[Total No. of Questions: *12*] **[Total No. of Printed Pages:** *2*]

UNIVERSITY OF PUNE

[4362]- 198

S. E. (CHEMICAL) Examination - 2013

PRINCIPLE OF DESIGN (2008 Course)

[Time: *3* **Hours]** **[Max. Marks: 100]**

Instructions:

1 *Answer any three questions from each section.*

2 *Answers to the* ***two sections*** *should be written in* ***separate answer-books****.*

3 *Neat diagrams must be drawn wherever necessary.*

4 *Figures to the right indicate full marks.*

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

6 *Assume suitable data, if necessary.*

SECTION -I

Q.1	A	Explain codes and standards used in design.	8
	B	Give difference between process design & mechanical design.	8
		OR	
Q.2	A	Explain stress-strain diagram of ductile material.	8
	B	Define the terms load, stress and strain. Discuss the various types of stress and strain.	8
Q. 3	A	The piston rod of a steam engine is 50mm in diameter and 600 mm long. The diameter of the piston is 400 mm and the maximum steam pressure is 0.9 N/mm^2. Find the compression of the piston rod if the Young's modulus for the material of the piston rod is 210 kN/mm^2	8
	B	Describe Normal stress & maximum shear theory.	8
		OR	
Q. 4	A	Describe maximum principal strain & maximum distortion energy	8
	B	Calculate the force required to punch a circular blank of 60 mm diameter in a plate of 5 mm thick. The ultimate shear stress of the plate is 350 N/mm^2.	8
Q. 5	A	Calculate a suitable diameter for a solid circular shaft to transmit 150 kW at 180 rpm if the allowable shear stress is 80 MPa.	9
	B	What is keys, explain different types of keys.	9
		OR	

Q. 6	A	What is shaft, explain different types of shaft.	9
	B	A solid shaft is driven by a belt running over 400 mm diameter pulley running at 200 rpm. The tight side and slack side tensions are 1000 N and 500 N respectively. If the maximum torque exceeds the mean torque by 20% and maximum allowable shear stress is 240 MPA, find suitable diameter of shaft and power transmitted. Take F.O.S=6.	9

SECTION II

Q. 7	A	Explain with diagram, different belt drives.	8
	B	Derive the relation to calculate velocity ratio of belt drive with total percentage slip.	8

OR

Q. 8	A	What is bearing, explain different types of bearings.	8
	B	An engine running at 150 rpm. Drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and pulley on the line shaft is 450mm.A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Find the speed of dynamo shaft, when 1) There is no slip, and 2) there is a slip of 2% at each drive.	8
Q. 9	A	Explain with diagram different pipe joints.	8
	B	Explain with diagram different welded joints.	8

OR

Q. 10	A	A seamless steel pipe carries 1000 cubic meter of steam per hour at a pressure of 2 N/mm^2 with a velocity of 28 m/s. a) Calculate the inside diameter of the pipe and wall thickness if tensile stress in the material of pipe is 40 MPa. (take C=9 mm) b) Calculate the dimensions of a circular flanged pipe joint.	16
Q. 11	A	Describe with neat diagram, globe valve.	9
	B	Write note on valve characteristics.	9

OR

Q. 12	A	Give difference between positive displacement pump & centrifugal pump.	9
	B	Write note on NPSH.	9

UNIVERSITY OF PUNE
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S. E. (Chemical)
Chemical Engineering Thermodynamics-I
(2008 Pattern)

Total No. of Questions : 12 **[Total No. of Printed Pages :5]**
[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

(1) Answer three question from each section I and three question from each section II
*(2) Answers to the **two sections** should be written in **separate answer-books**.*
(3) Neat diagram must be drawn wherever necessary.
(4) Black figures to the right indicate full marks.
(5) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.
(6) Assume suitable data, if necessary.

SECTION-I

Q1.

a) One mole of a gas which obey's the relation PV=RT, is initially at 300k and 0.1MPa. the gas is heated at constant volume till the pressure rises to 0.5 MPa and then allowed to expend at constant temperature till the pressure reduces to 0.1 MPa. Finally the gas is returned to its original state by compressing at constant pressure. Calculate the work done by the gas in each of the processes and also estimate the network done by the gas. [8]

b) Two kilograms of CO_2 gas is contained in a piston-cylinder assembly at a pressure of 6.5 bar and a temperature of 300k. The piston has a mass of 5000 kg and a surface area of $1m^2$. The friction of the piston on the wall's is significant and cannot be ignored. The atmospheric pressure is 1.01325 bar . The latch holding the piston in position is suddenly removed and the gas is allowed to expand. The expansion is arrested when the volume is double the original volume. Determine the work appearing in surrounding. [8]

OR

Q2.

a) Derive the mathematical statement of First law of thermodynamics to steady state steady flow process [8]

b) 5 kg of air is heated from initial state of 37°C and 101.33 kpa until its temperature reaches 237°C. Calculate ΔU,Q,W, and ΔH for the following processes:
   1) Isochoric process
   2) Isoberic process

   Air assumed to be an ideal gas. We are given that C_p=29.1J/mol.k, C_v=20.78 J/mol.k [8]

Q3.

a) Air is compressed from an initial condition of 1 bar, 25°C and 0.0247g m^3 volume to a final state of 5 bar and 25°C by three different mechanically reversible processes in a closed system
   1) Heating at constant volume followed by cooling at constant pressure.
   2) Isothermal compression.
   3) Adiabatic compression followed by cooling at constant volume

   Assume air to be an ideal gas with C_v=(5/2)R and C_p=(7/2)R. calculate the work required, heat transferred and changes in internal energy and enthalpy of the air for each process. [12]

b) What do you understand by an equation of state? What are the limiting conditions to be satisfied by such equations? [6]

OR

Q4.

a) Reported values for the virial coefficient's of isopropanol vapour at 200°C are B= -0.388 m^3/kmol, C= -26×10^{-3} m^6/$kmol^2$
   Calculate V and Z for isopropanol vapour at 200°C and 10 bar by:
   1) The ideal gas equation

2) The virial equation. [10]

b) Derive an expression for work done for reversible adiabatic process [8]

Q5.

a) Explain
   1) Hess's law of constant heat summation
   2) Heat of reaction
   3) Heat of formation
   4) Heat of combustion [8]

b) For the following reaction the standard heat of reaction at 298K is -164.987 KJ.

$Co_2(g)+4H_2(g)\rightarrow 2H_2O(g)+CH_4(g)$

The constant's in the heat capacity equation (J/molk) are given below. [8]

	$\propto$	β	γ
Co_2	26.75	42.26×10^{-3}	-14.25×10^{-6}
H_2	26.88	4.35×10^{-3}	-0.33×10^{-6}
H_2O	29.16	14.49×10^{-3}	-2.02×10^{-6}
CH_4	13.41	77.03×10^{-3}	-18.74×10^{-6}

Calculate the standard heat of reaction at 773 k

OR

Q6.

a) Derive and expression for effect of temperature on standard heat of reaction [8]

b) On the basis of the data and chemical reactions given in the following lines, find the heat of formation of Z_nSO_4 from its constituent elements.

$Z_n+S= Z_nS$ $\Delta H= -44.0$ kcal/kmol

$2\ Z_nS+3O_2=2\ Z_nO+2SO_2$ $\Delta H= -221.88$ kcal/kmol

$2SO_{2+}O_2=2SO_3$ $\Delta H= -46.88$ kcal/kmol

$Z_nO+ SO_3=Z_nSO_4$ $\Delta H= -55.10$ kcal/kmol [8]

SECTION-II

Q7.

a) A carnot engine absorb's heat to the tune of 585 KJ/cycle from a hot reservoir at 650° and discard's heat to a cold reservoir at 30° then
   1) What is the theoretical efficiency of the carnot engine?
   2) What amount would be released to the cold reservoir? [4]

b) Explain third law of thermodynamics with entropy concept? [6]

c) A rigid vessel of $0.06m^3$ volume contains an ideal gas, $C_v=(5/2)R$, at 500K and 1 bar.
   1) If heat in the amount of 15KJ is transferred to the gas, determine its entropy change.
   2) If the vessel is fitted with a stirrer that is rotated by a shaft so that work in the amount of 15KJ is done on the gas, what is the entropy change of the gas if the process is adiabatic? What is total change in entropy? [8]

OR

Q8.

a) Explain carnot cycle and carnot principle. [8]

b) A rigid and insulated tank of volume $2m^3$ is divided into two equal compartments by a partition one compartment contains an ideal gas at 400 k and 3 MPa, while the second compartment contains the same gas at 600K and1 MPa. The partition is punctured and the gases are allowed to mix. Determine the entropy change of the gas. The isoberic molar heat capacity of the gas is equal to $(5/2)R$ [10]

Q9.

a) Derive maxwell's Relation's [8]

b) Derive Clausis-Clapeyron equation [8]

OR

Q10.

a) Mercury has a density of 13.69×10^3 g/m^3 in the liquid state and 14.193×10^3 kg/m^3 in the solid state, both measured at the melting point of 234.33 k at 1 bar. If the heat of fusion of mercury is 9.7876 kj/kg, what is the melting point of mercury at 10 bar? [8]

b) Carbon tetrachloride boils at 349.75 k at 1 bar. Its latent heat of vaporization is 194.8 kj/kg. what would be the boiling point of carbon tetrachloride at 2 bar? [8]

Q11.

a) Explain with neat sketch the vapour compression cycle [8]

b) A vapour compression refrigeration cycle in which the refrigerant HFC-134 enters the compressor as superheated vapour at 0.18 MPa and -10°C at a rate of 0.06 kg/s and leaves at 1.0 MPa and 45°C. the refrigerant is cooled in the condesor to 29°C and 0.75 MPa and is throttled to 0.2 MPa. Determine:
   1) The amount of heat removed from clod space
   2) The power input required
   3) The COP of the refrigeration cycle

   Given that

   Enthalpy of superheated vapour at -10°C & 0.18MPa=245 kj/kg

   Enthalpy of superheated vapour at 45°C & 1.0MPa=277.22 kj/kg

   Enthalpy of superheated vapour at 29°C & 0.75MPa=92.22 kj/kg [8]

OR

Q12.

a) What are the properties of refrigerant which are required to be considered for its selection? [8]

b) A vapour compression refrigeration system with ammonia as the working fluid is to operate between266 K and 300 K. Determine the following:

1) COP given that the enthalpy of satenated vapour at 266k = 656 kj/kg and enthalpy of superheated vapour leaving the compresser=724 kj/kg, enthalpy of saturated liquid at 300 k = 144 kj/kg.
2) COP is a temperature approach of 5k is necessary in the evaporator & condenser, & the efficiency of compressor is 75% . Enthalpy of saturated vapour at 261k=652 kj/kg. Enthalpy of saturated vapour entering the condenser= 758 kj/kg, enthalpy of saturated liquid at 305k=159 kj/kg
3) The COP of an Ideal carnot refrigerator [8]

[Total No. of Questions: *12*] **[Total No. of Printed Pages: 6]**

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S. E. (*Chemical*) Examination - 2013

Process Calculation (2008 Course)

[Time: *3* Hours] **[Max. Marks: 100]**

Instructions:

1 *Answers to the* ***two sections*** *should be written in* ***separate answer-books****.*

2 *Neat diagrams must be drawn wherever necessary.*

3 *Black figures to the right indicate full marks.*

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

5 *Assume suitable data, if necessary.*

SECTION –I

Q.1 A The flow rate of sodium chloride solution through a pipe is reported as 150kg/sec. The density of solution is 1.150 gm/cm^3, calculate the volumetric flow in cubic feet per minute 6

B Carburetted water gas has the following composition by volume: Hydrogen 35.2%, Methane 14.8%, Ethylene 12.8%, Carbon dioxide 1.5 %, Carbon monoxide 33.9% and Nitrogen 1.8%. The gas is available at 101.3 kN/m^2 and 300K. Express the composition by wt% and determine the average molecular weight and density of the gas. 10

OR

Q.2 A 17.2 gm of N_2O_4 gas, when heated to 100ºC at 720 mm Hg undergoes 90% dissociation according to the reaction $N_2O_4 \rightarrow 2NO_2$. Calculate the volume occupied by the gas mixture. 10

B An aqueous of Acetic Acid of 30% concentration (by mass) has density 1040 kg/m^3. Find Molality, Normality and Molality of the soluation. 6

Q. 3 A Pure sulphur is burnt in a burner at the rate of 0.3 kg/sec. Fresh dry air is supplied at 303 K and 100 kPa. The gases from the burner contain 16.5% SO_2, 3.5% O_2 and rest N2 on SO_3 free volume basis. The gases leave the burner at 1073 K and 101.3 kPa absolute. Calculate: 10

i) The fraction of sulphur burnt into SO_3

ii) The percentage excess air over the amount required to oxidize the sulphur to SO_2 and

iii) The volume of dry air un m^3/sec.

B A compound is found to contain 62.4% Ca and 37.6% C. 6

i) How many gram atoms of Ca and C present in 100 gm of the compound?

ii) Suggest an empirical formula for the compound.

OR

Q. 4 A Crystals of $MgCL_2.6H_2O$ have solubility of 190 gm per 100 gm ethanol at 298.15 K. It is desired to make 1000 kg of saturated solution. Calculate the quantities of the crystals and ethanol required to make the above solution. Also, find the composition of saturated solution by mass. 8

B A mixture of $CuSO_4.5H_2O$ and $FeSO_4.7H_2O$ weighs 100 gm. It is heated in an oven at 378 K to evaporate water of hydration. The mass of mixture after removal of water is 59.78 gm. Calculate the mass ratio of $CuSO_4$ to $FeSO_4$ in the mixture. 8

Q. 5 Formaldehyde is manufactured by the catalytic oxidation of methanol using an excess of air according to the reaction I. A secondary oxidation II also occurs if the conditions are not properly controlled. 18

$CH_3OH+0.5O_2 \rightarrow HCHO+H_2O$……..I

$HCHO+ 0.5O_2 \rightarrow HCOOH$……II

In a test run the product gases have the following composition by volume: CH_3OH=8.6%; HCHO=3.1%;

HCOOH=0.6%; H_2O=3.7%; O_2=16.0%; N_2=68%.

Calculate the following:

i) percentage conversion of methanol to formaldehyde

ii) percentage of methanol lost due to reaction II

iii) Molar ratio of methanol to air.

OR

Q. 6 A 1:3 nitrogen hydrogen mixture is fed to a converter resulting in 20% conversion to ammonia. After the complete separation of ammonia unconverted gases are recycled to the converter. The initial reaction mixture contains 0.2% argon by volume. It the limit argon in the reactor is 5% by volume of N_2-H_2 mixture in the reactor. 18

Estimate the following:

i) the fraction of recycle that is purged

ii) the moles of ammonia produced per 100 moles of feed

iii) the overall conversion of ammonia.

SECTION II

Q. 7 A Heat capacity of gaseous SO_2 is given by 8

$$C^{\circ}_{mp} = 43.458 + 10.634 \times 10^{-3}T - 5.945 \times 10^{5}\, T^{-2} kJ/kmol.k$$

Calculate the heat required to raise the temperature of 1.0 kg pure SO2 from to 1000 K.

B Write Short Note on: 8

i) Heat of Reaction

ii) Heat of Formation

OR

Q. 8 A Two kilogram of ice at 0ºC is heated so that it is completely converted to steam at 150ºC and 101.3kPa. What is the enthalpy change accompanying the process. The heat of 8

fusion of water at given 0ºC and 101.3 kPa is 335 kJ/kg. The heat capacity equation of liquid water is

$$Cp = 18.296 + 47.212 \times 10^{-2}T - 133.88 \times 10^{-5}T^2 + 1314.2 \times 10^{-9}T^3$$

and heat capacity of water vapor at 101.3 kPa is given by:

$Cp = 30.475 + 9.652 \times 10^{-3}T + 1.189 \times 10^{-6}T^2$, Where Cp is in kJ/kmol K and T is in K. Use steam table wherever necessary

B Flue gases leaving the boiler stack at 523 K have the following composition: 8

$$CO_2 = 11.31\%, H_2O = 13.04\%, O_2 = 2.17\% and\ N_2 = 73.48\%$$

(by volume). Calculating the heat lost in 1 kmole of gas mixture above 298K using the heat capacity Data given below:

$C^\circ_p = a + b \times T + c \times T^2 + d \times T^3$, kJ/(kmole.K)

Gas	A	b×10^3	c×106	d×109
CO_2	21.3655	64.2841	-41.0506	9.7999
H_2O	32.4921	0.0796	13.2107	-4.5474
O_2	26.0257	11.7551	-2.3426	-0.5623
N_2	29.5909	-5.141	13.1829	-4.968

Q. 9 A A solution of potassium dichromate in water contains 15% potassium dichromate by weight. 1000 kg of this solution is evaporated to remove some of water. The remaining solution is cooled to 298 K. If the yield of potassium dichromate crystals is 75%, calculate the amount of water evaporated. Solubility of potassium dichromate in water is 115 kg per 1000kg water. 8

B A solution of ethyl alcohol containing 8.6% alcohol is fed at the rate of 1000 kg/h to a continuous distillation column. The product (distillate) is a solution containing 95.5% alcohol. The waste solution from the column carries 0.1% of alcohol. All percentages are by mass. Calculate the mass flow rates of top and bottom products in kg/h and the percentage loss of alcohol. 8

OR

Q. 10 A A dryer is fed with wet solid to reduce the moisture content from 80% to 15%. The product leaving the dryer is sent to oven to reduce the moisture content to 2%. If 1000 kg of wet solid is fed to the dryer, find out the weight of the products leaving the dryer and oven. Also determine the amount of water removed in dryer and in oven. 8

B With respect to the Humidification operation, define the following: 8

i. Absolute humidity
ii. Molal humidity
iii. Percent humidity
iv. Humid volume
v. Wet bulb temperature
vi. Adiabatic saturation temperature
vii. Humid heat
viii. Dry bulb temperature.

Q. 11 A gas mixture consisting of 80% ethane and 20% oxygen is burned in an engine with 100% excess air. 80% of the ethane goes to CO_2, 10% to CO and 10% remains unburned. 18

Calculate the composition of the exhaust gases on:

i. Wet basis and
ii. Dry basis.

Data:

Atomic weight K=39,Si=28, Ca=40, Na=23, S=32.

OR

Q. 12 A coal sample from Godavari colliery has the following proximate and ultimate analyses. 18

Proximate Analysis	mass %	Ultimate Analysis	mass %
Moisture	7.0	Carbon	54.0
Volatile matter	26.0	Hydrogen	3.0
Fixed Carbon	46.0	Sulphur	0.4
Ash	21.0	Nitrogen	2.2

		Ash	21.0
		Oxygen(by diff)	19.4

The gross calorific value = 23392kJ/kg at 298.15 K.

Calculate :

i. The net hydrogen in the coal,
ii. The combined water in the coal,
iii. NCV of the coal.

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S.E Engineering Examinations 2013

MATHAEMATICS – III

(2008 COURSE)

[Total No. of Question=12] **[Total no. of printed pages= 7]**

[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

(i) Attempt q. No. 1 or q. no2, Q. No. 2, Q. No. 3 or Q. No. 4, Q. No. 5 or Q. No. 6 from Section I and Q No. 7 or Q. No. 8, Q. No. 9 or Q. No. 10. Q. No. 11 or Q No. 12 from section II.

ii) Answer to the two Sections should be written in separate answer-books.

iii) Figures to the right indicates full marks.

iv) Use of electronic pocket calculator is allowed.

v) Assume suitable data, if necessary.

Q.1 a) Solve any three [12]

1) $(D^2+3D+2)y = sine^x$

2) $(D^2+2D+1)y = 2cosx+3x+2+3e^x$

3) $(D^4 - 1)y = coshx$ Sinhx

4) $(1+x)^2 \frac{d^2y}{dx^2} + (1+x)\frac{dy}{dx} + y = 4\cos[\log(1+x)]$

5) $(D^2 - 4D + 4)y = e^{2x}sec^2x$ (by method of variation of parameter.)

b) Solve

$$\frac{dx}{x^2-y^2-z^2} = \frac{dy}{2xy} = \frac{dz}{2xZ}$$ [5]

Q. 2 a) Solve any three [12]

1) $\frac{d^2y}{dx^2} - \frac{dy}{dx} - 2y = 2logx + \frac{1}{x} + \frac{1}{x^2}$

2) $\frac{d^2y}{dx^2} - y = \frac{2}{1+e^x}$

3) $\frac{d^2y}{dx^2} + 4y = x \sin x$

4) $(D^2 - 4D + 4)y = e^x cos^2 x$

5) $x^2 \frac{d^2y}{dx^2} - 2x\frac{dy}{dx} - 4y = x^2 + 2\log x$

Q.2 b) Solve [5]

$\frac{dx}{dt} + y = e^t$

$-\frac{dy}{dt} + x = \bar{e}^t$

Q. 3 a) A body weighing 4.9 is hung from a spring. A pull of 10 N 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 [8]

b) A string is stretched and fastened to two points 'λ' apart. Motion is started by displacing the string in the from u= a sin $\frac{\pi x}{\lambda}$ from which it is released at time t=0^{λ}. Find the displacement u(x, t) from one end. [8]

OR

Q.4 a) In a heat exchange the temperatures x and y of two liquids satisfy the equations

$$\frac{dx}{dt} + 5x - 2y = t$$

$$\frac{dy}{dt} + 2x + y = 0$$

Find the temperatures x & y as a function of time, given that x=0 and y=0 at time t = 0

b) Solve the equation $\frac{\partial u}{\partial t} = a^2 \frac{\partial^2 u}{\partial x^2}$ [8]

Where u(x, t) satisfies the following conditions

i) u (0,t) = 0
ii) u (λ, t) = 0 $\forall\, t$
iii) u (x, 0) = x in $0 < x < \lambda$
iv) u(x, ∞) is finite

Q.5 a) Find the Fourier transform of [7]

$$f(x) = \begin{cases} 1 - x^2, & 1x1 \leq 1 \\ 0, & 1x1 > 1 \end{cases}$$

and hence evaluate

$$\int_0^\infty \left(\frac{xcosx - sinx}{x^3}\right) \frac{cos3x}{2}\, dx$$

b) Show that the Fourier transform of f(x) = $e^{-x^2/2}$ is $\bar{e}^{\lambda 2/2}$ [5]

c) Solve the integral equation [5]

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

OR

Q.6 a) Using Fourier integral equation show that [7]

$$\int_0^{\infty} \frac{cos\lambda x + \lambda sin\lambda x}{1+\lambda^2} d\lambda = \begin{cases} 0, & x < 0 \\ \pi/2\ , & x = 0 \\ \pi\bar{e}^{x}, & x > 0 \end{cases}$$

b) Find the Fourier sine transform of [5]

$$\frac{e^{-ax}}{x}$$

C) Find Fourier integral representation of [5]

$$f(x) = \begin{cases} \frac{\pi}{2} cosx\ , & |x| \leq \pi \\ 0, & |x| > \pi \end{cases}$$

Section-II

Q.7 a) Obtain Laplace transform of (any three): [12]

i) $\frac{\bar{e}^{at} - \bar{e}^{bt}}{t}$

ii) $e^{-4t} \int_0^t t \sin 3t \, dt$

iii) $(1+ 2t - 3t^2 + 4t^3)$ U (t-2)

iv) $\int_0^t erf\sqrt{u} \, du$

b) Using Laplace transform, evaluate: [4]

$$\int_0^\infty t^2 \, \bar{e}^t sint \, dt$$

OR

Q.8 a) Obtain inverse Laplace transform of (any three): [12]

i) $\frac{s}{(s^2+a^2)^2}$

ii) $\frac{1}{s}\log(\frac{s^2+a^2}{s^2+b^2})$

ii) $\frac{2s^2-6s+5}{s^3-6s^2+11s-6}$

iv) $\frac{\bar{e}^{3s}}{s^2+8s+25}$

Q.8 b) Find the Laplace transform of the periodic function: [4]

$$f(t) = \begin{cases} t, & 0 < t < \pi \\ \pi - t, & \pi < t < 2\pi \end{cases}$$

and $f(t+2\pi) = f(t)$

Q.9 a) Find the directional derivative of [5]

$\emptyset = 4 \text{ x } z^3 - 3x^2y^2z \; at \; (2,-1,2)$ along tangent to the curve $x=e^t \cos t$,

$y = e^t \sin t$, $z = e^t$ at $t = 0$

b) If the vector field [6]

$\bar{F} = (x + 2y + z)\,\bar{\imath} + (bx - 3y - z)\,\bar{\jmath} + (4x + cy + 2z)\,\bar{k}$ is irrotational, find a, b, c and determine $\emptyset$ such that $\bar{F} = \nabla\emptyset$.

c) Evaluate $\iint_S (\nabla \text{ X } \bar{F}).\overline{ds}$, where $\bar{F} = (x^3 - y^3)\,\bar{\imath} - xyz\,\bar{\jmath} + y^3\,\bar{k}$ and S is the [6] surface $x^2 + 4y^2 + z^2 - 2x = 4$ above the Y0z - plane.

OR

Q.10 a) Evaluate $\iint_S \frac{x\bar{\imath}+y\bar{\jmath}+z\bar{k}}{r^2} . \overline{ds}$ Where S is the surface of the sphere [6]

$x^2 + y^2 + z^2 = a^2$

b) With usual notations prove that (any two) **[6]**

i) $\nabla^4 (r^2 \log r) = \frac{6}{r^2}$

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

iii) $\nabla \text{ X } \left[\frac{\bar{a} \text{ X } \bar{r}}{r^3}\right] = \frac{3(\bar{a}.\bar{r})}{r^5}\bar{r} - \frac{\bar{a}}{r^3}$

C) Find the work done by the force

$\bar{F} = (x^2 - yz)\bar{\imath} + (y^2 - zx)\bar{\jmath} + (z^2 - xy)\,\bar{k}$ in taking a particle from

(1,1,1) to (3, -5,7) [5]

Q.11 a) Solve $\frac{dy}{dt} + 2y(t) + \int_0^t y(t)dt = sint$, given y(0) =1 using Laplace [5] transform.

Q.11 b) The transfer function of a second order system is given as [6]

G(s) = $\frac{6}{s^2+1.8s+1}$. Determine its properties such as overshoot, period of oscillation and $y(t)_{max.}$

C) Find the equations of stream line passing through the point (1,1,2) in case of steady motion of fluid defined by : $\bar{q} = -x\bar{\imath} + 2y\bar{\jmath} + (3 - z)\bar{k}$. [6]

OR

Q.12 a) Using the Laplace transform, solve the D.E. [5]

$y''+2y'+y = 6te^t$; y(0) =2, y′(0) =5.

b) Find the surface of equipressure in case of steady motion of a liquid which has velocity potential [6]

Ø = xy + yz + zx and is under the action of force

$\bar{F} = (mz + ny)\bar{\imath} + (nx + lz)\bar{\jmath} + (ly + mx)\bar{k}$

c) Is the motion represented by $(x^2-yz)\bar{\imath} + (y^2 - zx)\bar{\jmath} + (z^2 - xy)\bar{k}$ [6] irrotational? If so, find the corresponding velocity potential.

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S.E.(Chemical) Examination-2013

Chemistry -I

(2008 pattern)

Time-Three hours **Maximum Marks-100**

Total No. of Question=12 **[Total no. of printed pages= 5]**

Instructions:

(1)Answers to the two sections should be written in separate answer books.

(2)Neat diagram must be drawn wherever necessary.

(3)Figures to the right indicate full marks.

(4)Assume suitable data wherever necessary.

(5)Use of logarithmic tables,slide-rule,Molleir charts,calculator and steam tables is allowed.

SECTION-I

Q.1 (a)What are the postulates of molecular orbital theory?Explain paramagnetic behaviour of O_2 molecule. (6)

(b)Draw resonance structures of phenol and benzaldahyde? (4)

(c)Explain the relative order of stability of free radicals and carbanions? (6)

OR

Q.2 (a)What is LCAO approximation? Draw molecular orbital structure of butadiene? (6)

(b)What are the conditions necessary for resonance? (6)

(c)Give reason for the following. (4)

(i)Pyrrole is a weak base

(ii)Phenol is acidic in nature. (4)

Q.3 (a)Explain the stereochemical changes taking place during SN^1 and SN^2 reactions. (8)

(b)Give the mechanism of acylation of benzene. (4)

(c)Describe briefly Beckman's rearrangement. (4)

OR

Q.4 (a)Give the mechanism of E_1 and E_2 eliminations. (8)

(b)Write a note on diazocoupling. (4)

(c)Explain why $-NO_2$ group is deactivating and m-directing. (4)

Q.5 (a)Define and explain. (6)

(i)Cell Constant

(ii)Specific conductance

(iii)Equivalent conductance

(b)Discuss the principle,interferences and limitations of plane photometry. (6)

(c)State and explain Kohlrausch's law. The ^o CH_3COONa , ^oHCL and ^oNaCl are 91,426.16 and 126.45 $Ohm^{-1}cm^2$ equiv^2 respectively at 25^0C . Calculate ^o CH_3COOH . (6)

OR

Q.6 (a)Define conductometric titrations. Explain the conductometric titration curve for the following. (6)

(1)Strong acid with strong base

(2)Weak acid with strong base.

(b)Define polentiometric titrations and explain redox titration. (6)

(c)What are ion selective electrodes?

Describe the working and construction of a glass electrode. (6)

SECTION-II

Q.7 (a)Derive the integrated rate equation for second order kinetics for two reactants same initial conc? (6)

(b)What is steady state approximation? Explain it with suitable example. (6)

(c)Explain any two methods for the rate determination of reaction. (4)

OR

Q.8 (a)Explain the activated complex theory & derive the expression for rate equation. (6)

(b)Derive the photochemical rate law for reaction of H_2 & Cl_2 (6)

(c)Show that the time required for a first order reaction to complete 99.9% reaction is approximately 10 times its half life period. (4)

Q. 9 (a)What are the different types of chromatography?Explain thin layer chromatography in terms of Principle,technique & applications. (6)

(b)Define fuel cell.Explain construction,working & applications of H_2-O_2 fuel cell. (6)

(c)Explain applications of HPLC. (4)

OR

Q.10 (a)Give the instrumentation of gas chromatography. (6)

(b)Explain construction,working & applications of polymer electrolyte membrane fuel cell. (6)

(c)Define. (4)

(i)charge discharge cycle

(ii)Energy density

(iii)Specific energy

(iv)Power density

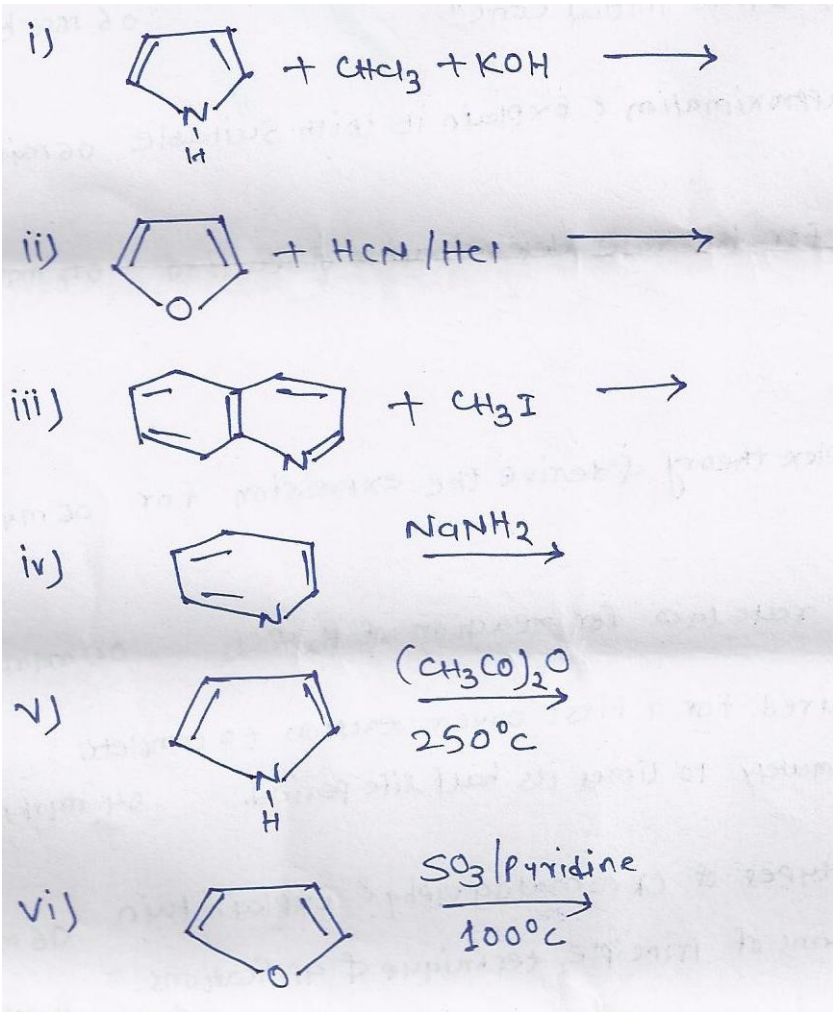
Q.11 (a)Write any three methods for the synthesis of pyridine. (6)

(b)Describe the methods of synthesis for the following types. (6)

(i)phenolphthalein

(ii)Alizarin

(c)Compare the following reactions. (6)



OR

Q.12 (a)How will you prepare quinoline from aniline? (6)

(b)Explain the classification of dyes on the basis of applications. (6)

(c)Explain why electrophilic substitution reaction takes place. preferentially at position 2 & or 5 in furun. (6)

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S. E.(Chemical Engineering)Examination - 2013

CHEMICAL ENGINEERING FLUID MECHANICS

(2008 Pattern)

[Total No. of Questions:12] **[Total No. of Printed Pages :4]**

[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

*(1) Answer **Q1 or Q2, Q3 or Q4, Q5 or Q6** from section I and **Q7 or Q8, Q9 or Q10, Q11 or Q12** from section II.*

*(2) Answers to the **two sections** should be written in **separate answer-books**.*

(3) Black figures to the right indicate full marks.

(4) Neat diagrams must be drawn wherever necessary.

(5) Use of logarithmic tables, slide rule, Mollier charts, electronics pocket calculator is allowed.

(6) Assume suitable data, if necessary.

SECTION-I

Q1 a) Discuss the time independent rheological behaviours of the fluids. [6]

b) The velocity distribution for flow over a flat plate is given by [10]

$$u = \frac{2}{3} y - y^2$$

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=0, y=5 and y=10 cm. Assume dynamic viscosity as 8.00 poises

c) What is stream line and stream tube? [2]

Q2 a) Discuss the followings: [6]

i) Laminar and turbulent flow

ii) Steady and unsteady flow

iii) Rotational and irrotational flow

b) Find the kinematic viscosity of an oil having specific gravity 0.981. [4]
The shear stress at a point in oil is 0.2452 N/m^2 and the velocity gradient at that point is 0.2 per second.

c) What is rheology? How fluids are classified according to their rheological behavior? [6]

d) Give an example for each of the following: [2]

i) Newtonian fluid

ii) Bingham plastic fluid

iii) Thixotropic fluid

iv) Rheopetic fluid

Q3 a) Derive Bernoulli equation, highlighting the assumptions made. [8]

b) The pressure difference between two points (A and B) in a pipe carrying liquid of density ρ_1 is to be measured by using a differential u-tube manometer. The manometer uses two manometric fluids of density ρ_2 and ρ_3. Where $\rho_2 > \rho_3$. By using the principle of hydrostatic equilibrium obtain an equation to calculate the pressure drop between points A and B on the pipe across which the manometer is connected. [8]

Q4 a) For one dimensional steady state flow of incompressible fluid show that: [8]

$$\frac{du}{dx} = 0$$

b) Water is flowing through a pipe having diameter of 300 mm and 200 mm at the bottom and upper end respectively. The pressure at the bottom is 26 N/cm^2 and the pressure at the upper end is 10 N/cm^2. Determine the difference in datum head if the rate of flow through the pipe is 40 l/s. Assume the upward flow in the pipe. [8]

Q5 a) For laminar flow of incompressible, Newtonian fluid through a horizontal circular pipe, show that the friction factor is f = 16/Re [8]

b) Water is pumped from a reservoir to a height of 1000 m from the reservoir level, through a pipe of 15 cm I.D. at an average velocity of 4 m/s. [8]

The pipe is 2000 m long and the overall efficiency of pump is 70%,
What is the energy required for pumping?
Take friction factor f = 0.046 $Re^{-0.2}$.

Q6 a) For laminar flow through circular pipe prove that the mean velocity is half the maximum velocity. [8]

b) A liquid is pumped through 15 cm diameter and 300 m long pipe at the rate of 20 tonnes per hour. The density of the liquid is 910 kg/m^3 and kinematic viscosity is 0.002 m^2/s. Show that the flow is laminar and determine the power required to maintain the flow. [8]

SECTION-II

Q7 a) A thin plate is moving in still atmospheric air at a velocity of 4m/sec. The length of the plate is 0.8 m and width 0.6 m.
Calculate: i) the thickness of the boundary layer at the end of the plate and ii) Drag force on one side of the plate.
Take density of air as 1.20 kg/m^3 and kinematic viscosity 0.15 stokes. [10]

b) With suitable example, describe in detail the method of dimensional analysis using Reyleigh's method. [8]

Q8 a) Explain the growth of Boundary layer for a flow over a flat plate. Indicate Laminar, Turbulent and Laminar sublayer of boundary layer. [8]

b) Calculate the momentum thickness for the following boundary layer velocity flow: [8]

$$\frac{u}{u_\infty} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$$

c) Define energy thickness. [2]

Q9 a) A 4 m deep bed of solids is to be backwashed with water. The average particle size of the solids in the bed is 1 mm and the specific gravity of the solid is 1.6 find the minimum fluidization velocity. [8]

b) Draw a neat sketch and explain the working of a Packed bed column. [8]

Q10 a) Derive an expression for minimum fluidization velocity. [8]

b) Discuss the classification of the fluidization & describe the particulate and aggregative fluidization. [8]

Q11 a) Draw a neat sketch and explain the working of the venturimeter. Derive an equation to calculate the flow rate by using the venturimeter. [8]

b) Three pipes of lengths 800, 600 and 400 m of diameters 400 mm, 300 mm and 200 mm respectively are connected in series. The ends of the compound pipe are connected to two tanks whose water surface levels are maintained at difference of 15 m. Determine the rate of flow of water through pipes, if f = 0.005 for all three pipes. What will be the diameter of a single pipe of length 1700 m and f = 0.005, which replaces three pipes. (Neglect minor losses) [8]

Q12 a) Draw a neat diagram and explain the operating characteristics of centrifugal pump. [8]

b) An orificemeter with orifice diameter 20 cm is inserted in a pipe of of 40 cm diameter. The pressure gauges fitted on upstream and downstream of the orifice gives the readings of 25 N/cm^2 and 10 N/cm^2 respectively. Find the rate of flow of water in the pipe. (Take c_d = 0.6) [8]

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S. E. (Chemical) Examination - 2013
CHEMICAL ENGINEERING MATERIALS (209344) (2008 Pattern)
[Total No. of Questions:12] **[Total No. of Printed Pages :2]**

[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

*(1) Answer **any three** from each section.*
*(2) Answers to the **two sections** should be written in **separate answer-books**.*
(3) Black figures to the right indicate full marks.
(4) Neat diagrams must be drawn wherever necessary.
(5) Use of logarithmic tables, slide rule, Mollier charts, electronics pocket calculator is allowed.
(6) Assume suitable data, if necessary.
(7) Your answers will be valued as a whole.

SECTION-I

Q1 a) Write a short note on Tensile Test. [6]

b) Explain necking in brief. [4]

c) State Hooke's law and explain stress-strain diagram. [6]

OR

Q2 a) Write the classification of Engineering materials. [6]

b) Define the following terms: [10]

i) Ductility

ii) Malleability

iii) Shear stress

iv) Factor of safety

v) Elasticity

Q3 Give in detail the classification of Hardness Test and explain impact test and types of impact test [16]

OR

Q4 a) Explain Rockwell Hardness Test in detail. [10]

b) Write the difference between destructive and non destructive hardness test. [6]

Q5 Draw Fe-Fe_3C equilibrium diagrams. Explain various reactions involved and different phases observed. [18]

OR

Q6 a) Give the classification of steels with examples. [10]

b) Discuss various methods of welding. [8]

SECTION-II

Q7 a) Define corrosion and explain in detail its any two types. [12]

b) Write short note on factors affecting corrosion [6]

OR

Q8 a) Write short notes on: [10]

i) Dry corrosion

ii) Wet corrosion

b) What is an oxide film? Explain its formation and growth mechanism [8]

Q9) Write short notes on following terms: [16]

i) Stress relaxation

ii) Corrosion resistance of plastic

iii) Wear/Abrasion Test

iv) Applications of polymer

OR

Q10 a) Define polymers. Explain different types of polymers with examples.[6]

b) Define polymerization. Explain addition and condensation polymerization.[10]

Q11 a) Write a short note on Vitrification process. [6]

b) Define ceramic materials and write the applications of ceramic materials. [6]

c) Enlist the differences mechanical properties of ceramic materials. [4]

OR

Q12 a) Define Glass materials and its types. [8]

b) Write short notes on: [8]

i) Refractories

ii) Clays

[Total No. of Questions: 12] **[Total No. of Printed Pages: 4]**

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S.E. (Chemical)
Chemistry-II
(2008 Pattern)

[Time: 3 Hours] **[Max. Marks: 100]**

Instructions:

i) Answers to the two sections should be written in separate answer-books.

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.

SECTION -I

Q.1 a) What is an adsorption isotherm? Explain and derive when Langmuir adsorption isotherm converts into freudlich isotherm. [6]

b) Explain the mechanism of metal co.ordination compound catalysed reactions in Wacker process. [6]

c) Explain the terms [4]
1) Activation energy
2) Zeolite catalysts

OR

Q.2 a) Explain the different types of adsorption Isotherms [6]

b) Write a short note on adsorption theory of Catalyst [6]

c) Give B.E.T. theory of multilayer adsorption [4]

Q.3 a) Define carbohydrates and how will you classify them? [6]

b) Explain the primary and secondary structure of proteins [6]

c) Explain the terms [4]
1) Co.enzyme
2) Vitamins

OR

Q.4 a) Describe in detail how open structure of glucose is elucidated [6]

b) Explain the characteristics of enzymes [6]

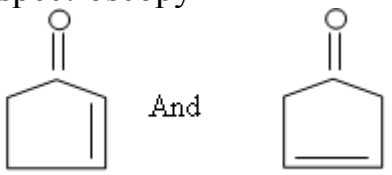
c) Explain the terms [4]
1) Zwitter ion
2) Isolectric point

Q. 5 a) Give the principle and instrumentation involved in IR spectroscopy [6]

b) What are the different electronic transitions in molecules on absorption of U.V. radiations? Give examples for each electronic transitions [6]

c) How you will distinguish following pairs from each other by UV or IR spectroscopy [6]

i)



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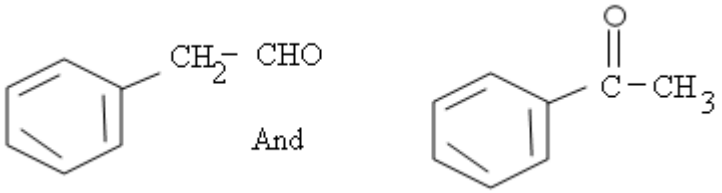

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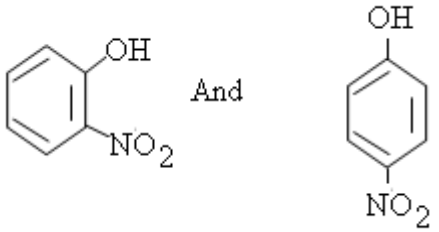

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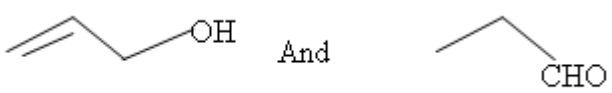


OR

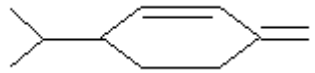
Q. 6 a) Explain the cause of IR absorption by molecules [6]

b) Define and explain the terms [6]
1) Auxochrome
2) Chromophone
3) Bathochromic shift

4) Hypsochromic shift

c) Calculate UV absorption maxima for the following [6]

i)



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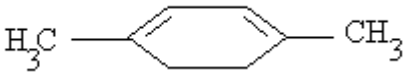

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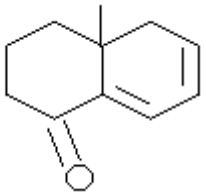

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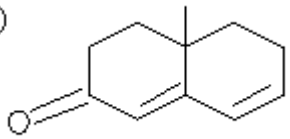

SECTION II

Q. 7 a) Define CFSE. Calculate the CFSE for the octanedral complex containing d^5,d^6 & d^9 in high spin state [6]

b) How does the valence bond theory account for the following facts [6]
i) $[Ni(CN)_4]^{2-}$ is diamagnetic & square planar
ii) $[Ni(CO)_4]$ is diamagnetic & tetrahedral
iii) $[Ni(CN)_4]^{2-}$ is paramagnetic & tetrahedral

c) Write the formulae of the following complexes [4]
i) Tetra carbonyl Nickel (0)
ii) Potassium hexacyano ferrate (II)
iii) Tris ethylendiamine cobalt ((III) Chloride
iv) Potassium tetracyano Nickel (0)

OR

Q. 8 a) What are the transition elements? Explain the following properties of transition metals. [6]
1) Tendancy to form complexes
2) Coloured compounds of transition metals

b) Discuss the structure of following complexes on the basis of CFT. [6]
1) $[FeC(N)_6]^{4-}$

2) $[Cof_6]^{3-}$

c) Define the following terms giving suitable examples [4]
1) Co-ordination number 2) ligand

3) Co-ordination Sphere 4) Ambident ligand.

Q. 9 a) What is green chemistry? Discuss the issues related to green chemistry. [6]

b) Give the traditional & green pathway for the synthesis of 1) Adipic acid 2) carbaryl pesticide [6]

c) Calculate the atom economy & environmental load factor for [4]

i) $+ HNo_3 + H_2SO_4 \longrightarrow$ $^{No2} + H_2o + H_2SO_4$

ii) $2Cl\text{-}CH_2\text{-}CH_2\text{-}OH + (aCOH)_2 \longrightarrow 2CH_2\text{-}CH_2 + CaCl_2 + H_2o$

o

(Atomic weight of H=1, C=12, N=14, O=16, S=32, CL=35.5 Ca=40)

OR

Q. 10 a) What is biotechnology? Explain various types of fermentations [6]

b) Give the applications of biotechnology for [6]
1) Antibiotics 2) Glucose manufacture

c) Write short note on biotechnology. [4]

Q. 11 a) Data from a domestic waste water BOD test is [6]
i) 7 ml of waste water sample was diluted in 350ml BOD bottle.
ii) Initial D.O.=9.5 mg/lit & 5 day D.O= 6.3 mg/lit. Estimate
i) $(BOD)_{s,}$ ii) ultimate BOD. Take K_D=rate constant=0.1/day

b) Write note on 1) Reverse asmosis 2) Ultrafiltration [8]

c) What is chemical oxygen demand? How is it determined [4]

OR

Q. 12 a) Write in short the characteristics of textile, paper, tannery & dye industry. Suggest suitable methods for the treatment of each of these waste waters. [8]

b) Comment [6]
i) Biological methods for the treatment of waste water are effective & economical
2) Waste minimization & waste recycling are the indeed steps in industrial waste water management.

c) Write note on: Disposal of Hazardous waste [4]

[Total No. of Questions: 12] **[Total No. of Printed Pages: 6]**

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S. E. (Chemical) Examination - 2013

HEAT TRANSFER (2008 Course)

[Time: 3 Hours] **[Max. Marks: 100]**

Instructions:

1 *Answer any three questions from Section I and any three questions from Section II*

2 *Neat diagrams must be drawn wherever necessary.*

3 *Black figures to the right indicate full marks.*

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

5 *Assume suitable data, if necessary.*

SECTION -I

Q.1 A What are the different modes of heat transfer? Explain? 8

B Calculate temperature at an interior point of the wall at a distance of 15 cm from inner surface of wall. The temperature of the inner & outer surface are 200^0 C & 80^0C. The thickness of the wall is 0.5 m 8

OR

Q.2	A	What is dimensional Analysis? Explain the significance of different dimensionless numbers?	8
	B	Two faces of an 80 mm thick stillness steel plate are maintained at 350^0C & 180^0C. How much heat is transferred through the plate per unit area, it the thermal conductivity of stainless steel is 16.3 W/m^{0}K?	8
Q. 3	A	Derive an expression for the rate of heat transfer through a composite plane wall considering of three heterogeneous layers having thermal conductivities k_1, k_2 and k_3 respectively?	9
	B	Furnace is constructed with 0.2 m of fire brick with thermal conductivity 1.4 W/m^{0}K, 0.1m of insulting brick with thermal conductivity 0.21W/m^{0}K and 0.2 m of building brick with thermal conductivity 0.7W/m^{0}K,. The inside temperature is 1200^0C and outside temperature is 330^0C. Find heat loss per unit area and temperature at junction of fire brick and insulating brick.	9

OR

Q. 4	A	Derive the equation for steady state heat conduction through composite cylinder bounded by fluids at different temperatures.	9

	B	A composite wall consists of three layers with thickness of 5cm, 10 cm, & 18 cm, having thermal conductivities 1.28, 0.58, & 0.42 W/m^0K respectively, The heat transfer coefficient on inner side is $22W/m^0$ K & on outer side is 10 W/m^0K Calculate the rate of heat loss per unit area if temperatures are 350^0 K & 300^0K on inner & outer side respectively. What are steady state temperature at interfaces of all three layers?	9
Q. 5	A	What in convection? Distinguish between natural and forced convection?	8
	B	Thermal conductivity of a material at any temperature is given by equation $K = 0.925 + 0.000486\ T(W/m\ K)$ If the plane wall of thickness 25cm is constructed using this material & the two sides are maintained at 1200^0C & 450^0C respectively. Calculate the heat flow rate per unit area	8
		OR	
Q. 6	A	What are Fins/ Explain different types of fins?	8
	B	An aluminium rod 25 mm in diameter & 100 mm long protrudes from a wall which is maintained at 250^0C into the environment maintained at 15^0C. Estimate the heat lost by rod assuming that rod end is insulated.	8

Also find the fin efficiency & temperature at the end of the fin?

Data:- "K" for Aluminium = 200 W/Mk

"h" between rod surface & environment = 15 W/m^2K

SECTION II

Q. 7	A	What are the different laws of Radiation ? Explain Planks law?	9
	B	Two large parallel plates with emissivities 0.2 & 0.6 are maintained at 1000K & 500 K respectively. A third plate with emissivity 0.08 in introduced as a radiation shield in between two plates. Calculate reduction in heat loss rate per unit area & temperature of the shield?	9

OR

Q. 8	A	Differentiate between specular & diffuse reflection? What is Radiation Shield? Radiosity & Irradiation?	9
	B	Calculate the heat flux emitted due to thermal radiation from a black surface at 5700^0C. At what wavelength is the monochromatic emissive power maximum & what is the maximum value?	9
Q. 9	A	Define heat exchanger? Give detail classification of Heat Exchanger?	8

	B	Water at the heat of 68 kg/min is heated from 35^0 C to 75^0 C by an oil having a Specific heat of 1.9 KJ/Kg^{0}c. The fluids are used in a counter flow double pipe heat exchanger & the oil enters the exchanger at 110^0 C & leaves at 75^0C. The overall heat transfer coefficient is 320 w/m^{2}k, specific heat of water is 4.18 KJ/kg^{0}C Calculate the heat exchanger area?	8

OR

Q. 10	A	Explain Shell & Tube heat exchanger? What is Fouling factor explain?	8
	B	A heat exchanger is designed to cool 300 kg/hr of liquid at 150^0C having specific heat value 3350 J/kg K using a parallel flow arrangement. Cooling water is available at 15^0C. If the overall heat transfer coefficient is 1100 w/m^{2}K & surface are available for heat transfer is 0.4 m^2. Calculate outlet temperature of two fluids & effectiveness of heat exchanger? Take water flow rate 800 kg/hr & specific heat of water is 4187 J/kg K.	8
Q. 11	A	What is Capacity, Economy & Steam consumption of evaporator? Explain standard vertical Calendria type of evaporator?	8
	B	An evaporator is to be fed with 5000 kg/hr of solution containing 10% solute by weight. The feed at 40^0C is concentrated to a solution containing 40% by weight of	8

solute under atmospheric pressure. Steam is available at an absolute pressure 3 atm. (The saturation Temp. of 134^0C). The heat transfer coefficient is 1500 Kcal/hr m^2 ^{0}C. Calculate

i) The heat transfer area that should be provided.

ii) The steam requirement.

Treat the solution as per pure water for enthalpy calculators.

Data:- Latent heat of steam = 2177.3 Kcal/kg

Temperature (^{o}C)		40	100	134
Enthalpy	Vapour	614.5	639.2	651.4
Kcal/Kg	Liquid	40.5	100	134.4

OR

Q. 12 A What is Evaporation? What are different types of evaporators? Explain Boiling point Elevation & Vacuum Evaporation? 8

B What are multiple effect evaporators? Explain? 8

[Total No. of Questions: 12] **[Total No. of Printed Pages: 3]**

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[4362]-200

S.E. (Chemical) Examination-2013

(Mechanical Operations

(2008 Course) (Sem.II)

[Time: 3 Hours] **[Max. Marks: 100]**

Instructions:

1) **Answer three questions from Section-I and three questions from section-II.**
2) **Answers to the two sections should be written in separate answer-books.**
3) **Neat diagrams must be drawn wherever necessary.**
4) **Figures to the right indicate full marks.**
5) **Assume suitable data wherever required.**

SECTION-I

Q.1 (a) Calculate the energy required to crush 100 tonnes per hour of limestone if 80% of the feed passes through a screen 3.75 cm aperture and 80% of the product passes through a screen with 0.03 cm aperture. The work index for limestone is 12.74, when the capacity is expressed in tonnes per minute energy required in HP and the size of feed and product in feet. [10]

(b) Explain the importance of screening operation in a process industry. [4]

(c) Explain the factors influencing the size of the product in the ball mill. [4]

OR

Q.2 (a) A material is crushed in jaw crusher and the average size of particle reduced from 50 mm to 10 mm with consumption of energy of 13 kW/(kg/s). What will be the consumption of energy needed to crush the same material of average size 75 mm to an average size of 25mm: [10]

(i) Assuming Kick's law

(ii) Assuming Rittinger law

(b) Differentiate between crushing and grinding [6]

(c) What are the various advantages of wet grinding. [2]

Q.3 (a) State the advantages and limitations of belt conveyors. [6]

(b) Explain the construction of flight conveyors [4]

(c) Explain shape factor [3]

(d) Why it is necessary to clean the belt? [3]

OR

Q.4 (a) Explain with a neat sketch construction of screw conveyor and its advantages and disadvantages. [8]

(b) Write notes on [8]

(i) Pneumatic conveyor

(ii) Chain and flight conveyor

Q.5 (a) What is degree of mixing and rate of mixing in case of dry solids and derive the expressions. [8]

(b) Describe the types of mixers for pastes and plastic mass. [8]

OR

Q.6 (a) Write short notes on [8]

(i) Mixing index

(ii) Sigma mixer

(b) With the help of neat sketch distinguish between radial flow and axial flow impellers. [8]

SECTION-II

Q.7 (a) What are the various factors which affects the rate of filtration? Derive an expression to calculate the rate of filtration. [8]

(b) A sludge is filtered in a plate and frame press filtered with 25 mm frames. For the first 600 sec, the slurry pump runs at maximum capacity. During this period the pressure rises to 415 kN/m^2 and 25% of the total filtrate is obtained. The filtration takes a further 3600 sec to complete at constant pressure and 900 sec is required for emptying and resetting the press. It is found that if the cloths are precoated with filter aid to a depth of 1.6 mm, the cloth resistance is reduced to 25% of its former value. What will be the increase in the overall through-put of the press if the precoat can be applied in 180 sec? [10]

OR

Q.8 (a) Explain leaf filter and filter press in detail. [8]

(b) A plate and frame press filtering a slurry, gave a total of $25m^3$ of filtrate in 30 min and 35 m^3 in 60 min when filtration was stopped. Estimate the washing time in minutes if 10 m^3 of wash water are used. The resistance of the cloth can be neglected and a constant pressure is used throughout. [10]

Q.9 (a) Describe with a neat sketch [8]

i. Particulate fluidization

ii. Aggregate fluidization

(b) Define fluidization. State the application of fluidization technique. [8]

OR

Q.10 (a) A tube of $0.05m^2$ cross-sectional area is packed with spherical particles up to a height of 0.25 m. The porosity of the bed is 0.35. It is desired to fluidize the particles with water (ρ =1000 kg/m^3, μ=10^{-3} Pa-sec). Calculate minimum velocity of fluidization by Ergun's equation. 8

Data: Diameter of particles=0.01m

Density of solid particles=2600 kg/m^3

(b) Explain Kynch theory of sedimentation. State clearly the assumptions. [8]

Q.11 (a) Explain with a neat sketch working and industrial applications of a cyclone separator. [8]

(b) Explain in detail Jigging separation technique. [8]

OR

Q.12 Write notes on [16]

(i) Scrubbers

(ii) Froth floatation

(iii) Electrostatic precipitator

(iv) Centrifugal classifier