

(*b*) Predict the product : [6]

(*i*) $CH_3CH_2CHOHCH_3 \xrightarrow{65\%\ H_2SO_4}$

(*ii*) $C_6H_5N_2Cl + C_6H_5OH \xrightarrow{H^+}$

(*iii*) $C_6H_6 \xrightarrow{\text{acetic anhydride}}$

Or

6. (*a*) Write short notes on the following : [6]

(*i*) Reformatsky rearrangement

(*ii*) Claisen rearrangement

(*iii*) Activating group.

(*b*) Discuss the mechanism of E_1 and E_2 reactions. [6]

7. (*a*) Electrophiles attack furan preferentially at position 2 and 5. Explain why ? [7]

(*b*) Give *two* methods each for the synthesis of the following : [6]

(*i*) Pyrrole

(*ii*) Pyridine

(*iii*) Furan.

Or

8. (*a*) Describe briefly color and constitution of a dye. [7]

(*b*) Describe synthesis of the following : [6]

(*i*) Crystal violet

(*ii*) Phenolphthalein.

Total No. of Questions—8] [Total No. of Printed Pages—3

Seat No.	

[4657]-563

S.E. (Chemical Engineering) (I Sem.) EXAMINATION, 2014
CHEMICAL ENGINEERING FLUID MECHANICS
(2012 PATTERN)

Time : Two Hours **Maximum Marks : 50**

N.B. :— (*i*) Attempt Q. No. **1** *or* Q. No. **2**, Q. No. **3** *or* Q. No. **4**, Q. No. **5** *or* Q. No. **6**, Q. No. **7** *or* Q. No. **8**.
(*ii*) Figures to the right indicate full marks.
(*iii*) Neat diagrams must be drawn wherever necessary.
(*iv*) Assume suitable data, if necessary.
(*v*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

1. (*a*) Draw shear stress-shear rate diagram and explain rheological behaviour of different fluids. [6]

(*b*) What is dynamic viscosity and kinematic viscosity ? State their units of measurements. [6]

Or

2. (*a*) The velocity distribution for flow over a flat plate is given by $u = 1.5y - y^2$. Where u is the point velocity in meter per second at a distance y meter above the plate. Determine the velocity gradient and shear stress at $y = 5$ and $y = 10$ cm. Assume the dynamic viscosity as 10 poise. [6]

P.T.O.

(b) What is the limitation of Bernoulli's equation ? [2]

(c) Explain the concept of atmospheric, absolute, gauge and vacuum pressure. [4]

3. (a) Derive Hagen-Poiseuille equation, highlighting the assumptions made. [8]

(b) A laminar flow is taking place in a pipe of diameter 200 mm. The maximum velocity is 1.5 m/s. Find mean velocity and radius at which this occurs. [4]

Or

4. (a) An oil of specific gravity 0.8 is flowing through a venturimeter having inlet diameter 20 cm and throat diameter 10 cm. The mercury differential manometer shows a reading of 25 cm. Calculate the discharge of oil through the horizontal venturimeter. Take C_d = 0.98. [6]

(b) Compare between an orificemeter and venturimeter. [6]

5. (a) Explain the concept of Boundary layer. [5]

(b) Explain Buckingham's π-theorem in detail. [8]

Or

6. (a) Derive on the basis of dimensional analysis suitable parameters to present thrust developed by propeller. Assume that thrust P depends upon angular velocity ω, speed V, diameter D, dynamic viscosity μ, mass density ρ, speed of sound in medium C. [7]

(b) Explain laminar boundary layer, turbulent boundary layer and laminar sub-layer. [6]

7. (a) What is equivalent pipe ? Derive Dupit's equation. [8]

(b) Explain operating characteristics of centrifugal pump. [5]

Or

8. (a) Explain different types of losses occurring through pipes. [5]

(b) An oil of specific gravity 0.9 and viscosity 0.06 poise is flowing through a pipe of diameter 200 mm at the rate of 60 liters/s. Find the head lost due to friction and power required to maintain the flow for a 500 m length. [8]

Total No. of Questions—8] [Total No. of Printed Pages—7

Seat No.	

[4657]-561

S.E. (Chemical/Printing Engineering)

(I Sem.) EXAMINATION, 2014

ENGINEERING MATHEMATICS—III

(2012 PATTERN)

Time : Two Hours **Maximum Marks : 50**

N.B. :— (*i*) Answer Q. No. **1** *or* Q. No. **2**, Q. No. **3** *or* Q. No. **4**, Q. No. **5** *or* Q. No. **6**, Q. No. **7** *or* Q. No. **8**.

(*ii*) Figures to the right indicate full marks.

(*iii*) Use of non-programmable calculator is allowed.

(*iv*) Assume suitable data, if necessary.

1. (*a*) Solve any *two* : [8]

(*i*) $(x+1)^2\frac{d^2y}{dx^2}+(x+1)\frac{dy}{dx}+y=2\sin\left[\log(x+1)\right]$

(*ii*) $\frac{d^2y}{dx^2}+y=\operatorname{cosec} x$ (by method of variation of parameters)

(*iii*) $\frac{dx}{2z-3y}=\frac{dy}{3x-z}=\frac{dz}{y-2x}$.

P.T.O.

(b) Solve the integral equation : [4]

$$\int_0^\infty f(x) \sin \lambda x \, dx = \begin{cases} 1, & 0 \le \lambda < 1 \\ 2, & 1 \le \lambda < 2 \\ 0, & \lambda \ge 2 \end{cases}$$

Or

2. (a) A body weighing 4.9 kg is hung from a spring. A pull of 10 kg will stretch the spring to 5 cm. The body is pulled down 6 cm below the static equilibrium position and then released. Find the displacement of the body from its equilibrium position in time t seconds, the maximum velocity and period of oscillation. [4]

(b) By considering Fourier cosine integral of e^{-mx} $(m > 0)$, prove that : [4]

$$\int_0^\infty \frac{\cos \lambda x}{\lambda^2 + m^2} \, d\lambda = \frac{\pi}{2m} e^{-mx}, \; m > 0, \; x > 0.$$

(c) Find the Fourier sine transform of [4]

$$f(x) = \begin{cases} 1, & 0 \le x \le 1 \\ 0, & x > 0 \end{cases}$$

and hence evaluate

$$\int_0^\infty \frac{\sin^3 x}{x} \, dx.$$

(b) Solve the equation : [6]

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$$

with conditions :

(i) $u(0, y) = 0$

(ii) $u(\pi, y) = 0$

(iii) $u(x, \infty) = 0$

(iv) $u(x, 0) = u_0$ for $0 < x < \pi$.

7. (*a*) A tightly stretched string with fixed end points $x = 0$ and $x = l$ is initially in a position given by : [7]

$$y(x, 0) = \sin^3\left(\frac{\pi x}{l}\right).$$

If it is released from rest from this position, find the displacement y at any distance x from one end and at any time t.

(*b*) Solve the equation : [6]

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}$$

where $u(x, t)$ satisfies the following conditions :

(*i*) $u(0, t) = 0$

(*ii*) $u(l, t) = 0$ for all t

(*iii*) $u(x, 0) = x$ in $0 < x < l$

(*iv*) $u(x, \infty)$ is finite.

Or

8. (*a*) Use Fourier transform to solve : [7]

$$\frac{\partial u}{\partial t} = \frac{\partial^2 u}{\partial x^2}, \quad 0 < x < \infty, \; t > 0$$

where $u(x, t)$ satisfies the conditions :

(*i*) $\left(\frac{\partial u}{\partial x}\right)_{x=0} = 0, \; t > 0$

(*ii*) $u(x, 0) = \begin{cases} x, & 0 < x < 1 \\ 0, & x > 1 \end{cases}$

(*iii*) $|u(x, t)| < M$.

3. (*a*) Attempt any *one* : [4]

(*i*) Find Laplace transform of :

$$F(t) = \begin{cases} e^{-4(t-5)\sin 3(t-5)}, & t > 5 \\ 0, & t < 5 \end{cases}$$

(*ii*) Find inverse Laplace transform of

$$\log\left(\frac{s+b}{s+a}\right).$$

(*b*) Solve by Laplace transform : [4]

$$\frac{dx}{dt} + 3x + 2\int_0^t x(t)\,dt = t,$$

given $x(0) = 0$.

(*c*) Find directional derivative of $\phi = e^{2x - y - z}$ at (1, 1, 1) along the line $2(x - 2) = y + 1 = z - 1$. [4]

Or

4. (*a*) Attempt any *one* : [4]

(*i*) Prove that :

$$\bar{a} \cdot \nabla\left[\bar{b} \cdot \nabla\left(\frac{1}{r}\right)\right] = \frac{3(\bar{a} \cdot \bar{r})(\bar{b} \cdot \bar{r})}{r^5} - \frac{(\bar{a} \cdot \bar{b})}{r^3}.$$

(*ii*) Prove that :

$$\nabla^2\left[r^n \log r\right] = \left[n(n+1)\log r + 2n + 1\right] r^{n-2}.$$

(b) Verify whether the following vector field is irrotational if so, find scalar potential ϕ such that $\bar{F} = \nabla\phi$. [4]

(c) The transfer function of second order system is given as : [4]

$$G(s) = \frac{10}{s^2 + 1.6s + 4}$$

Determine overshoot and $y(t)_{max}$.

5. (a) Find the work done in moving a particle once round the circle $x^2 + y^2 = 1$, $z = 1$ under the field of force : [4]

$$\bar{F} = (2x + y - z)\bar{i} + (x - 3y + z^2)\bar{j} + (3x^2 - 4y^3)\bar{k}.$$

(b) Evaluate : [5]

$$\iint_S \left[(z \sin y)\bar{i} + y\bar{j} + z^3\bar{k}\right] \cdot d\bar{S}$$

over the cylinder $x^2 + y^2 = 1$, $z = 0$, $z = 1$.

(c) Evaluate : [4]

$$\iint_S (\nabla \times \bar{F}) \cdot d\bar{S}$$

where

$$\bar{F} = (x - y)\bar{i} + (x^2 + yz)\bar{j} - 3xy^2\bar{k},$$

S is the surface of cone $z = 4 - \sqrt{x^2 + y^2}$ above xy-plane.

Or

6. (a) Evaluate : [4]

$$\int_C \bar{F} \cdot d\bar{r}$$

where

$$\bar{F} = (x - y)\bar{i} + y^2\bar{j} + (z - 2)\bar{k}$$

along the curve $x = 2t$, $y = t^2$, $z = 3t$ from $t = 0$ to $t = 1$.

(b) Prove that : [4]

$$\iint_S (\phi\nabla\psi - \psi\nabla\phi) \cdot d\bar{S} = \iiint_V \left(\phi\nabla^2\psi - \psi\nabla^2\phi\right) dV$$

where V is the volume bounded by surface S.

(c) Use Stokes' theorem to evaluate : [5]

$$\iint_S (\nabla \times \bar{F}) \cdot d\bar{S}$$

where

$$\bar{F} = (x - z^2)\bar{i} + (y - 3x)\bar{j} + z^3y\bar{k},$$

S is the surface $x^2 + y^2 + z^2 - 4z = 1$ above the plane $z = 0$.

Total No. of Questions—8] [Total No. of Printed Pages—4+1

Seat No.	

[4657]-565

S.E. (Chemical Engg.) (First Semester) EXAMINATION, 2014

PROCESS CALCULATIONS

(2012 PATTERN)

Time : Two Hours **Maximum Marks : 50**

N.B. :— (*i*) Answer Q. No. **1** *or* **2**, Q. No. **3** *or* **4**, Q. No. **5** *or* **6**, Q. No. **7** *or* **8**.

(*ii*) Neat diagrams must be drawn wherever necessary.

(*iii*) Figures to the right indicate full marks.

(*iv*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(*v*) Assume suitable data, if necessary.

1. (*a*) A saturated solution of salicylic acid ($C_7H_6O_3$) in methanol contains 64 kg salicylic acid per 100 kg of methanol. Find the composition of the solution in weight % and mole %. [5]

(*b*) A gas mixture contains nitrogen and other gases. The average molecular weight of the gas mixture is calculated as 18.74 if the molecular weight of nitrogen is taken as 14 and as 30.08 if it is taken as 28. Find the mole percent of nitrogen in the gas mixture. If the other two components are CO_2 and O_2, find their mole percent. [7]

P.T.O.

Or

2. (*a*) The strength of a phosphoric acid sample solution is found to be 35% P_2O_5 by weight. Determine the purity of the flakes. (Atomic weight of P = 31). [5]

(*b*) A 100 kg mixture of 27.8% acetone (A) and 72.2% chloroform (B) by weight is to be extracted with a mixed solvent containing water (S_1) and acetic acid (S_2). The original mixture and the solvent are well shaken, allowed to attain equilibrium and separated into two layers. The composition of the two layers is given below : [7]

	Composition, weight %			
Layer	A	B	S_1	S_2
Upper layer	7.5	3.5	57.4	31.6
Lower layer	20.3	67.3	2.8	9.6

Find the quantities of the two layers and composition of the mixed solvent added.

3. (*a*) In the manufacture of chlorine, feed containing HCl gas and air are fed to the oxidizer. The product leaving the oxidizer is found to contain 13.2% HCl, 6.3% O_2, 42.9% N_2, 30% Cl_2 and 7.6% water by weight. Calculate the excess air used, the composition of feed (by weight) entering the reactor and conversion. [7]

(*b*) 100 kg of tin is melted in a jacketed open pan. The jacket is fed with vapours which are condensed to supply the heat required for the process. Calculate the amount of vapours required. Data for tin : Molecular weight = 118.7, M.P. = 505 K, latent heat of fusion = 7201 kJ/kg, heat capacity of solid c = 21.14 + 0.02 T kJ/kmol K, where T is in K. Latent heat of vapour used in jacket = 278 kJ/kg. [6]

Or

4. (*a*) The reaction between ethylene and hydrogen bromide to form ethyl bromide is carried out in a continuous reactor. The product stream is analyzed to give 50 mol % C_2H_5Br and 33% HBr. Calculate the conversion of the limiting reactant and the percentage excess of the other. The feed stream contains ethylene and hydrogen bromide only. [6]

(*b*) Obtain an empirical equation for calculating the heat of reaction at any temperature T(K) for the reaction $CH_4(g) + C_2H_4(g) \rightarrow C_3H_8(g)$, ΔH_R^0 at 298 K = – 82.66 kJ/mol. Specific heat data is given below where $C_P = a + bT$ (kJ/kmol K) : [7]

Gas	a	$b \times 10^3$
CH_4	19.2494	52.1135
C_2H_4	4.1261	155.0213
C_3H_8	–4.2227	306.264

5. (*a*) Define absolute humidity, molal humidity, relative humidity and percentage humidity. Give the relation between molal and absolute humidity. [6]

(*b*) Wet solid containing 30% moisture is to be dried to a water content of 2% by circulating hot air. Fresh air contains 0.018 kg water vapour/kg dry air and exhaust air contains 0.095 kg/kg moisture. Calculate the volumetric flowrate of fresh air for drying 100 kg/h wet solids, if this air is available at 300 K and 101.325 kPa. [7]

Or

6. (*a*) A solution of ferric chloride in water contains 64% $FeCl_3$ by weight. Calculate the amount of $FeCl_3.6H_2O$ which will crystallize at 300 K from 1000 kg feed solution. The solubility of ferric chloride in water at 300 K is 68.3% by weight of $FeCl_3$. (Atomic weight of Fe = 63). [7]

(*b*) Define dry bulb temperature, wet bulb temperature, relative saturation, percentage saturation, vapor pressure. [6]

7. (*a*) Calculate the gross and net calorific in value in kJ/kg of a gas mixture at 298 K containing CH_4 : 89.4%, C_2H_6 : 5%, C_3H_8 : 1.9%, C_4H_{10} : 1%, CO_2 : 0.7% and N_2 : 2%. The GCV data (kJ/mol) : CH_4 : 890.65, C_2H_6 : 1560.69, C_3H_8 : 2219.17, C_4H_{10} : 2877.4. The latent heat of water = 2432.5 kJ/kg. [8]

(*b*) Define calorific value, GCV and NCV. [4]

Or

8. (*a*) A furnace is fired with fuel oil. The Orsat analysis of the flue gases indicates 10.6% CO_2, 6% O_2 and rest N_2 by volume. Find the percentage excess air used. [6]

(*b*) What is proximate and ultimate analysis ? [6]