**UNIVERSITY OF PUNE**

**[4364]-651**

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

**Process Dynamics & Control**

**(2008 Pattern)**

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

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

***Instructions:***

*(1)Answer any three questions from each section I and II.*

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

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

*(4) Black figures to the right indicate full marks.*

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

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## SECTION-I

Q.1 (a) Derive transfer function of single tank liquid level system. Draw a suitable sketch. **[8]**

(b) What are the design elements of control system? Explain with examples. **[8]**

**OR**

Q2. (a) A mercury bulb thermometer showing a steady state temperature of 25°C is suddenly immersed into a hot bath at 120°C. If the time constant of thermometer is 8 sec. find:

I. Thermometer reading after 8 sec
II. Time required to read 90°C on thermometer
III. Time required for 75% response. **[8]**

(b) Discuss the incentives for chemical process control **[8]**

Q3. (a) Discuss the characteristics of underdamped response and plot the graph of overshoot and decay versus damping factor $\xi$ **[9]**

(b) Derive the transfer function of two tank interacting system. **[9]**

**OR**

Q4. (a) Define P, I and D controller and derive their transfer function. Discuss their open loop and closed loop response with diagram. **[9]**

(b) Consider a second order system with following transfer function **[9]**

$$G(s) = \frac{Y(s)}{X(s)} = \frac{1}{S^2 + S + 1}$$

Introduce a step change of magnitude 1 into the system and find

i. Percent overshoot
ii. Decay ration
iii. Ultimate value of Y (t)
iv. Rise time

Q5. (a) Sketch the root locus for the following transfer function **[10]**

$$G(s) = \frac{K}{S^2(S^2 + 2S + 2)}$$

(b) Using Routh-Hurwitz criteria. Check the stability of system described by following equation. **[6]**

$$S^3 + 6S^2 + 11S + 6 = 0$$

**OR**

Q6. Define controller turning and discuss the following turning methods. **[16]**

1) Cohen Coon technique
2) Time Integral performance criteria
3) One-quarter decay ration

**SECTION - II**

Q7. (a) Sketch the Bode plot **[9]**

$$G(s) = \frac{1}{(2S + 1)(5S + 1)}$$

(b) Derive the response of general First order system to Sinusoidal input. Define amplitude and phase lag. **[9]**

**OR**

Q8. (a) Explain Gain Margin and Phase margin with a neat sketch **[4]**

(b) Sketch the Bode Plot for PI controller **[8]**

(c) Sketch the Nyquist Plot for PD controller **[6]**

Q9. (a) Explain Ratio Control with a neat sketch. **[8]**

(b) Explain with a neat sketch Inverse Response system **[8]**

**OR**

Q10. (a) Explain the control instrumentation of cascade control for a jacketed CSTR **[8]**

(b) Draw a neat sketch and explain **[8]**

1) Feed-back control action

2) Feed-forward control action.

Q11. (a) Explain the reconstruction of continuous time signals from discrete time signal by using hold element. **[8]**

(b) Write a note on PLC and SCADA system **[8]**

**OR**

Q12. (a) Explain in detail the role of digital computer in process control. **[8]**

(b) What is Plant Wide control? Explain with a suitable example. **[8]**

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

**UNIVERSITY OF PUNE**

**[4364]-668**

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

***Chemical Process Safety (2008 Course)***

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

***Instructions:***

1 *Answer 3 questions from section –I and 3 questions from section-II*

2 *Neat diagrams must be drawn wherever necessary.*

**SECTION -I**

| | | | |
|---|---|---|---|
| Q.1 | | Discuss in details the safety aspects in the design of chemical process plants. | 16 |
| | | **OR** | |
| Q.2 | | Define and explain Hazard, Toxicity, flammability, Threshold limit value and Accident with appropriate examples. | 16 |
| Q. 3 | A | Discuss various legislations on safety control presently applicable in chemical process plants. | 8 |
| | B | Explain material safety data sheet with the format during as industrial hygiene study. | 8 |
| | | **OR** | |
| Q. 4 | A | What are the effects of noise on human being? List their legislative measures. | 8 |
| | B | How will you evaluate exposure to volatile toxicants by monitoring? | 8 |
| Q. 5 | | What is a fire triangle? What do you understand by fire prevention, fire protection and fire lighting? What are the various ways of fire extinguition? | 18 |
| | | **OR** | |
| Q. 6 | A | Distinguish between fires and explain. Explain various types of explosion. | 12 |
| | B | Explain flammability characteristic of liquid and vapors. | 6 |

**SECTION II**

| | | | |
|---|---|---|---|
| Q. 7 | A | How are flammable and toxic chemical stored? What precaution is taken while handling of three chemical? | 10 |
| | B | What are the preventive and protective measures to prevent fire in chemical industry? | 6 |
| | | **OR** | |

| | | | |
|---|---|---|---|
| Q. 8 | A | What are the methods for fire protection? Describe with examples. | 10 |
| | B | Explain the various safety devices for relieving pressure. | 6 |
| Q. 9 | A | Differentiate between Hazards, Risk and safety. Give classification of Hazards. | 10 |
| | B | What are the basic preventive and protection measures to hazards? | 8 |
| | | **OR** | |
| Q. 10 | A | Explain the classification of Hazards and Hazard ratings. | 8 |
| | B | What is the basic information required to carry out the HAZOP? Explain. | 10 |
| Q. 11 | A | Suggest a suitable control scheme for the safe operation of chemical reactor. | 10 |
| | B | What are the objectives and benefits of safety audit? | 6 |
| | | **OR** | |
| Q. 12 | | Explain<br>i) Disaster Management<br>ii) Personal Protective Equipments<br>iii) Role of computers in safety<br>iv) Safety checklist for a chemical process plant. | 16 |

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

**UNIVERSITY OF PUNE**
**[4364]-669**
**B. E.(*Chemical Engineering*) Examination - 2013**
***Food Technology***
***(2008 Course)(CH409349)***

**[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.*

**SECTION -I**

| | | | |
|---|---|---|---|
| Q.1 | A | Discuss the current status of food industries in India. | 10 |
| | B | Explain physical and chemical properties of food. | 8 |
| | | **OR** | |
| Q.2 | A | Write in detail constituents of the food material? | 8 |
| | B | What is the effect of food processing on nutritional and sensory properties? | 10 |
| Q. 3 | A | Explain the various methods of sorting of food materials. | 8 |
| | B | What is cleaning of food? Give the types with advantage and disadvantage? | 8 |
| | | **OR** | |
| Q. 4 | A | Elaborate methods of storage of solid foods. | 8 |
| | B | What do understand by degradation of food? Explain any two methods of prevention of food degradation. | 8 |
| Q. 5 | A | What is effect of pasteurization on nutritive value, flavor, microorganism and enzymes present in milk? | 8 |
| | B | What are steps involved in oil purification? | 8 |
| | | **OR** | |
| Q. 6 | A | What is the effect of sterilization on food materials? | 8 |
| | B | Explain the process of manufacturing of milk powder? | 8 |

**SECTION II**

| | | | |
|---|---|---|---|
| Q. 7 | A | Describe the industrial process for manufacturing of jam and jellies. | 10 |
| | B | What are the preservatives used in food industries. | 8 |
| | | **OR** | |
| Q. 8 | A | Explain in detail the industrial manufacturing process of beverages. | 10 |

| | | | |
|---|---|---|---|
| | B | Describe the process of manufacturing of pickles and Squashes? | 8 |
| Q. 9 | A | Explain with an application various size reduction equipments used in food industries. | 8 |
| | B | What is the effect of size reduction on properties of food materials. | 8 |
| | | **OR** | |
| Q. 10 | A | Describe the process and equipments used for hot air dehydration of food materials. | 8 |
| | B | Write a note on freeze drying and freeze concentration. | 8 |
| Q. 11 | A | Describe the importance of food packaging in food industry. | 8 |
| | B | Describe the properties of packaging materials. | 8 |
| | | **OR** | |
| Q. 12 | A | What are various material required for handling food materials in food industry? | 8 |
| | B | Write a note on coating/ operation for food materials. | 8 |

[4364- 661]

**B.E. (Chemical Engineering)**

**PIPING DESIGN AND ENGINEERING**

**2008 Course (Elective- II)**

Time: 3 Hours Marks: 100

**Instructions to the candidates:**

1. Answer three questions from each section.
2. Neat diagrams must be drawn wherever necessary
3. Figures to the right indicate full marks.
4. Assume suitable data, if necessary
5. Answers to the two sections should be written in separate Answer books.

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## SECTION-I

**Q.1a)** Explain the different minor losses occurring in piping systems? **(10)**

**Q.1b)** Water flows through a 16-in pipeline (0.375-in wall thickness) at 3000 gal/min. Using the Hazen-Williams equation with a C factor of 120, calculate the pressure loss due to friction in 1000 ft of pipe length? **(08)**

**OR**

**Q.2a)** Draw and explain the significance of Moody diagram in determining the friction factor for turbulent flow? **(08)**

**Q.2b)** Two pipes each 300 mm long are available for connecting to a reservoir from which a flow of 0.085 $m^3/s$ is required. If the diameter of the two pipes are 0.30 m and 0.15 m respectively. Determine the ratio of the head loss when the pipes are connected in series to the head loss when they are connected in parallel. Neglect minor losses. **(10)**

**Q.3a)** Which are the different elements alloyed in carbon steel for modifying its chemical composition to obtain the desired mechanical and physical properties? **(08)**

**Q.3b)** Write down the different sections of ASME Boiler and Pressure Vessel Code? **(08)**

**OR**

**Q.4a)** List out the major codes and standards providing engineering bodies in piping? Explain any two in detail? **(16)**

**Q.5a)** Explain the steps used for sizing of pressure relief valves as per API RP 520? **(08)**

**Q.5b)** Explain the guidelines used for selecting the proper type of Rupture Disk? **(08)**

**OR**

**Q.6a)** How to size control valves for liquid and gas service? **(08)**

**Q.6b)** Write down the construction and the different types of globe valves employed in controlling the flow? **(08)**

## SECTION II

**Q.7a)** Explain the correct piping arrangement with the help of submergence laws for centrifugal pump? **(08)**

**Q.7b)** Calculate the deposition velocity of heterogeneous slurry with a solid specific gravity of 3.0 in water. for a pipeline with an 8-in internal diameter. The particle size = 1 mm, and volume concentration = 15 percent. **(08)**

**OR**

**Q.8a)** Explain the Homogenous and Heterogeneous Flow in slurry pipe lines? **(08)**

**Q.8b)** How to calculate NPSHa and NPSHr? How to increase NPSHa?

**(08)**

**Q.9a)** Which are the considerations involved in the pipe rack design?

**(08)**

**Q.9b)** Explain the concept of PFD, P&ID and utility diagram?

**(10)**

**OR**

**Q.10a)** Which data is required to finalize the pipe rack width, number of levels, elevations and bent spacing?

**(10)**

**Q.10b)** Explain in detail the different types of plot plan?

**(08)**

**Q.11a)** Calculate the heat loss per square foot of surface area for steam pipe insulated with calcium silicate. Following data is available:

Pipe size: NPS 6 (DN 150), 6.625 in (168 mm) actual OD

Operating temperature: 400 F (204 °C), Ambient temperature: 75 F (24 °C)

Insulation thickness: 2 in (51 mm) nominal & 2.11 in (54 mm) actual

Insulation type: Calcium silicate, Length of pipe: 75 linear ft (22.8 m)

**(08)**

**Q.11b)** Discuss the design criteria used in insulation system design for piping applications?

**(08)**

**OR**

**Q.12) Write short notes on**

1) High alloy steel & its usage in piping

2) Design criteria used in insulation system design for piping applications

3) Pipeline Economics

**(16)**

**UNIVERSITY OF PUNE**

**[4364]-652**

**B.E CHEMICAL REACTION ENGINEERING – II(409344)**

**(Semester - I) Examination**

**(2008 Course)**

**[Total No. of Questions:]** **[Total No. of Printed pages :4]**

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

***Instructions :***

*(1) Answer **any 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) *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, electronic pocket calculator and steam tables is allowed.*

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

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## SECTION-I

Q.1 a) For fluid particle reactions, derive expression for time of complete conversion for small particles in strokes regime. [8]

b) Particles of uniform size are 60% corseted on the average when flowing through a single fluidized bed. If the reactor is made twice as large but contains same amount of solids and with the same gas environment. Determine the conversion of solids. [10]

**OR**

Q.2 a) A feed consisting 35% of 50 $\mu m$ radius particles 35% of 100 $\mu m$ radius particles, 30% g 200 $\mu m$ radius particles is to be reacted in a fluidized bed reactor (at a steady-state) from a vertical 2m long ,20 cm ID pipe. The time required for complete conversion is 5, 10 and 20 min for the three sizes of feed, find conversion of solids for a feed rate of 1 kg solids/min if bed contains 10kg solids. [10]

b) Explain various contacting patterns in fluid-solid reactions. [8]

Q.3 a) In case of fluid-fluid reaction taking place in the tower reactor the inlet partial pressure of reactant is 0.002atm and outlet partial pressure is 0.003 atm. The conc. of liquid phase reactant entering is 132 mol/$m^3$. Following operating parameters have been determined. $k_{ag}$ .a =32000 mol/ hr. $m^3$. atm, $k_{a1}$ =0.1 / hr, $H_A = 125 * 10^0$ atm. $m^3$/mol [10]

$a = 1*10^5$ mol/ hr.$m^2$ , $C_T$=56000 mol/$m^3$ L= 7 * $10^5$atm. $J_I$ = 1 atm.
Determine the height of the tower

b) what are the different types contactors used for fluid-fluid reactions [6]

**OR**

Q4. a) Component A from gas is to be reduced from 2% to 5ppm by converter current contact with liquid containing reactant B of concentration $C_B$ = 500 $m^o$ / 1$m^3$. Find the height of the tower needed. [10]
Data – $K_{AG}$. a = $3*10^{-4}$ mol / s.$m^3$. Pa, $k_{A1}.a = k_{Bi}.a = 6* 10^{-4}$ / sec
$H_A$ = 10 Pa. $m^3/m^{01}$ , $c_1$ = 20 m01 /sec.$m^2$,
L = 80 mol /sec.$m^2$ Total pressure = 1 bar

b) Draw concentration profile for various cases of kinetic regimes for mass transfer and reaction for fluid – fluid reactions. [6]

Q.5 a) Low temperature (-195.8°c) nitrogen adsorption data were obtained for an Fe – $Al_20_3$ ammonia catalyst. The results for 50. 4 g sample are [10]

| P,mmHg | 8 | 30 | 50 | 102 | 130 | 148 |
|---|---|---|---|---|---|---|
| V,$cm^3$ | 103 | 116 | 130 | 148 | 159 | 163 |

$^o$c, 1atm

| P,mmHg | 233 | 258 | 330 | 442 | 480 | 550 |
|---|---|---|---|---|---|---|
| V, $cm^3$ | 188 | 198 | 221 | 270 | 294 | 365 |

Estimate the surface area for this catalyst.

b) Derive performance equation for batch solids, batch fluids for a heterogeneous reaction obeying first order reaction kinetics and first order deactivation. [6]

**OR**

Q. 6 a) What is pore volume distribution? Describe the mercury penetration method for measurement of pore – volume distribution. [8]
What is $N_2$ desorption method?

b) Write short notes on i) Catalyst deactivation [8]
ii) catalyst activation

**SECTION –II**

Q.7 ) Determine the size of packed bed reactor required to treat 2000 mol / hr of pure A at 117°c with initial concentration of 0.1 mol/ lit to 35% conversion all at 3.2atm. [18]
$A \rightarrow 4R$ . Data –

| CA, mol / lit | 0.039 | 0.0575 | 0.075 | 0.092 |
|---|---|---|---|---|
| $-r_A$ , mol / hr. kg | 3.4 | 5.4 | 7.6 | 9.1 |

**OR**

Q.8 ) An experimentel rate measurement on the decomposition of A is made with a particular catalyst. It is likely that film resistance to mass transfer influences the rate. Could this run have been made in the regime of strong pore diffusion? Would you expect to have temperature variations within the pellet or across the gas film? Data – spherical particle dp = 2.4 mm, L = R/3 = 0.4mm, Dc = $5*10^{-5}$ $m^3$ / hr.m. cat , kcff = 1.6 KJ/hr.mcat.k for gas film surrounding the pellet h = 160 KJ/ $hr^2$. cat. k, Kg = 300 $m^3$/hr.$m^2$. cat for the reaction $\Delta Hr$ =1600 KJ/mol, $C_{Ag}$ = 20 mol/$m^3$, $-r_{Aobs} = 10^5$ m01/hr.$m^3$.cat. Assume that the reaction is first order [18]

Q .9 a) A catalytic reaction A → 4R is run at 3.2 atm and 118°c in a PFR and contains 0.01 Kg is catalyst and uses a feed consisting of partially converted product of 20 lit/hr of pure unrelated A. the results are as follows. [10]

| Run | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $C_{Ain}$ mol/lit | 0.100 | 0.080 | 0.060 | 0.040 |
| $C_{Aout}$ mol/lit | 0.084 | 0.070 | 0.055 | 0.038 |

Find a rate equation to represent thins reaction

b) Explain steps involved in solid catalyzed reaction with neat diagram [6]

**OR**

Q.10. a) For the following reaction occuring on the catalyst derive the rate expression for surface reaction to be rate controlling and dual site mechanism $s_1$, are the sites occupied by $H_2O$ and $CH_3OH$ and $S_2$ are occupied by $O_2$ [12]

$CH_3OH + \frac{1}{2} O_2 \leftrightarrow CHO + H_2O$

$A + \frac{1}{2} B \leftrightarrow C + D$

$A (g) + S_1 \leftrightarrow A .S,$

$B (g) + S_2 \leftrightarrow B . S_2$

$A . S_1 + B . S_2 \leftrightarrow C (g) + D.S_1 + S_2$

$D. S_1 \leftrightarrow D (g) + S_1$

b) Draw any two sketches of catalytic reactors for packed bed reactors used to carry out solid catalyzed reactions. [4]

Q.11 a) Explain design of stayed adiabatic reactors with the design equations. [10]

b) Compare relative merits and demerits of fluidized and packed bed reactors. [6]

**OR**

Q.12 a) Derive michaelis-menton equation for the decomposition of urea using enzyme urease. The suggested mechanism is as follows. [10]

i) $NH_2COHN_2$ + urease $\underset{\rightarrow}{k1}$ [ $NH_2COHN_2$. .urease]*

ii) [$NH_2COHN_2$.urease]* $\underset{\rightarrow}{k2}$ urease + $NH_2CONH_2$

iii) [$NH_2COHN_2$.urease]* + $H_2O$ $\underset{\rightarrow}{k3}$ $2NH_3$ + $CO_2$ + urease

b) Write a short note on slurry reactor [6]

**UNIVERSITY OF PUNE**

**[4364-653]**

**B.E.(Chemical) Examination 2013**

**Chemical Engineering Design II**

**(2008 pattern)**

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

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

**Instructions:**

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

(2)Answer to the TWO sections should be written in separate answer books

(3)Neat diagrams must be drawn whenever 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 whenever necessary.

## SECTION-I

Q.1 (a)Describe any three types of agitators giving their range of rpm,functioning and application. (8)

(b)How is vortex formation avoided?What problems are encountered when vortex is formed? (6)

(c)What is the function of stiffeners welded on the outside of the shell wall of a jacketed vessel? (4)

OR

Q.2 (a)Design a turbine agitator shaft and blade only with the following specifications for a vessel of 1500 mm diameter.Data: (16)

Diameter of agitator: 450 mm

Internal pressure in the vessel :0.5 $N/mm^2$

Speed:250 rpm

Sp.Gravity of liquid in the vessel-1.3

Viscosity of liquid in the vessel-600cp

Overhang of the agitator shaft between bearing and agitator 1350mm

No. of Agitator blades(Flat):6 nos.

Width of the blade: 75 mm

Thickness of the blade:8 mm

No.of baffles at tank wall:4nos.

Shaft material-commercial cold rolled steel

Permissible shear stress in the shaft:55 $N/mm^2$

Elastic limit in tension:246 $N/mm^2$

Modulus of elasticty:1.95 x $10^5$ $N/mm^2$

Value of Power No. :4.3

(b)What is the function of offset in a baffle. (2)

Q.3 (a)Give the AIChE method for prediction of plate efficiency. (8)

(b)Compare the performance of different types of plates. (8)

OR

Q.4 (a)Calculate the column diameter for a sieve plate column with the following specification for an acetone-water system. (10)

Maximum feed rate :10,500kg/h

Minimum feed rate70% of maximum

Number of stages:15

Slope of the bottom operating line:5.0

slope of top operating line:0.57

Top product composition:94 mol%

Bottom product Composition

Essentially water

Reflux Ratio:1.35

Column efficiency: 60%

At bottom conditions:

Vapour Density:0.72 $Kg/m^3$

Liquid Density:954 $Kg/m^3$

Surface tension:0.057Nm

k1: 0.075

For top conditions:

Vapour Density:2.05 $Kg/m^3$

Liquid Density:753 $Kg/m^3$

Surface tension:0.023Nm

k1:0.09

(b)Explain downcomer backup and its effect with relevant equations. (6)

Q.5 (a)Explain in which cases packed columns are preferred over plate columns. (6)

(b)Give Cornell;s method for calculating height of transfer unit based on gas and liquid phase. (10)

OR

Q.6 (a)Estimate using Onda's method using the following data: (12)

| | |
|---|---|
| liquid Flow rate | 16.6 $kg/m^2s$ |
| Gas flow rate | 0.79 $kg/m^2s$ |
| Critical surface tension | 0.06 N/m |
| Surface tension for liquid | 0.07 N/m |
| Viscosity of liquid | 0.001 $Nm/s^2$ |
| Interfacial area(a) | 194 $m^2/s^3$ |
| Density of liquid | 990 $kg/m^3$ |

Diffusivity in liquid: $1.7 \times 10^{-9} m^2/s$

Diffusivity in gas: $1.45 \times 10^{-5} m^2/s$

Diameter of packing material: 38mm

$k_5$: 5.23

Viscosity of gas: $0.018 \times 10^{-3}$ $Ns/m^2$

Molecular weight of liquid: 18

Molecular weight of gas: 29

(b)Give reasons why channelling and bypassing may occur in a packed column. (4)

SECTION-II

Q.7 (a)What safety devices are used in pressure vessels to prevent pressure build up? (6)

(b)What are impingement separators? (6)

(c)When are rupture and relief valves used in combination? (6)

OR

Q.8 (a)Write about knockout drum,role of demister pads and reflux drums. (10)

(b)Design a steam water separator for the following conditions. (8)

Steam flow rate: 2450kg/h

Water flow rate: 1200kg/h

Density of water: $950 kg/m^3$

Density of vapour: $2.16 kg/m^3$

Operating pressure: 4 bar

Q.9 (a)Give the design considerations for piping used in very hot and very cold conditions. (8)

(b)What is the Hardy Cross Method? (8)

OR

Q.10 (a)Explain the fluid dynamic parameters in pipeline design. (12)

(b)What are factors affecting orifice diameter? (4)

Q.11 (a)What is the importance of codes and standards piping?Name any standards for piping design. (8)

(b)How is appropriate material selection important for piping?Explain with example. (8)

OR

Q.12 (a)What are the different types of gaskets? (8)

(b)Explain the terms gasket seating and effective gasket seating width. How does wrong material selection of gasket affect performance? (8)

**UNIVERSITY OF PUNE**

**[4364-654]**

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

**Environmental Engineering**

**(2008 pattern)**

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

**[Total No. of Question=12]** **[Total no. of printed pages= 2]**

**Instructions:**

(1)Answer 3 questions from Section-I. Answer question 3 from Section-II,

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

(3)Neat diagrams must be drawn whenever 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 wherever necessary.

**SECTION-I**

Q.1 (a)Discuss Environment in detail.

(b)Elaborate on Nitrogen cycle in detail with diagram. (16)

**OR**

Q.2 (a)What are the basic mechanisms of removing gases from stack?

(b)With neat sketch explain settling chamber. (16)

Q.3 (a)Explain with neat figure venturi scrubber.

(b)Explain with neat figure the design aspects of cyclone separator. (16)

**OR**

Q.4 (a)Explain kyoto protocol.

(b)Discuss Isokinetic sampling. (16)

Q.5 Write a short note on: (18)

(a)Air pollution laws & standards.

(b)ozone depletion

OR

Q.6 Write a short note on: (18)

(a)Green House effect

(b)Effects of carbon monoxide on human.

**SECTION-II**

Q.7 (a)Differentiate clearly between BOD & COD. How do you determine the BOD and What are the limitations of BOD test.

(b)State whether COD values and BOD values of same sample would be same?or different ?If it is different ,which will be greater?Why? (18)

**OR**

Q.8 (a)What is the difference between preliminary treatment and primary treatment?

(b)Explain tertiary treatment in detail. (18)

Q.9 (a)Distinguish clearly between the working of an oxidation ditch and oxidation pond.

(b)Write in detail the design parameters of aerated lagoons and mention the advantages & disadvantages of the same. (16)

**OR**

Q.10 (a)Explain neutralization in detail.

(b)Discuss various treatment adopted for treatment industrial wastewater. (16)

Q.11 (a)Write the difference between grab sample and composite sample.

(b)Explain the characteristics of pulp & paper mill waste. (16)

**OR**

Q.12 (a)Discuss about sludse dispisal.

(b)How composting is done?What are its applications in waste management? Discuss. (16)

# UNIVERSITY OF PUNE

# [4364]-655

## B. E. (Semester - I) Examination-2013

## B.E (Chemical) (Elective-I)

## Membrane Technology (2008 Course) (409341)

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

***Instructions :***

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

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## SECTION-I

Q.1 a) State the separation process used for separating mixture of constituents differing in – particle size, vapor pressure, freezing point, affinity, electric charge, density. [6]

b) Explain the importance of separation operation in chemical manufacturing processes. [6]

c) Explain the criteria for selection of appropriate separation process for given application. [6]

OR

Q.2 a) State advantage and limitations of membrane separation processes over conventional separation processes. [6]

b) Classify membranes based on homogeneity, transport mechanism, nature of material, electric charge , morphology, [6]

c) With suitable sketch explain the basic principle of membrane separation process. [6]

Q.3 Explain use of following polymeric materials used for membranes [16]

a) Linear or branched chain polymers

b) copolymers (random, block, graft type.)

c) Cross- linked type.

(Give suitable applications)

**OR**

Q.4 Explain the effect of following properties of polymeric membrane on separation characteristics. [16]

a) Chain flexibility. (effect of main chain and side groups).

b) Molecular weight

c) Chain interactions.

Q.5) Explain the following methods for preparation of membrane [16]

a) Sintering

b) Stretching

c) Track etching

d) Template leaching

**OR**

Q.6) What are composite membranes? Explain the following methods of preparation of composite membrane- [16]

a) Interfacial Polymeriration.

b) Dip coating

c) Plasma Polymerization

## SECTION –II

**Q.7)** What is characterisation of process membrane? Explain following methods of characterisation of process MF membrane [16]

a) SEM
b) Bubble – point method
c) Mercury intrusion porometray
d) Permeability method.

**OR**

Q.8) Explain the following methods of characterisation of UF membrane [16]

a) Gas adsorption – desorption

b) Thermoporometry

c) Permporometry.

d) Liquid displacement.

Q.9) Distinguish between solution diffusion model and pore flow model for describing transport through membranes. [8]

b) Explain the following mechanisms used to describe transport through porous membranes- [8]

i) surface of screen filtration.
ii) Depth filtration

**OR**

Q.10a) Explain the following mechanisms of transport through micro porous membranes. [8]

i) Kundsen diffusion
ii) Surface diffusion

b) Explain transport in an ion exchange membrane process such an electrodialysis [8]

Q.11 a) What is concentration polarization in membrane? Explain the following models used for polarization of membrane [12]

i) Boundary layer film model
ii) Gel layer model.

b) What is membrane fouling? State the sources of fouling and remedies to reduce the effect of fouling. [6]

**OR**

Q.12) Explain the contraction and working of following membrane modules – [18]

a) Spiral wound module.
b) Tubular module
c) Hollow fibre module
d) Plate and frame module.

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**[4364]-656**

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

**Bioprocess Engineering (2008 Course)**

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

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

**Instructions:**

1 *Answer 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 *Black figures to the right indicate full marks.*
5 *Use of electronic pocket calculator is allowed*
6 *Assume suitable data, if necessary.*

## SECTION -I

| | | | |
|---|---|---|---|
| Q.1 | A | Discuss in detail the various types of liquids? | 8 |
| | B | Explain the structure and functions of biomembranes? | 8 |

OR

| | | |
|---|---|---|
| Q.2 | Write short notes on following<br>i) DNA and RNA<br>ii) Proteins and their diverse biological applications | 16 |

| | | |
|---|---|---|
| Q. 3 | Explain the manufacturing for a) Vitamin A and b) citric Acid | 16 |

OR

| | | |
|---|---|---|
| Q. 4 | Discuss the importance of effluent treatment in bioprocessing? Explain the different aerobic and anaerobic treatments for winery wastewater? | 16 |

Q. 5 A What are the factors which influence enzyme activity? Explain each factor in detail/ 10

B Derive the Michaelis Menten equation for describing the enzyme kinetics? 8

OR

Q. 6 A What is meant by modulation of enzyme activity? What are the different modulation effects? 8

B The following experimental data were collected during a study of the catalytic activity of an intestinal peptidase with substrate glycylglycine. 10

Glycylglycine + $H_2O$ ⟶ 2glycine

| $S_0$ (mmol) | Product formed ($\mu$mol/min) |
|---|---|
| 1.5 | 0.21 |
| 2.0 | 0.24 |
| 3.0 | 0.28 |
| 4.0 | 0.33 |
| 8.0 | 0.40 |
| 18.0 | 0.45 |

Use graphical analysis to determine the $V_{max}$ and $K_m$ for this enzyme preparation and substrate

## SECTION II

Q. 7 A Drive an expression for maximum possible dilution rate and also state its significance? 10

B Explain the kinetic implications of endogenous and maintenance metabolism? 8

OR

Q. 8 A Derive design equation for CSTR for continuous cultivation of cells and also explain Monod kinetics? 10

B E coli being used for production of recombinant porcine growth hormone. The bacteria are grown aerobically in a batch culture with glucose as growth limiting substrate. Cell and substrate concentration are measured as a function of culture time, the results are listed below: 8

| Time (h) | Cell Conc. ($kg/m^3$) | Substrate Conc. ($kg/m^3$) |
|---|---|---|
| 0.0 | 0.20 | 25.0 |
| 0.33 | 0.21 | 24.8 |
| 0.5 | 0.22 | 24.8 |
| 0.75 | 0.32 | 24.6 |
| 1.0 | 0.47 | 24.3 |
| 1.5 | 1.00 | 23.3 |
| 2.0 | 2.10 | 20.7 |
| 2.5 | 4.42 | 15.7 |
| 2.8 | 6.9 | 10.2 |
| 3.0 | 9.4 | 5.2 |
| 3.1 | 10.9 | 1.65 |
| 3.2 | 11.6 | 0.2 |
| 3.5 | 11.7 | 0.0 |
| 3.7 | 11.6 | 0.0 |

i) Plot $\mu$ as a function of time

ii) What is the value of $\mu_{max}$?

Q. 9 A Explain the fed batch mode of fermenter operation in terms of features, advantages, disadvantages, concentration time profiles, mass balances and examples? 8

B What are the different variants of continuously operating bioreactors? Explain in brief? 8

OR

Q. 10 A What is meant by critical oxygen concentration and its significance with respect to cell growth? 8

B Compare between physical and chemical methods of enzyme immobilization. State advantages and disadvantages of both? 8

| | | | |
|---|---|---|---|
| Q. 11 | A | Explain the importance of bioprocess economics? | 8 |
| | B | Discuss solvent extraction with examples used in bioseparations? | 8 |
| | | OR | |
| Q. 12 | | Write short notes on<br>1) Ultra-filtration<br>2) Electrophoresis<br>3) Drying | 8 |

**University of Pune**
**B.E. (chemical)**
**4364-658**
**Examination – 2013**
**Chemical Process Synthesis**
**(2008 Pattern)**

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

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

***Instructions :***

*(1) Answer **03 question from each section.***
*(2) Answers to the **two sections** should be written in **separate answer-books**.*
*(3) Figures to the right indicate full marks.*
*(4) Use of logarithmic tables, slide rule, Mollier charts, Electronic packet calculator is allowed.*
*(5) Neat diagrams must be drawn whenever necessary.*
*(6) Assume suitable data, if necessary.*

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Section I

Q1. A) Discuss hierarchy of chemical process design. [8]
B) Explain in detail the different considerations for the development of New Process. [8]

OR

Q2. A) Discuss in detail the onion model of process design. [8]
B) Discuss the approaches to chemical process design . [8]

Q3. A) Explain idealized reactor model for ideal batch reactor. [8]
B) Explain the effect reactor pressure on the reactor volume and selectivity. [8]

OR

Q4. A) Explain different types of reaction system. [8]
B) Discuss in detail reactor performance. [8]

Q5. A) Discuss in detail separation of heterogeneous and homogeneous mixtures. [14]
B) Discuss the term azeotropic distillation. [4]

OR

Q6. A) Explain various types of dryers with neat sketch. [10]
B) Write a short note on: [8]
1. Various parameters on the performance on absorption
2. Evaporation

Section II

Q7. A) Explain heat integration in sequencing of simple distillation column. [8]
B) Discuss thermal coupling for direct and indirect distillation sequencing. [8]

Q8. A) Explain distillation sequencing using thermal coupling. [8]
B) Discuss optimization of reducible structure. [8]

OR

Q9. A) Discuss integration of refrigeration cycles. [8]
B) Explain heat recovery problem with one hot stream and one cold stream with suitable examples. [8]

OR

Q10. A) Discuss overall heat exchanger network and utilities. [10]
B) Discuss integration of heat pump. [6]

Q11. A) Explain the intensification of hazardous materials and attenuation of hazardous materials. [12]
B) Discuss major hazards in process plants. [6]

OR

Q12. A) Write short note on: [18]
1. Fire and explosion
2. Quantities measures of inherent safety.

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# [4364]-662

## B. E. (Chemical) Examination - 2013

## ADVANCED SEPARATION PROCESSES

**(2008 Pattern)**

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

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

***Instructions :***

*(1) Answers three questions from* ***Sections 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) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*

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## SECTION I

Q1) a) Explain the basic concept of chromatography process. [6]

b) Give the application of chromatography in separation of enzymes and proteins. [6]

c) Explain adsorption mechanism in separation of fluid-solid system. [6]

**OR**

Q2) a) Give the details of chromatography column design and fidling. [6]

b) Explain in detail 'Adsorption Cycle' with neat sketches. [12]

Q3) a) Give the advantages of membrane separation process over other separation technique. [8]

b) Explain four basic types of RO module currently manufactured. [8]

**OR**

Q4) a) Calculate the osmotic pressure of a solution containing 0.10 gmol NaCl/1000 g $H_2O$ at $25^0$C. Density of water = 997.0 kg/$m^3$. [6]

b) Give the classification of the membrane process. [6]

c) Explain the following terms: [4]

i) Permeability

ii) Osmotic Pressure

Q5) a) Give the characteristics of the complexing agent used in [8]

chemical-complexation.

b) Explain the reactive distillation process in detail. [8]

**OR**

Q6) a) Give the solution characteristics of chemical complexation process. [8]

b) Explain 'Reactive crystallization' process in detail. [8]

## SECTION II

Q7) a) Give the flotation techniques classification on the basis of mechanism of separation and size of material separated. [9]

b) Explain 'Collapse and drainage phenomena'. [9]

**OR**

Q8) a) Give the design and development of flotation equipment. [9]

b) Give the application of flotation technique. [9]

Q9) a) Explain the adsorption properties and applications of molecular sieve. [8]

b) Explain Zone refining process in detail. [8]

**OR**

Q10) Write short notes on: [16]

a) Zone Electrophoresis

b) Adductive Crystallization.

Q11) Explain the classification of unit operations based on the property difference. [16]

**OR**

Q12) Write short notes on: [16]

a) Exchange Reaction

b) Ring oven technology application.

**UNIVERSITY OF PUNE**
**[4364]-663**
**B. E. (CHEMICAL) Examination 2013**
**PETROLEUM REFINING (409342)**
**(2008 Course) (SEM I) (ELECTIVE II)**

**[Total No. of Questions:12]** **[Total No. of Printed pages :2]**
**[Time : 3 Hours]** **[Max. Marks : 100]**

***Instructions :***

(1) *Answers any 3 questions from each section*
(2) *Answers to the two Sections should be written in separate answer-books*
(3) *Neat diagram must be drawn wherever necessary.*
*(4) Figures to the right indicate full marks.*
*(5) Assume suitable data, if necessary.*

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## SECTION I

Q.1a) What is the need of refining the crude oil? Describe with suitable examples? [8]

b) What is Cetane Number? Describe the tests and properties of Diesel [8]

**OR**

Q.2a) What are the key issues and challenges for refineries in India? [6]

b) What is Octane Number? Discuss the growth of petrochemical Industry in India [10]

Q.3a) What are different types of pipe still heaters? Describe Heating through exchangers and pipe still heaters with schematic diagram? [16]

**OR**

Q.4 Describe Vacuum distillation Unit with suitable Diagram and Distinguish between ADU and VDU with respect to various processing parameters? [16]

Q.5a) What is cracking operation? Differentiate between thermal cracking and Catalytic cracking? [8]

b) What is reforming process? Describe reforming process with schematic diagram [10]

**OR**

Q.6 Write short notes on [18]

a) TBP apparatus

b) Tests and properties of Kerosene

c) Thermal cracking.

## SECTION II

Q.7a) Why desulphurization is necessary? Describe hydrodesulphurization process with schematic diagram [16]

**OR**

Q.8 What are different treatment operations for petroleum fraction? With neat schematic diagram describe HAD process [16]

Q.9 a) Describe Coking operation with schematic diagram [10]

b) What is the blending operation and explain the line blending operation? [6]

**OR**

Q.10a) Write a note on packing material used for petroleum products? [8]

b) Discuss various safety aspects in the refinery [8]

Q.11 Describe various recent trends in petroleum with respect to distillation? and recent trends of worldwide refineries? [18]

**OR**

Q.12 Write short notes on: [18]

a) Discuss various strategies of marketing of petroleum and petroleum products

b) Recent advances in packing material used for petroleum products

c) Origin and composition of Petroleum

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

**UNIVERSITY OF PUNE**
**[4364]-664**
**B. E. (*CEMICAL*) Examination - 2013**
***PROCESS MODELING & SIMUATION***
**(2008 Course)(40935)**

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

**Instructions:**

1 *Answers to the two sections should be written in separate answer-books.*
2 *Black figures to the right indicate full marks.*
3 *Neat diagrams must be drawn wherever necessary.*
4 *Assume suitable data, if necessary.*
5 *Answer any three questions from Section I and any three questions from Section II*
6 *Answer three question from each section*

## SECTION -I

| | | | |
|---|---|---|---|
| Q.1 | A | Draw a flowchart showing the major steps in process modeling. Show the interrelations between the flowchart stages. Alongside each major step, list in brief, point the key issues for each major modeling task. | 8 |
| | B | Provide a classification of the major categories of equations in a Mechanistic process model. What are the subclasses in each major category? Outline how each of the classes of equations in interrelated. | 8 |

**OR**

| | | | |
|---|---|---|---|
| Q.2 | A | State the law of mass action. | 4 |
| | B | Give different uses of mathematical model. | 8 |
| | C | What are limitations of mathematical models? Give examples. | 4 |
| Q. 3 | A | The penultimate step in cappuccino making is the steaming of milk before the hot milk in poured over the espresso. Consider this process of steaming the milk. Steam is | 16 |

injected from a nozzle immersed in the container of cold milk.

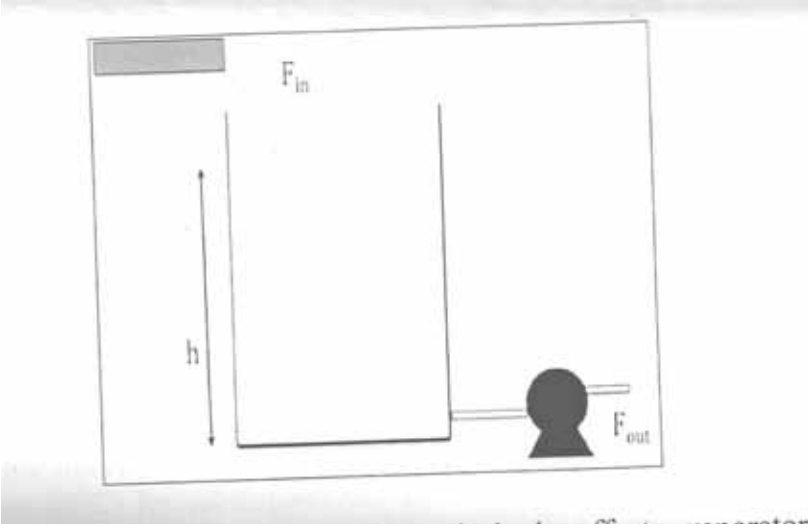
i) Comment of whether the steaming process can be considered to be a lumped of distributed parameter system. Provide reason to support your answer.

ii) Comment on whether the system can be considered as steady-state or transient with respect to each of three relevant balance equations – (a) Overall Energy Balance (b) Overall material Balance and (c) Mole Balance Provide reasons to support your answer

**OR**

Q. 4 A Consider a holding tank of uniform cross-sectional area (A) as shown in the adjoining picture. The tank is fed by continuous supply of wastewater flowing in at a constant volumetric flow rate(Fin). The liquid level in the tank is to be maintained at a desired height (level) denoted as h. A centrifugal pump connected at the outlet can control the outflow (F*out*) of the liquid from the tank. The tank is open (uncovered) at the top. For the holding tank system described above, identify as many as of the following variables as you can and provide supporting reasons for your choice. 16

- State variable
- Input variable
- Output variable
- Manipulated variable
- Disturbance variable



Q. 5 A Develop mathematical model of single effect evaporator. Use notations as usual. Write assumptions. Draw neat figure. 18

B A single effect evaporator is to be designed to concentrate a 20%(by wt.) solution of sodium hydroxide to a 50% solution. The dilute solution at 1093 $^{o}$C is to be fed to the evaporator at the rate o 18143 Kg/hr. for heating purposes; a saturated steam at 10$^{o}$ C is used. Sufficient condenser area is available to maintain a pressure of 667 Kg/M$^{2}$ in the vapor space of the evaporator. On the basis of overall heat transfer coefficients of 300 kilocalorie / hour/ square meter/ $^{o}$C. Compute

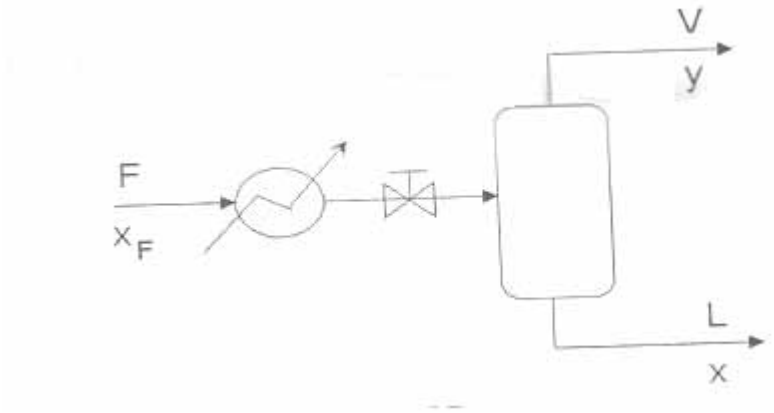
a) Heating area required.
b) Steam consumption and steam economy.

**OR**

Q. 6 A Develop a model for Shell & Tube Heat exchanger 18

**SECTION II**

Q. 7 A Develop a model for Flash distillation column. Write modeling assumptions. 18



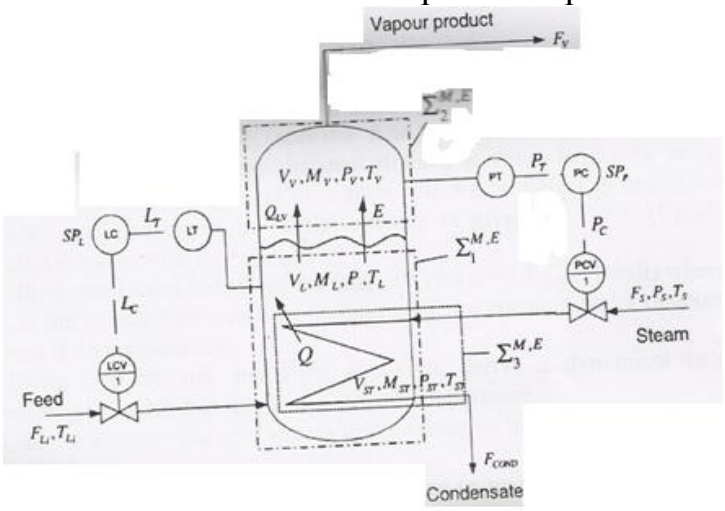

**OR**

Q. 8 A Develop a mathematical model of a single component vaporizer shown in following figure. Such equipment can be used to vaporize a liquid such as acetone (at 20$^{o}$C) for subsequent use in a vapour phase reaction. Heat is added to the liquid via a steam coil which is then used to control the pressure in the vapour space of the vaporizer. A pressure control loop for the vapour space is needed which adjusts steam flow. Steam is supplied at saturated conditions at a 18

pressure of 120 kPa(g). The liquid level is controlled by adjusting the feed rate to the vaporizer. The purpose of the model is to predict the dynamic behaviour of the system under changes to vapour flowrate and feed conditions. The key controlling mechanisms are the heat transfer from the steam to the fluid, the non-equilibrium vapour-liquid behaviour, fluid and steam flow through valve (including their characteristics), steam condensation and phase change.

Your tasks are to:

a) Restate the problem definition
b) Restate all relevant controlling factors
c) State the data you require and where you might access it.
d) State all your modeling assumptions and justify them.
e) Develop the mathematical model and clearly describe all the development steps




Q. 9 A Consider the following 3 reactions taking place in a liquid-base system: a continuously stirred tank reactor (CSTR). 16

i. $A \xrightarrow{r_1} 2B$, Where $r_1 = K_1 C_A$

ii. $A \underset{r_3}{\overset{r_2}{\rightleftharpoons}} C$, Where $r_2 = K_2 C_A^{1.5}$ and $r_3 = K_3 C_c^2$

iii. $2B \xrightarrow{r_4} 3D + C$, Where $r_4 = K_4 C_B^2$

Derive the equations that can be solved for the steady state concentrations of A,B,C and D. You may assume that species A is fed to the reactor in a single stream, flowing in at Qm3/s, with a concentration of Cin A. Please state all other assumptions that you make while answering the question.

Note : Please do not simplify your equations.

**OR**

Q. 10 A Consider a mixing tank with fluid volume V where fluids A and B with densities $\rho A$ and $\rho b$, specific heat capacities Cp. A, Cp, B and temperatures TA and TB are the inlet streams at volumetric flow rates FA and FB. The outlet stream is at a flow rate FA + FB. The specific heat capacity and density of the outlet streams is given by 16

$Cp = (Cp, {}_A F_A + C_{P,B} F_B)/F$ and $\rho = (\rho_A F_A + \rho_B F_B)/F$

The fluid also looses heat from the tank at a rate q = kT (T-Twall) where $T_{wall}$ is the constant tank wall temperature, kT is a constant and T denotes the current fluid temperature.

1. Using step by step modeling approach, derive a dynamical balance describing the time-dependent exit stream temperature.

2. Can the steady state exit stream temperature be higher that both TA and TB? Explain.

3. Calculate, the steady- state exit temperature, using that

- V = 10 m3
- $\rho$A = 1200 kg/m$^3$ and $\rho$b = 950 kg/m$^3$
- Cp, A = 2440 J/(kg. K) and Cp, B = 3950 J/(kg. K)
- TA = 320 K and TB = 350 K and Twall = 300K
- FA = FB = 0.05 m3/s
- kT = 200 W/ (m2. K) x 24 m2 = 4800 W/K

Q. 11 A Consider the modeling of a jacketed CSTR, fed with a single inlet stream. Under some fairly straightforward assumptions, one can show that the steady temperature of the fluid leaving the tank is given by: 16

$\frac{F^{in}}{V}\left[T^{in} - T\right] - \frac{UA_s}{\rho c_{pV}}\left[T - T_j\right] + \frac{2k_0(-\Delta H_r)}{\rho c_p} C_A^2 e - \frac{E_a}{RT} = 0$

After substituting in relevant values for the constant physical properties, and fixing the value of CA, the equation can be reduced to :

$2.6 - 1.45\ T + 5 \times 10^5 e - \frac{2000}{T} = 0$

Perform 2 iterations of the Newton- Raphson algorithm for finding the roots of a nonlinear equation. A reasonable starting guess for. T(0) is the same temperature as the inlet stream : i.e. T(0) = Tin =290K. Note : you do not need to derive the mass-balance equation above.

**OR**

Q. 12 A Classify and explain the methods of treatment of non linear models.

B List out the software's available for process simulation. Explain any one. 16

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

**UNIVERSITY OF PUNE**

**[4364]-665**

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

***Process Engineering Costing And Plant Design (2008 Course)***

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

***Instructions:***

1 *Answer three question 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, if necessary.*

## SECTION –I

| | | | |
|---|---|---|---|
| Q.1 | A | Explain 'Pilot plant data' is required even if 'Laboratory data' is available. | 9 |
| | B | Explain the following factors considered for plant design<br>i) Material of Construction<br>ii) Equipment design and Specification<br>iii) Safety factor | 9 |

**OR**

| | | | |
|---|---|---|---|
| Q.2 | A | Illustrate Material and Energy Balance. Develop the rate equation for batch and flow reactors. | 9 |
| | B | Explain in detail technical factors used for process selection. | 9 |
| Q. 3 | A | A batch reactor was procured at Rs. 80000 with a service life of 10 years. Its salvage value is estimated to be Rs.7000. Evaluate the Reactor value (or book) value of the equipment at the end of its service life of 5 years using.<br>i) Straight-line method.<br>ii) Textbook declining-balance method.<br>iii) Double declining-balance (200 percent) method (i.e., the declining-balance method using a fixed-percentage factor giving a depreciation tare equivalent to twice the minimum rate with the straight-line method). | 8 |

B Explain the methods for determining depreciation and compare them. 8

**OR**

Q. 4 A Explain following terminologies to the process industries.. 8
i) Taxes
ii) Insurances

B A glass reactor has been designed for the use in a chemical process. A standard type of heat exchanger with a negligible scrap value costs Rs. 4000 and will have a useful life of 6 years. Another proposed glass reactor of equivalent design capacity costs Rs. 6800 but will have a useful life of 10 years and a scrap value of Rs.800 Assuming an effective compound interest rate of 8% per year, determine which glass reactor is cheaper by comparing the capitalized costs. 8

Q. 5 A Explain with a neat sketch cumulative cash position showing effects of cash flow with time for an industrial operation neglecting time value of money. 8

B A company has three alternative investments which are being considered. Because all there investments are for the same type of unit and yields same service only one of the investments can be related. If a company In-charge expects 15% rate of return on original investment which one will be suitable? 8

| Item | Investment(I) | Investment(II) | Investment(III) |
|---|---|---|---|
| Initial Fixed Capital (Rs.) | 1,00,000 | 1,70,000 | 2,10,000 |
| Working Capital Investment (Rs.) | 10,000 | 10,000 | 15,000 |
| Annual Cash Flow (Rs.) | 30,000 | 52,000 | 59,000 |
| Annual Expenditure (Rs.) | 15,000 | 28,000 | 21,000 |

**OR**

Q. 6 A Explain in detail mathematical methods for profitability evaluation with neat diagram 8

B Explain cost indexes and explain their importance while estimating equipment costs by scaling such as six-tenth-factor rule. 8

## SECTION II

Q. 7 A The following equation shows the effect of the variables x and y on the total cost for a particular operation: 8

$$C_T = 2.33x + \frac{11900}{xy} + 1.86y + 10$$

Determine the values of x and y which will give the least total cost.

B Explain with neat sketch the break-even chart for production schedule and its significance for optimum analysis. 8

**OR**

Q. 8 A A plant produces refrigerators at the rate of P units per day. The variable costs per refrigerator have been found to be Rs. (47.73+0.1 P1.2).the total daily fixed charges are Rs. 1750 and all other expenses are constant at Rs. 7325 per day. The profit is selling price per refrigerator minus total cost per refrigerator. Total cost per refrigerator is given as 8

$$C_T = 47.73 + 0.1P^{0.2} + \frac{1750+7325}{P}$$

If the selling price per refrigerator is Rs. 173

Determine :

i) The daily profit at a production schedule giving the minimum cost per refrigerator.

ii) The daily profit at a production schedule giving the maximum daily profit.

iii) The production schedule at the break-even point.

B Write a general procedure for one and more variables to determine the optimum conditions. 8

Q. 9 A Write an explanatory note on pinch technology. 8

B Discuss the points in brief while preparation of techno-economic feasibility report. 8

**OR**

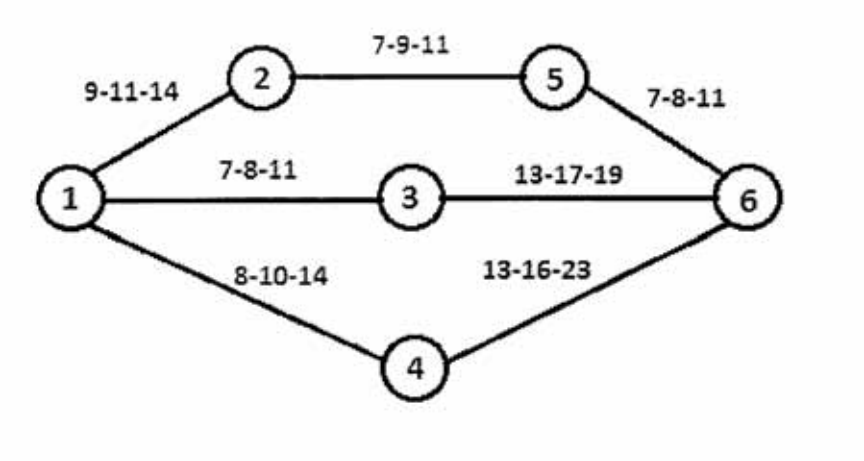
Q. 10 A Derive the following equation for the optimum outside diameter of insulation in a wire for maximum heat loss. 8

$$D_{Opt} = \frac{2K_m}{(h_c+h_{r)_c}}$$

Where $K_m$ is the mean thermal conductivity of the insulation and $(h_c + h_r)_c$ is the combined and constant surface heat transfer coefficient. The values of km and $(h_c + h_r)_c$ can be considered as constants independent of temperature level and insulation thickness.

B Find the values of x, y and z that minimize the functions $x+2y^2+z^2$ subject to the constraint that x+ y+ z=1, making use of the Larangian multiplier. 8

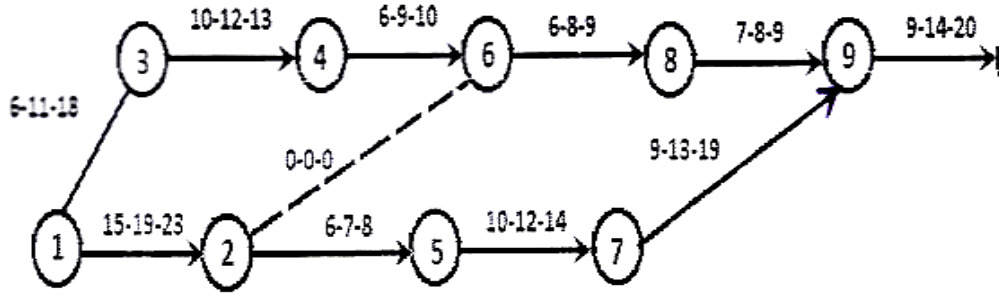
Q. 11 A Following network diagram shows the three time estimates for various activities and find the path considering:
i) Optimistic time (a)
ii) Pessimistic time (b)
iii) Critical path using PERT. 12




B Explain the various factors considered while deciding the plant location. 6

**OR**

Q. 12 A Determine the expected time and variance for each activity in the network shown below. 9




B Draw and explain the layout and name the parts. 9

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

**UNIVERSITY OF PUNE**
**[4364]-667**
**B. E. (Chemical) Examination - 2013**
**Energy Conservation In Chemical Process Industries (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. *Answers to the two sections should be written in separate answer-books.*
3. *Neat diagrams must be drawn wherever necessary.*
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 | Explain the scope of energy conservation and its importance in process industries. | 8 |
| | B | State second law of thermodynamics. | 2 |
| | C | Explain the benefits of energy efficiency towards industry, nation & globe. | 8 |
| | | OR | |
| Q.2 | A | Define Energy Management & State its objectives, Explain the principles of energy management | 8 |
| | B | Explain the responsibilities and duties of energy manager to be assigned under the energy conservation act 2001 | 10 |
| Q. 3 | A | Discuss the selection of steam traps and its effect on energy consumption. | 8 |
| | B | Cogeneration- A boon to sugar industry. Explain it importance. | 8 |
| | | OR | |
| Q. 4 | A | State the importance of heat and material balance. State its guidelines. | 8 |
| | B | Define energy audit as per the energy conservation Act 2001. Explain detailed energy audit methodology. | 8 |
| Q. 5 | A | A substance of mass 25 kg @$25^0$c is heated to $75^0$C. if the specific heat of the substance is 0.25Kcal/Kg$^0$C. Calculate the quantity of heat added in the substance. | 3 |
| | B | Explain the procedure of thermodynamic analysis for a exchanger. | 5 |
| | C | Explain improvements needed to reduce the available energy losses for | 8 |

fractionation process.

OR

| | | | |
|---|---|---|---|
| Q. 6 | A | How and where the energy losses can be minimized in a Mixing Vessel? | 8 |
| | B | Enlist the ideas for improvement of a Boiler efficiency? | 8 |

## SECTION II

| | | | |
|---|---|---|---|
| Q. 7 | A | State briefly the methods of process synthesis. Explain importance of Heat Exchange Network (HEN) in a process industry. | 8 |
| | B | Enlist the checklist for the potential energy conservation opportunities in Boilers and Heat Exchangers. | 8 |

OR

| | | | |
|---|---|---|---|
| Q. 8 | A | Enlist the checklist for energy conservation in lighting system. | 8 |
| | B | Explain the advantages of Pinch Technology in a Chemical Process Industries. | 8 |
| Q. 9 | A | What is energy conservation? State its importance and classification. | 6 |
| | B | Explain energy audit and energy monitoring | 6 |
| | C | Write short note on importance of good housekeeping. | 4 |

OR

| | | | |
|---|---|---|---|
| Q. 10 | A | Explain the model role of equipment manufacturer in the development and future prospects for a process industries. | 8 |
| | B | State the guidelines of energy conservation measures in a distillation units. | 8 |
| Q. 11 | A | Write short notes on<br>1) Process Design for Energy Conservation<br>2) Energy Savings in good house keeping<br>3) List any three energy loss components in chemical plant. | 12 |
| | B | What are the important precautions to be addressed while designing a Dairy Industry | 6 |

OR

| | | | |
|---|---|---|---|
| Q. 12 | A | What are the important technical feasibility parameters that a energy engineer should consider during the analysis of energy conservation opportunities in a process designated industries. | 8 |
| | B | Write any ten key steps in monitoring and targeting that you will undertake as an Energy Manager in your plant considering appropriate process design calculations. | 10 |

**[Total No. of Questions: 12]** **[Total No. of Printed Pages2]**

**UNIVERSITY OF PUNE**
**[4364]-671**
**B. E. (Chemical Engineering) Examination - 2013**
**NANOTECHNOLOGY (Elective - IV) (2008 Course)**
**[Time: 3 Hours]** **[Max. Marks: 100]**

**Instructions:**

1 *Answer three question 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 *Black figures to the right indicate full marks.*
5 *Assume suitable data, if necessary.*
6 *Use of electronic pocket calculator is allowed.*

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**SECTION -I**

| | | | |
|---|---|---|---|
| Q.1 | A | Explain the different routes used for chemical modification of carbon nanotubes? | 10 |
| | B | Write down the synthesis procedure for fullerenes? | 8 |
| | | OR | |
| Q.2 | A | Explain different purification methods used for carbon nanotubes? | 10 |
| | B | Discuss in brief about the various carbon nanostructures and their properties? | 8 |
| Q. 3 | A | Explain the difference between ALD and CVD? | 8 |
| | B | Explain with neat sketch Molecular beam epitaxy for synthesis of nanoparticles? | 8 |
| | | OR | |
| Q. 4 | A | What is reactive sputtering? RF sputtering is insulating targets- Explain? | 8 |
| | B | "Bottom-up technique is more convenient for nano fabrication"- Explain. | 8 |
| Q. 5 | A | Explain scanning tunneling microscope (STM) in brief? | 8 |
| | B | Explain principle and operation of Fourier Transform Infrared microscope (FTIR)? | 8 |
| | | OR | |
| Q. 6 | A | With neat sketch explain principle and operation of scanning | 8 |

| | | | |
|---|---|---|---|
| | | electron microscope (SEM)? | |
| | B | Discuss the different characterization techniques based on electron microscopy? | 8 |

**SECTION II**

| | | | |
|---|---|---|---|
| Q. 7 | A | What is doping? Explain types of dopant used in extrinsic semiconductor? | 8 |
| | B | Derive Schrodinger's equation? Also explain any two applications of Schrodinger's equation? | 10 |
| | | OR | |
| Q. 8 | A | What are various bands in semiconductors? Also explain concept of band gap? | 8 |
| | B | What is quantum dot, quantum well and wire? Explain in detail? | 10 |
| Q. 9 | A | Explain experimental procedure for finding out contact angle. Explain with neat sketch? | 8 |
| | B | Explain the concept f colloid stability various parameters affecting on it? | 8 |
| | | OR | |
| Q. 10 | A | Discuss in detail about Self-assembly and Catalysis? | 8 |
| | B | Explain various methods available for measuring surface tension? | 8 |
| Q. 11 | A | Discuss different nanocoatings? Explain its applications and benefits? | 8 |
| | B | How nanotechnology can be used for environmental pollution abetment? | 8 |
| | | OR | |
| Q. 12 | A | Write short notes on: | 16 |

1) Applications of nanoparticles in waste water treatment
2) Biological applications of nanoparticles
3) Nanoparticles & nanodevices
4) Self cleaning nanomaterials

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

**UNIVERSITY OF PUNE**
**[4364]-672**
**B. E. (Chemical Engineering) Examination – 2013**
**FUEL CELL TECHNOLOGY (2008 Course)**
**(Elective - IV) (409350) (Theory)**

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

***Instructions:***

1 *Answers to the* ***two sections*** *should be written in* ***separate answer-books****.*
2 *Black figures to the right indicate full marks.*
3 *Draw schematics wherever necessary.*
4 *Write the chemical reactions wherever necessary..*
5 *Assume suitable data, if necessary.*

**SECTION –I**

Q.1 A Explain the salient features of the storage of hydrogen as fuel for fuel cell. 8

B Explain the feasibility of application of fuel cell vehicles vis-à-vis battery operated vehicles in transportation. 8

**OR**

Q.2 A Explain the thermodynamics steps involved in fuel cells. 8

B Discuss the operating temperature of different types of fuel cell and the limitations arising out of that 8

Q. 3 Gibbs free energy for the formation of water is-59.69 cal/mole at STP conditions. In the typical SOFC. The partial pressures of hydrogen, oxygen and water vapor are 0.8 , 0.21 and 0.3 atm. Assume that activities of the components are proportional to their partial pressures. The cell is operated at 885 $^{0}$ C. Calculate: 18

i) Standard open circuit potential.
ii) Open circuit potential at the operating conditions.
Faraday's constant is 96487 J/V.mol.

**OR**

Q. 4 Develop the comprehensive material balance for the SOFC generating 500 kW power at 85% CHP efficiency and 60 % electrical efficiency, by using externally reformed methane as a fuel and theoretical excess air as an oxidizer. 18

Q. 5 A A current density of 15 A/m $^{2}$ is obtained when pure hydrogen in fed to SOFC at the pressure of 1.7 atm. Total pressure of gases on anodic side is observed to be 2.4 atm. Air is supplied at 1459 mm of Hg. The cell is operated at 1767 degree Fahrenheit. The diffusion factors for hydrogen ,oxygen and water vapour are 95,70 and 55 C/s.m$^{2}$.atm respectively. 8

Calculate concentration overpotential across cathode and anode.

B Calculate fuel utilization factor, air ratio, power output and fuel efficiency of SOFC using following data: 8

Average current density: 18 A /$m^2$
Active anode surface area: 0.5 $m^2$
Fuel Flow rate : 29 mol/h
Fuel Composition: $H_2$ – 85 % and CO -15 %
Air flow rate: 25 mol/h
Output Potential : 230 V
Lower Heating Value of fuel:30000 kcal/Kg

**OR**

Q. 6 Derive Nernst equation for calculating open circuit potential of SOFC using air as an oxidizer for the following conditions: 16
(a)Pure methanol as a fuel and
(b)Ethanol and $H_2$ in the proportion of 15.85% each as a fuel.

## SECTION II

Q. 7 A Explain the Kroger-Vink defect structure in solids. 8

B Explain the effect of limiting reforming factor on the performance of SOFC. 8

**OR**

Q. 8 A Derive the Butler- Volmer form of equation for the charge transfer rates. 8

B Explain the mechanism by which oxygen vacancies are generated in the crystal structure. 8

Q. 9 A Derive the correlation to calculate defect mole fraction for pure solids at thermal equilibrium. 9

B Calculate mole fraction of defect at 150 and 950 $^0$ C. Defect energy is 66 KJ/mol. Comment on the significance of results. 9

**OR**

Q. 10 A Analyze the criterion for the selection of hydrocarbon as fuel for SOFC. 4

B Explain the role of different components of SOFC. 4

C Explain the working principle of Breathalyzer using Fuel cell. 10

Q. 11 A Design a planner SOFC stack to generate 450 kW power for ethanol as a fuel. 8

B Design a tabular SOFC stack to generate 750 kW power for methane as a fuel. Single tube has anodic diameter of 188 mm and active length of 1.5 m 8

**OR**

Q. 12 Develop a mathematical model for SOFC system using methane as fuel. The system is divided in three subsystems: 16
(a)Fuel Processing
(b)Fuel Cell and
(C)Post combustion

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

**UNIVERSITY OF PUNE**
**[4364]-673**
**B. E. (Chemical) Examination - 2013**
**PETROCHEMICAL ENGINEERING (Sem II)**
**(Elective IV)(2008 Course)**

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

**Instructions:**

1 *Answer three question from each section*
2 *Answer any three questions from Section I and any three questions from Section II*
3 *Answers to the two sections should be written in separate answer-books.*
4 *Neat diagrams must be drawn wherever necessary.*
5 *Black figures to the right indicate full marks.*

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## SECTION -I

| | | | |
|---|---|---|---|
| Q.1 | A | Describe the methods of preparation of feedstock's for petrochemical production and discuss the various petrochemical Feedstock challenges with suitable examples. | 8 |
| | B | What are the main basic building blocks of petrochemical industry explain with suitable examples? Give the details of petrochemical products that are produced from benzene? | 8 |
| | | OR | |
| Q.2 | A | What are basic principle sources of aromatics? Describe the BTX aromatic separation by suitable diagram. | 16 |
| Q. 3 | A | Describe CDU with suitable diagram? Distinguish between CDU and VDU | 16 |
| | | OR | |
| Q. 4 | A | Enumerate the synthetic chemical intermediates and products from olefins and describe the production of ethylene by naphtha cracking process | 10 |
| | B | Write a note on furnaces used in petrochemical plants? | 6 |
| Q. 5 | A | Describe with schematic diagram Aromatic solvent | 8 |

| | | | |
|---|---|---|---|
| | | extraction unit | |
| | B | Write in details about the various separation and purification techniques used in petrochemical industry? | 10 |
| | | OR | |
| Q. 6 | A | Write a note on following<br>a) Fluid Catalytic Cracking units<br>b) Growth of petrochemical Industry in India<br>c) Delayed coking | 18 |
| | | **SECTION II** | |
| Q. 7 | A | Along with schematic diagram and major engineering problems describe the production of terephthalic acid from p-xylene? | 16 |
| | | OR | |
| Q. 8 | A | With neat schematic diagram describe about the production of maleic anhydride from benzene? And also discuss the major engineering problems? | 16 |
| Q. 9 | A | What is addition polymerization . Describe the steps and mechanisms of addition polymerization | 10 |
| | B | Explain classification of different polymerization process along with its advantages and disadvantage. | 6 |
| | | OR | |
| Q. 10 | A | With neat sketches explain in detail about production of PVC along with its engineering problems | 10 |
| | B | What are various polymeric products? Differentiate between different polymerization processes. | 6 |
| Q. 11 | A | **“Power on, India on”.** Write views on power generation through petrochemical plants. | 8 |
| | B | Discuss about recent advances in petrochemical plants & refineries in India | 10 |
| | | OR | |
| Q. 12 | A | Write a note on following :<br>a) Safety consideration in petrochemical plants<br>b) Major petrochemical plants in India as well as in world<br>c) Hydrocarbon and its classification | 18 |

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

**UNIVERSITY OF PUNE**
**[4364]-215/674**
**B. E. (Chemical) Semester II (Elective 2)Examination - 2013**
**COMPUTER – AIDED PROCESS CONTROL(409348) (2003 & 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.*

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## SECTION –I

Q.1 A Explain role of digital computer in process control 6

B Distinguish between control system used for batch and continuous processes 6

C Distinguish between DDC & DCS control systems. 6

OR

Q.2 A Explain the following architectures for computer-aided process control systems- 9

i) Centralized (supervisory)
ii) Distributed
iii) Heirarchial

B Explain the functions and essential features of HMI (or MMI) used in computer-aided process control systems 9

Q. 3 A A MIMO system is represented by state-space model in the form 8

$x(t) = Ax(t) + BU(t) + TD(t)$ $y(t) = C\,x\,(t)$

derive transfer function model of this system in the form-

$Y(s) = G(s)\,\bar{U}\,(s) + G_d(s)\,\bar{D}\,(s)$

Where the symbols have their usual meaning. How will you determine poles and zeros of transfer function G(s)

B A 2x2 process having inputs $m_1$, $m_2$ and output $Y_1$, $Y_2$ is controlled using two controllers having transfer functions $Gc_1$ and $Gc_2$ installed between ($m_1$-$y_1$) & ($m_2$-$y_2$) respectively. Sketch the closed-loop block diagram. Also derive the closed-loop servo response transfer function in the form- 8

$\bar{Y}(s) = (1+ GpGc)^{-1}\,GpGc\,\bar{Y}_{SP}(s)$ Where Y(t) & $Y_{SP}(t)$ are output and set-point vector Gp, Gc are process and controller transfer function matrices

OR

Q. 4 A If a 2x2 process has open-loop steady-state gain model 8

$Y_1 = K_{11}M_1 + K_{12}M_2$ $Y_2 = K_{21}M_1 + K_{22}M_2$

Define and derive the expression for R.G.A. of the system.

B State the properties of RGA of a MIMO system. How will you determine the best pairing of input-output variables for control purpose using RGA. 4

C Calculate the RGA for wood and Berry distillation column having steady-state gain matrix 4

$$K = \begin{array}{c} \\ Y_1 \\ Y_2 \end{array} \begin{array}{c} \begin{array}{cc} M_1 & M_2 \end{array} \\ \begin{pmatrix} 12.8 & -18.9 \\ 6.6 & -19.4 \end{pmatrix} \end{array}$$

Comment on pairing of input-output variables which will result in control loops with minimum interaction

Q. 5 A Draw and explain block diagram for computer-aided process control systems 8

B Find inverse Z-transform of the following function using long division method 8

$$\bar{Y}(z) = \frac{z^{-1}}{1+z^{-1}+z^{-2}+z^{-3}}$$

Also find corresponding sequence of sampled values y(t) at sampling interval of 1 min.

OR

Q. 6 A State BIBO criteria for stability of discrete-time system, If a system has discrete-time transfer function 8

$$D(z) = \frac{a_0+a_1z^{-1}+a_2z^{-2}+----+amz^{-m}}{1+b_1z^{-1}+b_2z^{-2}+----+bnz^{-n}}$$

Then derive the graphical condition for stability (in Z-plane ) of the system.

B Derive pulse transfer functions :- $G_p(s) = \frac{10}{(0.15+1)(25+1)}$ , 8

$H(s) = \frac{1-e^{-Ts}}{s}$ If a PI controller having Kc = 0.1, $T_I$ = 1 min, T = 1min is used derive the characteristic equation of the system. Comment on stability of this closed-loop system.

## SECTION II

Q. 7 A Explain the working of ADC & DAC used as process-related interfaces 8

B Explain communication hierarchy in computer-control system. 8

OR

Q. 8 A Explain the following data transfer techniques-pilling, interrupt. 8

B Explain ISO reference model for communication between computer network systems 8

Q. 9 A Explain the following basic components of DCS- 16

a) Operator's console

b) VDU
c) Keyboards & displays

OR

Q. 10 A Draw block diagram of PLC-architecture and describe function of each block 16

Q. 11 A Write short notes on the following 18
a) PLC programming using ladder diagram
b) Plantwide control systems
c) Distillation column control

OR

Q. 12 A Write short notes on the following 18
a) Decouplers used in MIMO control system
b) Temporal hierarchy of control structure in PWC
c) Process control computer software systems.

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

**UNIVERSITY OF PUNE**
**[4364]-675**
**B. E. (Chemical) Examination - 2013**
**Catalysis (2008 Course)**

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

***Instructions:***

1 *Answer 3 question from section-I and 3 question 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 *Neat diagrams must be drawn wherever necessary.*
5 *Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*

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**SECTION -I**

Q.1 A Explain the mechanism of homogenious catalysis. 8
B Explain the types of the catalysis. 8

**OR**

Q.2 A Explain the qualitative nature and concept of catalysis and catalyst. 10
B Explain the application of catalysis in organic industrial processes. 6

Q. 3 A Give the general characteristics of catalysis. 6
B For the reaction, A→4R, (gaseous reaction) run at 3.2 atm and $117°C$.The rate at this temperature is measure as $-VA^1 = 96\ C_A$, Mol/kg cat.hr. Determine the amount of catalyst needed in a packed bed reactor with a very large recycle rate for 35% conversion of A to R for a feed rate of 2000 mol/hr of pure A. 10

**OR**

Q. 4 A small experimental packed bed reactor (w= 1 kg) using very large recycle of product stream gives the following kinetic data: 16

| A→R | $C_A$, mol/m$^3$ - | 1 | 2 | 3 | 6 | 9 |
|---|---|---|---|---|---|---|
| $CAo = 10mol/m^3$ | $\vartheta_o, lit/hr$ - | 5 | 20 | 65 | 133 | 540 |

Find the amount of catalyst needed for 75% conversion for a flow rate of 1000 mol A/hr of a $C_{AO}$=8 mol/m$^3$ feed stream:

i. In a packed led reactor with no recycle of exit fluid
ii. In a packed led reactor with very high recycle.

Q. 5 A Give the difference between physical adsorption and chemical adsorption 9
B Explain in detail the 'Langmuir adsorption isotherm' 9

**OR**

Q. 6 The catalytic reaction A→4R, is studied in a plug flow reactor using various amounts of catalyst and 20 lit/hr of Afeed at 3.2 atm and 117 degrees C.the concentration of A in the effluent stream is recorded for the various runs as follows: 18

| Run | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Catalyst used, kg | 0.02 | 0.04 | 0.08 | 0.16 |
| Count, mol/hr | 0.074 | 0.04 | 0.044 | 0.029 |

Find the rate equation for this reacting using the differential method of analysis

## SECTION II

Q. 7 A Explain the major steps involved in the preparation of the catalyst. 8

B Explain the helium- mercury method for determining the void volume and so did density of the catalyst. 8

**OR**

Q. 8 A Explain BET method for determination of surface area of the catalyst. 8

B Explain nitrogen – desorption method for pure volume distribution of the catalyst. 8

Q. 9 A Write short notes on the following 16

i. Application of zeolites
ii. ZSM-5

**OR**

Q. 10 A Write short notes on the following 16

i. Industrial application of molecular sieves
ii. Fluid catalyst cracking

Q. 11 A Explain the methods for evaluating the constants (k and $C_m$) of the m-m equation. 9

B Give the kinetics of competitive Inhibition. 9

**OR**

Q. 12 Substrate A and enzyme E flows through a mixed how reactor of volume (v) 6 lit. Find a rate equation to represent the action of enzyme on the substrate using the following data. 18

| | | | |
|---|---|---|---|
| $C_{EO}$, mol/lit- | 0.02 | 0.01 | 0.001 |
| $C_{AO,}$ mol/lit- | 0.2 | 0.3 | 0.69 |
| $C_A$, mol/lit - | 0.04 | 0.15 | 0.6 |
| X , l/h - | 3 | 4 | 1.2 |