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

P1213

[3564]-275
B.E. (Chemical)
ENVIRONMENTAL ENGINEERING
(Elective - I) (Revised 2003 Course)

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

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate books.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Write expressions for the following: **[4]**

i) Relationship between ppm and volume concentration & pollutant.

ii) Mass - Volume concentration.

b) The mean concentration of sulphur dioxide in Mumbai is 47 $\mu g/m^3$. What is the equivalent concentration in ppm at 25°C and 1 atm? **[3]**

c) State three adverse effects of population growth on the environment. **[3]**

d) A cylindrical ESP of diameter 0.3 m is used for separating pulverized coal flyash from a furnace gas stream. If the volumetric flow rate of the gas is 0.05 m^3/s, what will be the length of the precipitator for obtaining a collection efficiency of 99.90% what % change in electrode collection area is required to increase the collection efficiency from 99.90 to 99.95%? **[8]**

OR

Q2) a) Classify air pollutants according to source type. **[3]**

b) Give the source and harmful effects on the human health on the particulate pollution created by lead, nickel and mercury. **[3]**

c) Compare the conventional and high efficiency cyclones in terms of efficiency and dimensions. **[4]**

d) A multitray settling chamber having 8 trays, including the bottom surface handles 6 m^3/s of air at 20°C. The trays are spaced 0.25 m apart and the chamber is to be wide and 4 m long. What is the minimum particle size of density 2000 kg/m^3 that can be collected with 100% efficiency? What will be the efficiency of the settling chamber if 50 μm particles are to be removed? Laminar flow condition within the chamber and presence of no dust initially on trays may be assumed.

$V_t = 30{,}000\ \rho_p d_p^2$, μ_g at 20°C = 1.81×10^{-5} kg/m.s. **[8]**

P.T.O.

Q3) a) Draw a neat sketch of settling chamber and explain. **[4]**

b) With sketch explain the working principle and equation of efficiency for electrostatic precipitator. **[4]**

c) Explain kyoto protocol. **[4]**

d) A conventional cyclone with diameter 1.0 m handles 3.0 m^3/s of standard air carrying particles with a density of 2000 kg/m^3. For $N_e = 6$, determine the cut size. Inlet width = 0.25 m and Inlet diameter = 0.5 m. **[4]**

OR

Q4) a) Draw a neat sketch of fabric filter and explain. **[4]**

b) Explain the spray towers and centrifugal towers with neat diagrams. **[6]**

c) Explain Isokinetic sampling. **[3]**

d) Explain Venturi scrubber with neat sketch. **[3]**

Q5) Write short notes on any four of the following: **[16]**

a) Ozone depletion.

b) Chemical pollution.

c) Water and air pollution laws.

d) Effect of carbon monoxide on humans.

e) Control of air pollution in automobiles.

OR

Q6) Write short notes on any four of the following: **[16]**

a) Selection of particulate collector.

b) Green house effect.

c) Pollution control in industrial combustion operation.

d) Toxic effects of gaseous pollutants.

e) Adsorption method for removal of gaseous pollutants.

SECTION - II

Q7) a) Calculate the reaction constant K and ultimate first stage BOD (L_u) using least square method when the BOD results are obtained on a sample of untreated waste water at 20°C.

t, days	2	4	6	8	10
BOD, mg/lit	11	18	22	24	26

Also plot the BOD curve. **[12]**

b) Discuss how the least square method can be used to calculate the BOD constants for the waste water. **[6]**

OR

Q8) a) Define and explain the significance of the following parameters in activated sludge process **[12]**

i) Volumetric loading rate (VL).

ii) Food to Mass ratio (F/M).

iii) Hydraulic retention time.

iv) Mean cell residence time.

v) Recycle ratio.

vi) Mixed liquor suspended solids (MLSS).

b) Discuss how process control is carried out in activated sludge process. **[4]**

c) What are the nine categories of water pollutants. **[2]**

Q9) a) Explain oxygen sag curve. **[4]**

b) A large stream has a reaeration (base e) $K_2 = 0.45\ day^{-1}$ and the rate of deoxygenation $K_1 = 0.25\ day^{-1}$. The dissolved oxygen deficit (DO) of the mixture of water stream and the wastewater at the point of discharge is 5 mg/lit and the ultimate BOD of waste (L_u) is 65 mg/lit. Calculate the critical time (t_c) and the critical deficit (D_c) **[6]**

c) Explain primary, secondary and tertiary treatment of wastewater. **[6]**

OR

Q10) a) Explain trickling filter with neat diagram. **[4]**

b) A completely mixed activated sludge process is to be used to treat a wastewater flow of 1000 m³/hr having a BOD of 250 mg/lit. Design criteria as follows.

$Y = 0.4$, $K = 0.8\ day^{-1}$, $K_d = 0.1\ day^{-1}$, $K_s = 75$ mg/lit, $\theta_c = 5$ days and $X = 2000$ mg/lit MLSS

Calculate the substrate exit concentration and the volume of aeration tank. **[6]**

c) Explain sedimentation & floatation. **[2]**

d) Explain acid rain. **[2]**

e) Define COD & BOD. **[2]**

Q11) Write short note on any four: **[16]**

a) Disinfection by Chlorine, Ozone & UV.

b) Aerobic and anaerobic lagoons.

c) Incineration process in solid waste management.

d) Water pollution by pesticides & detergents.

e) Adsorption process for waste water treatment.

OR

Q12) Write short note on any four: **[16]**

a) Compasting of disposal of solid waste.

b) Water pollution by population growth.

c) Membrane separation.

d) Ion exchange process in the tertiary treatment of wastewater.

e) Water quality standards.

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

P1212

[3564]-274
B.E. (Chemical)
PROCESS EQUIPMENT DESIGN - II
(2003 Course)

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

Instructions to the candidates:

1) ***Answer three questions from Section I and three questions from Section II.***
2) ***Answers to the two sections should be written in separate 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

Q1) a) Toluene is continuously nitrated to mononitro-toluene in a cast iron vessel, 1m diameter, fitted with a propeller agitator 0.3m dia, rotating at 2.5 Hz. The temperature is maintained at 310 K by circulating 0.5 kg/sec cooling water through a stainless steel coil 25mm OD and 22mm ID, in form of a helix, 0.8m in diameter. The reacting material properties are given below. If the mean water temperature is 290 K, what is the overall heat transfer coefficient for desired heat transfer?

Properties – Water

K = 0.59 W/m.K, C_P = 4180 J/kg.K, μ = 1.08 mNs/m², ρ = 998 kg/m³.

Reactant – K = 0.40 W/m.K, C_P = 1880 J/kg.K, μ = 6.5 mNs/m², ρ = 1666 kg/m³, $\mu_s = 8.6 \times 10^{-3}$ N.s/m².

Thermal conductivity of stainless steel = 15.9 W/m.K. **[12]**

b) Explain vortex and swirling and methods to avoid it. **[6]**

OR

Q2) a) Find power required for mixing of 5000 lit of liquid with sp. gravity 0.90 and viscosity 100 C_P in an agitated tank. Pitched blade turbine impeller running at 90 rpm is used. Tank dia. is 1m and the ratio of agitator dia. to tank dia. is 0.40. Use following power no. Reynolds no. relationship. **[6]**

NRe	NPr	NRe	NPr
1000	1.1	3000	1.3
2000	1.2	4000	1.4

b) Calculate the diameter of the shaft used in agitation system. Torque acting over the shaft is 1,20,000 kg.cm while bending moment acting over the shaft is 35,500 kg.cm. Factor of safety = 6. Ultimate tensile strength of material of shaft = 7000 kg/cm². Ultimate shear stress is 75% of UTS. **[8]**

P.T.O.

c) Write a short note on Anchor agitator. **[4]**

Q3) a) A double drum dryer is to be designed for drying a paste with a capacity of 110 kg/hr. The dryer is heated with indirect steam available at atm. pressure (100°C). The following data is available.
Temp. of paste = 20°C.
Initial moisture content of paste = 70% (wet basis).
Final moisture content of paste = 10% (wet basis).
Heat transfer from condensing steam = 8500 W/m².K.
Heat capacity of paste material = 3400 J/kg.K
Thermal conductivity = 0.8 W/m.K.
Thickness of layer of material = 1mm.
Thickness of drum wall = 10 mm.
Thermal conductivity of iron drum = 45 W/m.K.
Air is blown over surface of material at a velocity of 1.6 m/s. Temp. of air = 42°C.
Relative humidity of air = 40%.
Latent heat of vaporization of water = 2240 kJ/kg.
Max. temp. of outer surface of material being dried = 50°C.
Vapour pressure of water at 80°C = 350 mmHg.
P.P. of water in air at 42°C = 22 mmHg.
Rate of flow of moisture being evaporated can be estimated by eq^{n} – $G = 1.14 \times 10^{-5} u^{0.8} (\triangle P)$
u = velocity of air flow over surface m/s. **[12]**

b) Write a note on rate of drying. **[4]**

OR

Q4) a) A 100 kg batch of granular solids containing 30% moisture is to be dried in a tray dryer to 15.5% of moisture by passing a current of air at 350 K tangentially across its surface at a velocity of 1.8 m/s. If the constant rate of drying under these conditions is 0.0007 kg/sm² and the critical moisture content is 15%. Calculate the approximate drying time. Assume the drying surface to be 0.03 m²/kg dry mass. **[10]**

b) Explain solvent drying. **[6]**

Q5) a) Feed containing 50 mole% A and 50 mole% B is to be distilled in a fractionating column to get top product containing 99 mole% and bottom product containing 10 mole% A. The relative volatility of the binary mixture is 2.5. The reflux ratio 2kg mole per kg mole of product is used. The feed enters at its bubble point. Estimate the no. of plates required in rectifying section, stripping section and the total no. of plates. **[10]**

b) Explain the different terms used in design of sieve plate column. **[6]**

OR

Q6) Acetone is to be recovered from aqueous waste stream by continuous distillation in a sieve plate column. Find out various plate areas and check whether the weeping will occur in this column, by using the following data.
Maximum feed rate = 10,000 kg/hr,
Minimum feed rate = 70% of maximum
Molar feed rate = 672.9 kmol/hr
Vapor rate at top = 55.5 kmol/hr
Vapor rate at bottom = 162.3 kmol/hr
Liquid rate at bottom = 811.6 kmol/hr
Slope of bottom operating line = 5
Slope of top operating line = 0.57
Bottom composition = essentially water
At bottom - ρ_V = 0.72 kg/m³, ρ_L = 954 kg/m³, $K_1 = 7.5 \times 10^{-2}$, liquid surface tension = 87×10^{-3} N/m.
At top - ρ_V = 2.05 kg/m³, ρ_L = 753 kg/m³, $K_1 = 9 \times 10^{-2}$, liquid surface tension = 23×10^{-3} N/m.
Take tray spacing as 0.5m, K_2 = 30.6. All notations are usual. **[16]**

SECTION - II

Q7) a) Sulphur dioxide produced by combustion of sulphur in air is absorbed in water. Pure SO_2 is then recovered from the solution by steam stripping. The feed is 5000 kg/h of gas containing 8% w/w SO_2. A 95% recovery of SO_2 is required. The gas is cooled to 20°C. Physical properties of gas can be taken as those for air.
No. of overall gas transfer units = 8
Liquid flow rate = 29.5 kg/s
Find the diameter of column for a pressure drop of 20 mm H_2O/m packing height.
Data - Type of packing = Intalox saddle,
Material = Ceramic, Size = 38 mm, $F_P = 170 m^{-1}$, Gas density = 1.21kg/m³, Liquid density = 1000 kg/m³, Liquid viscosity = 10^{-3} N.s/m². **[10]**

b) Give the advantages and disadvantages of plate column and packed column. **[8]**

OR

Q8) a) A feed containing 45% more volatile component enters a packed bed. The distillate from the packed bed contains 95% more volatile component and bottom product contains 10% more volatile component. Relative volatility of the mixture is 3.0. A Total condenser is used and the tower is operated with a reflux ratio of 1.25 times the minimum reflux ratio. The HTU values for rectifying section are H_y = 0.5, H_x = 1.0. Mass transfer coefficient is constant across the column. Determine the flow rates, steam consumption and packing height required to achieve the separation. **[10]**

b) Explain the estimation of packed bed height for an absorption column with all the relevant equations. **[8]**

Q9) a) Make a preliminary design for a separator to separate a mixture of steam and water. Steam flow rate is 2000 kg/h and water flow rate is 1000 kg/h. Operating pressure is 4 bar.
Liquid density = 927 kg/m³,
Vapour density = 2.2 kg/m³.
Design the separator without a demister pad. **[10]**

b) Comment on need of auxiliary process vessels. **[6]**

OR

Q10) a) In the manufacture of 2-ethyl hexanol by low pressure OXO process n-butyldehyde is reacted with 2% by weight of sodium hydroxide solution. Approximately 90% of butyldehyde is converted to 2-ethyl hexanol. The mixture of organic phase and aqueous phase is separated in a decanter. In the manufacture of 60 Tons/day of 2-ethyl hexanol the following conditions are involved. Organic phase flow rate = 2883.5 kg/hr, ρ = 830 kg/m³, μ = 6.5 mNs/m².
Aqueous phase = flow rate = 425.4 kg/hr.
Density = 1050 kg/m³, $\mu = 1.1 \times 10^{-3}$ N.s/m²
Design the decanter with various locations of stream take offs. **[10]**

b) Write a short note on Knockout drum. **[6]**

Q11) a) Explain the pipeline design for transportation of crude oil. **[8]**

b) Water is flowing through a pipeline at a rate of 1.3 kg/sec. The ID of pipeline is 27 mm and length of pipeline is 2150 m. Estimate the pressure drop in the pipeline.
Density of water = 1000 kg/m³, viscosity = 0.001 N.s/m². **[8]**

OR

Q12) a) Natural gas with specific gravity of 1.20 at 143000 kPa and 45°C is being blown down to 102000 kPa. The flow rate could be from 95 m³/day to 39 m³/day. The drop through pressure reducing regulator is 3100 kPa, leaving 1000 kPa for the pipe. The pipe length is 140 m upstream of the regulator and 8.7 m downstream. Determine upstream and downstream pipe diameters.
M.W. of gas = 20, Ψ = 0.60 **[9]**

b) Derive an equation for estimation of pressure drop for a known pipe diameter and desired flow rate for a turbulent flow. **[7]**

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

P1211

[3564]-273

B.E. (Chemical)

CHEMICAL PROCESS SYNTHESIS

(2003 Course)

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

Instructions to the candidates:

1) ***Answer Three questions from Section I and Three questions from Section II.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables, electronic pocket calculator and steam tables is allowed.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) Vinyl chloride is to be manufactured by direct chlorination of ethylene. Discuss in details the development, overall design and hierarchy of process design. **[18]**

OR

Q2) a) Explain the concept of Onion Model. **[10]**

b) Write in brief about various considerations in process design. **[8]**

Q3) a) Describe various parameters to analyze reactor performance. **[8]**

b) What are various idealized reactor models? **[8]**

OR

Q4) Explain the effect of following parameters on choice of reactor: **[16]**

a) Temperature. b) Catalyst.

Q5) Describe in details: **[16]**

a) Azeotropic distillation. b) Evaporation.

OR

Q6) Write notes on: **[16]**

a) Absorption. b) Drying.

P.T.O.

SECTION - II

Q7) Explain with sketches the concept of heat integration of sequences of simple distillation column. **[16]**

OR

Q8) Write in details with neat diagram the distillation sequencing using thermal coupling. **[16]**

Q9) a) What are composite curves? How you will obtain them? **[8]**

b) How a problem table algorithm is formed? **[8]**

OR

Q10) a) Describe combined heat and power generation. **[8]**

b) Explain integration of refrigeration cycles. **[8]**

Q11) Write in brief on: **[18]**

a) Toxic releases from processes. b) Fire hazards.

OR

Q12) Explain in details the attenuation of hazardous materials. **[18]**

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

P1265

[3564]-276
B.E. (Chemical Engg.)
BIOPROCESS ENGINEERING (Elective - I)
(2003 Course) (409341)

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

Instructions to the candidates:

1) ***Answer 3 questions from each section.***
2) ***Answers to the different sections must be written in separate answer books.***
3) ***Assume suitable data, if necessary.***

SECTION - I

Q1) Explain in brief : **[16]**

a) Osmoregulating toxins.

b) Ammylase.

c) Co-enzyme.

d) Specific growth rate of bacteria.

OR

Q2) Explain in brief : **[16]**

a) Membrane structure.

b) Limiting nutrient.

c) Apo-enzyme.

d) Yield coefficient.

Q3) a) Explain process for manufacture of citric acid. **[9]**

b) Explain the method of process design of UASB. **[9]**

OR

Q4) a) Explain the manufacturing process of vinegar. **[9]**

b) Explain the manufacturing process of vitamin A. **[9]**

Q5) Derive the kinetic expression for the following :

$$E + S \Leftrightarrow ES; \qquad K_m \qquad (1)$$

$$ES \xrightarrow{k} E + P; \qquad (2)$$

$$E + P \Leftrightarrow EP; \qquad K_p \qquad (3)$$

P.T.O.

Where K_m and K_p are the thermodynamic dissociation constants for reversible reactions 1 and 3 respectively. 'k' is the kinetic constant for reaction 2. What type of kinetics is represented by the above equations? **[16]**

OR

Q6) Data for the enzyme catalyzed reaction S $\rightarrow$ P is as follows : **[16]**

[S] (M)	6.25×10^{-6}	7.50×10^{-5}	1.00×10^{-4}	1.00×10^{-3}	1.00×10^{-2}
v (nmoles.lit^{-1}.min^{-1})	15.00	56.25	60.00	74.90	75.00

a) Estimate V_{max} and K_m.

b) What would 'v' be at [S] = 2.5×10^{-5} M and at [S] = 5.0×10^{-5} M?

c) What would 'v' be at 5.0×10^{-5} M if the enzyme concentration were doubled?

d) How will you verify that 'v' represents a true initial velocity?

SECTION - II

Q7) What is the relative activity and the degree of inhibition caused by a competitive inhibitor when [S] = K_m and [I] = K_i? **[16]**

OR

Q8) a) Explain how balanced growth of microbes is needed to be maintained for chemostat and prove that for sterile feed D = μ. **[6]**

b) Operation of a typical CSTR follows the Monod kinetics where $\mu_{max} = 0.5\ h^{-1}$ and $K_s = 2$ g/l.

i) At steady state with no cell death, if $S_0 = 50$ g/l and Y = 1 (g cells / g substrates), what dilution rate D will give the maximum total rate of cell production?

ii) For the same value of D using tanks of the same size in series, how many vessels will be required to reduce the substrate concentration to 1 g/l? **[10]**

Q9) a) A marine microorganism contains an enzyme that hydrolyzes glucose-6-sulphate (S). The assay is based on the rate of glucose formation. The enzyme in a cell-free extract has kinetic constants of $K_m = 6.7 \times 10^{-4}$M and $V_{max} = 300$ nmoles.lit^{-1}.min^{-1}. Galactose-6-sulphate is a competitive inhibitor (I). At 10^{-5}M galactose-6-sulphate and 2×10^{-5}M glucose-6-sulphate, 'v' was 1.5nmoles.lit^{-1}. min^{-1}. Calculate K_i for galactose-6-sulphate. **[12]**

b) Calculate the peak oxygen consumption of specific yeast population in g/(lit.h). Actively respiring yeast population requires 0.32 g oxygen/ (hr.g of dry cell mass). Cell population density is 10^9 cells per ml and single cell volume is 10^{-10} ml. 80% of active cell mass is water. **[4]**

OR

Q10) Ethanol is produced in a chemostat from glucose using saccharomyces cerevisiae. The outlet concentration of glucose is 50 g/lit. The feed rate of glucose is 1000 lit/hr. Calculate the specific (i) cell growth rate and (ii) volume of the fermenter.

Data : a) Maximum specific growth rate $\mu_{max} = 0.33\ hr^{-1}$.

b) I = 93 g/lit.

c) K_I = 100 g/lit.

d) Michaelis-Menten constant K_s = 1.7 g/lit. **[16]**

Q11) Explain the following : **[18]**

a) Reactor dynamics.

b) Bubble column bioreactor.

c) Ion exchange chromatography.

OR

Q12) a) Write short note on determination of oxygen transfer rates and measurement of $K_L a'$. **[5]**

b) Explain various geometries of enzyme catalyzed CSTRs with schematic diagram. **[6]**

c) Derive the design equation of CSTR cell reactor with recycle and wall growth. **[7]**

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

P1214

[3564]-281
B.E. (Chemical)
PETROLEUM REFINING
(2003 Course) (409341) (Elective - I)

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

Instructions to the candidates:

1) ***Answer three questions from Section-I and three questions from Section-II.***
2) ***Answers to the two sections should be written in separate 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

Q1) a) Discuss the specifications of the following petroleum products : **[12]**

i) LPG.
ii) Gasoline.
iii) Diesel Oil.

b) Explain in short : Refining of crude oil. **[4]**

OR

Q2) a) Write in details : Worldwide opportunities in Petroleum Refining. **[8]**

b) Explain specifications of kerosene and engine oil. **[8]**

Q3) Describe in details the atmospheric distillation. **[16]**

OR

Q4) Explain with neat sketch : Vacuum Distillation. **[16]**

Q5) Explain with neat diagrams : Reforming. **[18]**

OR

Q6) Describe with neat sketches : Hydrocracking. **[18]**

SECTION - II

Q7) a) Explain in details : Acid Refining. **[12]**

b) Discuss types of refining. **[4]**

OR

P.T.O.

Q8) a) Explain : Hydro-desulphurization. **[8]**

b) Discuss in details : HDM. **[8]**

Q9) a) Note various additives in petroleum processes. **[8]**

b) Write down safety norms in refining. **[10]**

OR

Q10)a) Explain strategies of marketing of petroleum products. **[12]**

b) Discuss transportation methodologies of petroleum products. **[6]**

Q11)Write short notes on : **[16]**

a) Catalysts used in petroleum refining.

b) Packing materials for petroleum products.

OR

Q12)a) Discuss various recent trends in petroleum distillation. **[8]**

b) Explain settling and moisture removal in pre-refining. **[8]**

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

P1176

[3564] - 291
B.E. (Chemical)
PETROCHEMICAL ENGINEERING
(2003 Course) (409348)

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

Instructions to the candidates:

1) ***Answer Three questions from Section I and Three questions from Section II.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables electronic pocket calculator is allowed.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) Discuss types of crude oil distillation. Explain with neat diagram the synthesis of petrochemicals. **[16]**

OR

Q2) a) Write in brief : Present growth and future prospectus of petrochemical industry in India. **[12]**

b) Define petrochemicals with examples. **[4]**

Q3) With neat sketches, explain in details the production of napthalene. **[18]**

OR

Q4) a) Explain any one method for production of aromatics. **[12]**

b) Give classification of hydrocarbons. **[6]**

Q5) Draw neat diagram and discuss in details: Catalytic cracking. **[16]**

OR

Q6) Write in details about various separation and purification techniques used in petrochemical processes. **[16]**

P.T.O.

SECTION - II

Q7) A long with essential reaction steps, write in details about the production of ethylene glycol. **[16]**

OR

Q8) Discuss in details the various types and uses of second generation intermediates used as solvents and formulating agents. **[16]**

Q9) What are various polymeric products? Describe any two bulk polymerization products along with manufacturing processes. **[16]**

OR

Q10) Explain in details with suitable industrial examples : Types of polymerization process. **[16]**

Q11) 'Power on. India on.' What are your views on power generation through petrochemical plants? Explain the methodology for integration of refinery and petrochemical plant for power generation. **[18]**

OR

Q12) a) What are the important safety considerations in petrochemical plants? **[8]**

b) Explain one case study for control of pollution in petrochemical complex. **[10]**

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

P1175

[3564] - 290
B.E. (Chemical Engg.)
FUEL CELL TECHNOLOGY
(2003 Course) (409348)

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

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate books.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***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.***
6) ***All questions are compulsory.***

SECTION - I

Q1) a) Explain schematically the working principle of Alkaline Fuel Cell (AFC). **[8]**

b) Explain the thermodynamic aspects involved in fuel cell. **[8]**

OR

Q2) a) Discuss the types of material used for fabrication of anode and cathode of various fuel cells, along with their specific characteristics. **[8]**

b) Discuss the operating temperature of different types of fuel cell and the limitations arising out of that. **[8]**

Q3) At STP condition, Gibbs free energy for the formation of water vapor is – 55.14 cal/mole. In the typical SOFC, pure methane is fed at the pressure of 3 atm. Total pressure of gases on anodic side of fuel cell is observed to be 3.5 atm. Air is supplied at 1.2 atm. Fuel and air are supplied at the same operating temperature of 900 ºC. Faraday constant is 96486 J/V. mol. Calculate

a) Standard open circuit potential.

b) Open circuit potential at the operating condition. **[18]**

OR

P.T.O.

Q4) a) A current density of $10A/m^2$ is obtained when pure hydrogen in fed to SOFC at the pressure of 1.8 atm. Total pressure of gases at anodic side is observed to be 2.2 atm. Air is supplied at 1.5 atm. The cell is operated at 950 atm. The diffusion factor for hydrogen, oxygen and water vapor are 95, 70 and 55 C/s. m^2. atm. Calculate concentration overpotentials across anode and cathode. **[9]**

b) Calculate fuel utilisation factor, air ratio, power output and fuel efficiency of SOFC using the following data.

Average current density	= 11 A/m^2
Active anode surface area	= 0.2 m^2
Fuel flow rate	= 20 mol/h
Fuel composition : hydrogen	= 70 % and CO = 30%
Air flow rate	= 20 mol/h
Output potential	= 230V
Lower heating value of fuel	= 25000 kcal / kg

[9]

Q5) In a typical SOFC, pure oxygen is used as oxidiser. Derive Nernst Equation for calculating open circuit potential of SOFC for the following conditions :

a) Pure butane as fuel and b) H_2 and methane in the proportion of 40 : 60, as a fuel. **[16]**

OR

Q6) Calculate material balance for SOFC generating 400 kW power at 80% CHP efficiency, using methane as a fuel and 40% theoretical excess air as an oxidiser. **[16]**

SECTION - II

Q7) a) Explain Kröger-Vink defect structure in solids. **[8]**

b) Explain the effect of limiting reforming factor on the performance of SOFC. **[8]**

OR

Q8) a) Explain the mechanism of charge transfer in TPB. **[8]**

b) Derive the Butler-Volmer form of equation for the charge transfer rates. **[8]**

Q9) a) Design a tubular SOFC stack to generate 500 kW power for methane as a fuel. Single tube has anodic diameter of 18 mm and active length of 1.5m. **[10]**

b) Calculate mole fraction of defects in a pure solid crystal at 250 and 1050 ºC temperature. Defect energy is 50 kJ / mole. Comment on the significance of result. **[8]**

OR

Q10) a) Design planar SOFC to generate 300 kW power for ethanol as fuel. **[10]**

b) Explain mechanism of oxidative reforming of methane. **[8]**

Q11) Develop a mathematical model for SOFC system using methane as fuel. The system is divided in three subsystems: a) fuel processing, b) fuel cell and c) post combustion. **[16]**

OR

Q12) Develop a mathematical model for SOFC system generating combined heat and power using biomass as feed. System consists of a) biomass gasifier and b) SOFC. **[16]**

P1174

[3564] - 288
B.E. (Chemical)
INDUSTRIAL HAZARDS AND SAFETY
(2003 Course)

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

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate books.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***

SECTION - I

Q1) a) Discuss the ingredients of successful safety program. Draw a neat sketch. **[8]**

b) Explain the importance of safety program in chemical Industries. **[8]**

OR

Q2) Explain the three steps of Accident process. Discuss one of the significant disaster. **[16]**

Q3) a) Explain the importance of Industrial Hygine and focus on Govt regulations related to Industrial Hygiene. **[9]**

b) Determine the eight-hour TWA workers exposure if workers are exposed to toluene vapors as follows;

Duration	Measured concentration (PPM)
2	110
2	330
4	90

[9]

OR

Q4) a) Determine the TLV for uniform mixture of dusts containing.

Dust	Conc.wt%	TLV in ppcf
Nanosbestiform talc	70	20
Quartz	30	2.7

[9]

P.T.O.

b) Explain about the estimation of workers exposure to Noise and toxic vapors. **[9]**

Q5) a) Distinguish between fires and explosions. **[8]**

b) What are the different types of fire extinguishers? Give their applications. **[8]**

OR

Q6) a) Discuss in details about. **[16]**

b) Fire triangle.

c) Minimum oxygen concentration.

SECTION - II

Q7) a) Discuss the storage and handling of flammable and toxic chemicals. **[9]**

b) Draw a neat sketch of vent sizing package (VSP) for aquiring runway reactions data and explain the details. **[9]**

OR

Q8) Explain the details of : **[18]**

a) Design to prevent fires and explosions.

b) Explosion proof equipments and instruments.

Q9) Write a short notes on : **[16]**

a) Process Hazard checklist.

b) Hazard survey.

OR

Q10) a) Explain the procedure of HAZOP study. **[8]**

b) Give the details of review of probability theory for Risk Assessment. **[8]**

Q11) a) Explain the safety plan for Emergency. **[8]**

b) Discuss the Emergency shutdown system. **[8]**

OR

Q12) Write short notes on : **[16]**

a) Role of computers in safety.

b) Tackling of Disasters.

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

P1173

[3564] - 286
B.E. (Chemical)
FOOD TECHNOLOGY (Elective - II)
(2003 Course)

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

Instructions to the candidates:

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

SECTION - I

Q1) a) Discuss the current status of food processing industry in India. **[8]**

b) What are the different types of cleaning and sorting operations in food processing? **[8]**

OR

Q2) a) Explain the physical and chemical properties of food. **[8]**

b) Discuss the effect of growth of food industry on Indian economy. **[8]**

Q3) a) Explain the emulsification and membrane separation in food industry. **[8]**

b) Explain the applications of extraction and crystallization in food industry. **[8]**

OR

Q4) a) What is the difference between sorting and grading? Explain various methods. **[8]**

b) Classify and explain the post harvesting cleaning operation. **[8]**

Q5) a) What are the various factors affecting heat resistance of micro-organisms? **[8]**

b) Describe the commercial heat preservation methods. **[10]**

OR

Q6) a) What is pasteurization? Explain the methods of pasteurization. **[6]**

b) Explain various methods of oil filtration. **[6]**

c) Explain the process of manufacture of milk powder. **[6]**

P.T.O.

SECTION - II

Q7) a) What are different evaporation equipments used in food processing? Explain any two. **[8]**

b) Explain drying operation in food industry. **[8]**

OR

Q8) a) What are various food preservation methods used in food industry? Discuss their effect on quality. **[8]**

b) Explain the irradiation process and the effect of radiation on microorganisms. **[8]**

Q9) a) How is fruit juice manufactured by traditional method? **[6]**

b) How do chemicals influence ripening? **[6]**

c) How Jams and Jellys are prepared? **[6]**

OR

Q10) a) What is the effect of freezing on sensory qualities of vegetables and meat? **[8]**

b) Discuss the various bakery products and explain in brief their manufacturing. **[10]**

Q11) a) Explain chocolate and sugar confectionary. **[8]**

b) What is hazard analysis? How is it important in food processing? **[8]**

OR

Q12) a) What is the importance of packaging in food industry? **[8]**

b) Explain the packaging methods of liquid food products. **[8]**

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

P1172

[3564] - 285
B.E. (Chemical)
COMPUTER-AIDED PROCESS CONTROL
(2003 Course) (Elective - II) (Sem. - II)

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

Instructions to the candidates:

1) ***Answer three questions from Section - I and three questions from Section - II.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Your answers will be valued as a whole.***
6) ***Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***

SECTION - I

Q1) a) Compare the methods used for controlling batch and continuous processes. **[6]**

b) Explain supervisory computer control of process. **[6]**

c) Compare centralized and distributed control systems. **[6]**

OR

Q2) a) Describe various levels involved in hierarchical computer control systems. **[8]**

b) Describe DDC systems in detail. **[6]**

c) Write short note on HMI. **[4]**

Q3) a) Define controllability and observability of a process. State mathematical conditions for testing them for a given process. **[4]**

b) The distillation column has the following approximate transfer function model.

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} \dfrac{-0.12}{0.004s+1} & \dfrac{0.011}{0.055s+1} & \dfrac{-0.00175\, e^{-0.1s}}{0.00525s+1} \\ \dfrac{-0.013}{0.00325s+1} & \dfrac{0.075}{0.015s+1} & \dfrac{-0.00012\, e^{-0.25s}}{0.0141s+1} \\ \dfrac{-0.0043}{s} & \dfrac{0.04}{s} & \dfrac{0.000086}{s} \end{bmatrix} \times \begin{bmatrix} m_1 \\ m_2 \\ m_3 \end{bmatrix}$$

P.T.O.

i) Recommend the best pairing of variables based on RGA. **[8]**

ii) Also check the stability of the resulting control loops based on Nicderlinski index. **[4]**

OR

Q4) a) Derive the expression for RGA for 2×2 process having steady-state gain matrix

$$k = \begin{bmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{bmatrix}$$

state properties of RGA and also state the rules for determining the best pairing of input and output variables based on minimum interaction and stability of the resulting control loops. **[6]**

b) Test the controllability and observability of process having state-space matrices.

$$A = \begin{bmatrix} -1 & 0 & 3 \\ 2 & -1 & -1 \\ -3 & 1 & -2 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 0 \\ 0 \end{bmatrix}, C = \begin{bmatrix} 1 & 2 & 1 \end{bmatrix}.$$ **[10]**

Q5) a) A DDC system is used to control a second-order process (K = 1, T_1 = 0.1 min, T_2 = 2 min) with ZOH, using a PI controller (K_c = 0.1, T_I = 1). Derive the characteristic equation for the closed-loop system and hence test the stability of the system. Take sample time T = 1 min. **[8]**

b) Derive the expression for direct synthesis digital controller transfer function D(z) from servo response equation. **[4]**

c) Derive deadbeat controller for first-order process (K_p = 1, T_p = 0.5 min) with ZOH for unit step change in SP. Is this controller physically realizable. **[4]**

OR

Q6) a) Derive the expression for Dahlin's controller D(z) for unit step change in S.P. State the condition for physical realizability of Dahlin's controller. Compare the performance of dead beat & Dahlin's controller. **[8]**

b) What do you understand by ringing poles of digital controller D(z). **[4]**

c) Test the following controller algorithm for ringing poles.

$$D(z) = \frac{k\left(1-0.2z^{-1}\right)}{\left(1+0.4z^{-1}\right)\left(1-z^{-1}\right)}$$

How will you eliminate ringing pole? **[4]**

SECTION - II

Q7) a) Explain types of process control computer related bus interface. **[9]**

b) Explain block diagram for data acquisition using computer. **[9]**

OR

Q8) a) Explain polling and interrupt methods of communication between process control computer and peripheral devices. **[9]**

b) Explain various network topologies used for networking of process control computers. **[9]**

Q9) Explain essential components of industrial DCS system viz - GOS, LOS, LP, I/O boards, P/S and operator's interface. **[16]**

OR

Q10) a) Explain PLC architecture along with the essential components - P/S, I/O systems, memory, programmer units, peripheral devices. **[8]**

b) Explain advantages of PLC over control system using personal computer. Also state applications of PLC. **[8]**

Q11) a) Explain sequence of steps followed in process control design. **[8]**

b) Explain computer control of shell and tube heat exchanger using PC/XT I/O cards, microcontroller, for controlling temperature of hot water out let by manipulating steam flow rate and input cold water flow rate. **[8]**

OR

Q12) a) Explain computer control of jacketed batch reactor for controlling temperature inside the reactor by manipulating the flow rate of hot/cold liquid circulated through jacket. **[8]**

b) Explain working of antisurge controller. **[8]**

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

P1171

[3564] - 283
B.E. (Chemical)
CHEMICAL PLANT ENGG .
(2003 Course)

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

Instructions to the candidates:

1) ***Answer 3 questions from Section I and 3 questions from Section II.***
2) ***Answers to the two sections should be written in separate 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

Q1) a) What are the main factor in makin Techno-economic Reasibility study? Explain in detail. **[9]**

b) Discuss the importance of process flow diagrams in plant design. **[9]**

OR

Q2) a) Explain the Role of Laboratory data & pilot plant data. **[10]**

b) Explain the importance of flow sheeting in Chemical Industry. **[8]**

Q3) a) A Project Engineer would like to choose a plant location for following Manufacturing Units. Please help him during selection of proper site, giving justification.

i) Polystyrene Plant.

ii) Sulphuric Acid Plant. **[8]**

b) Explain in detail the factors affecting process selection. **[8]**

OR

Q4) a) Explain factors to be considered for preparing plant Layout with a suitable example. **[10]**

b) Explain plant safety operation & maintenance. **[6]**

P.T.O.

Q5) What are the different utilities required in chemical process plants? Discuss the factors to be considered while estimating any of two utility of plant. **[16]**

OR

Q6) What are various waste treatment in Chemical Industry. Explain any two waste water treatment with neat diagrams. **[16]**

SECTION - II

Q7) a) Explain Normal Pipe Size (NPS). **[4]**

b) Give the details of colour code for piping. **[8]**

c) Explain different Methods of pipe sizing. **[4]**

OR

Q8) a) What are the different methods of piping design? Write different steps of any one method, for process piping design. **[8]**

b) What are Methods of piping support? Explain any one with neat sketch. **[8]**

Q9) a) Explain single acting & double acting Reciprocating pump with neat diagram. **[10]**

b) Explain sizing of centrifugal pump & the term cavitation. **[6]**

OR

Q10) a) Explain principle construction & working of centrifugal pump with neat diagram. **[10]**

b) Define NPSH & explain it's importance. Draw one diagram indicating suction head, discharge head & NPSH desirable. **[6]**

Q11) a) A Chemical Manufacturing company wants to estimate the time for the project, various activities are identified as 10, 20, 30..... etc.

Their sequence is as under

i) Draw the network for these activities.

ii) Identify & estimate the time for critical path.

Activity sequence	Estimated time in weeks.
(10, 20)	12
(10, 30)	13
(10, 40)	12
(20, 50)	10
(30, 70)	19
(40, 60)	11
(50, 70)	10
(50, 80)	12
(60, 90)	09
(70, 100)	20
(80, 100)	15
(90, 100)	20

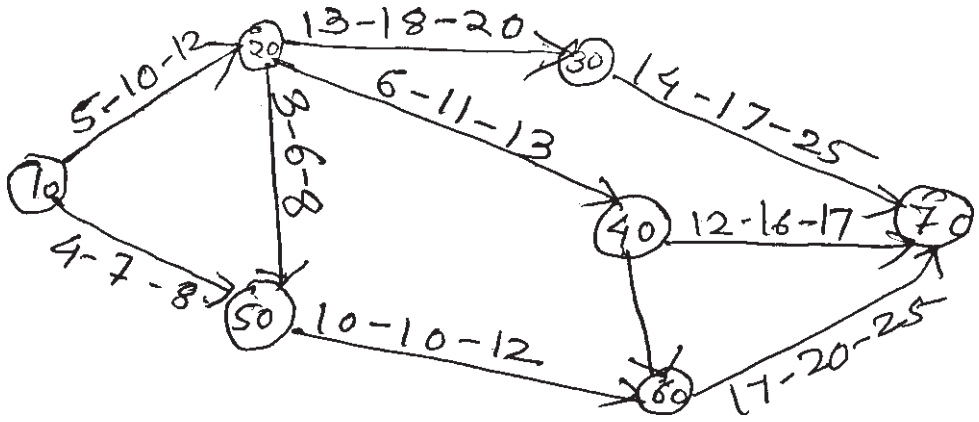
[10]

b) Define "Intrinsically" & "Extransic" safe process. **[4]**

c) Explain static & Mobile pressure vessel. **[4]**

OR

Q12) a) Consider the Network shown in Fig. determine the standard deviation & Expected time for each activity. For each activity the three estimates t_o-t_m-t_p are given along the arrow. **[10]**



b) 'HAZOP' is a tool of process risk assessment Explain. **[4]**

c) What is Float & how is it useful in CPM Networks. **[4]**

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Total No. of Questions : 6] **[Total No. of Pages :2**

P1170

[3564] - 280
B.E. (Chemical)
ADVANCED SEPARATION PROCESSES
(2003 Course) (Elective - I) (409341)
(Rev. - 03)

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

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate books.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Assume suitable data if necessary.***

SECTION - I

Q1) a) What is an adsorption isotherm? Give the 5 types. **[6]**

b) Explain temp. swing regeneration giving details of stripping and heat limited process. **[6]**

c) What are various applications of chromatography in separation of enzymes and proteins. **[6]**

OR

a) Discuss all aspects of pr. swing regeneration. **[6]**

b) Explain principles of adsorption. **[6]**

c) What is an adsorption selectivity? **[6]**

Q2) a) Discuss all aspects of dialysis. **[6]**

b) Discuss gas separation in porous and nonporous membranes. **[6]**

c) Explain pervaporation and mention its relevant equations. **[4]**

OR

a) What are applications of membrane separation processes? **[4]**

b) What are features of nonporous membranes? **[4]**

c) What is permeability? **[4]**

d) What is osmosis and osmotic pr. **[4]**

P.T.O.

Q3) Write short note on : **[16]**

a) Separations based on reversible chemical complexation.

b) Reactive distillation.

OR

Write short note on : **[16]**

a) Reactive extraction.

b) Reactive crystalization.

SECTION - II

Q4) a) Explain foam drainage and collapse phenomena. **[5]**

b) Explain properties of foam related to floatation process. **[5]**

c) What is froth floatation? Explain in detail. **[8]**

OR

a) Explain modes of operation of foam fractionation eqpt. **[8]**

b) Give applications of bubble and foam separation methods to protein and enzyme separation and waste water treatment. **[10]**

Q5) a) What is electrophoresis? Explain in detail. **[6]**

b) What are the modes of operation of electrophoresis? **[6]**

c) What are applications of electrophoresis? **[4]**

OR

a) What do you mean by electrodecantation or electroconvection? **[4]**

b) What do you mean by countercurrent electrophoresis. **[4]**

c) What do you mean by adductive crystallization. **[4]**

d) What do you mean by zone refining. **[4]**

Q6) a) What is centrifugation? Give the classification of centrifuges by size of dispersed Particles. **[5]**

b) What is ultracentrifuge? Explain in brief. **[6]**

c) Differentiate bet^{n} sedimenting and filtering centrifugation. **[5]**

OR

a) Explain selection of separation process with detailed case study. **[8]**

b) What are various applications of centrifugation. **[8]**

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

P1169

[3564] - 277
B.E. (Chemical Engineering)
ENERGY CONSERVATION
(2003 Course)

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

Instructions to the candidates:

1) ***Answers to the two sections should be written in separate books.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***

SECTION - I

Q1) a) Explain the different conventional and non-conventional sources of energy and given their advantages and disadvantages. **[10]**

b) Explain the role, types and design and material of absorption plate in solar feat plate collectors. **[6]**

c) Why solar energy is termed as low grade energy. **[2]**

OR

Q2) a) Draw a neat sketch of wind mill and discuss all its design details. **[8]**

b) Justify 'wind power generated is proportional to cube of velocity'. **[4]**

c) Discuss the tidal and geothermal energy as alternative source. **[6]**

Q3) a) What are the different methods of biochemical energy generation? Enlist the merits of such energy. **[8]**

b) Enlist the factors considered for optimization of bio-gas plant and explain its working. **[8]**

OR

Q4) a) Discuss the importance of nuclear option for power generation in India. Give reactions involved in nuclear fusion. **[8]**

b) Justify the fluidized Bed combustion of coal is efficient method of combustion. **[8]**

P.T.O.

Q5) a) What are the various heat recovery systems? Explain the working of recuperators. **[8]**

b) Draw a neat sketch of Heat pipe and explain its working. **[8]**

OR

Q6) a) Explain the power plant operation with the help of 'Rankin Cycle'. **[8]**

b) What is difference between on economizer and waste heat boiler? What precautions have to be taken while installing them, considering its effect on chimney? **[8]**

SECTION - II

Q7) a) Explain the steam generation by fluidized Bed Boiler. **[9]**

b) Describe the Heat Exchanger Network Synthesis. **[9]**

OR

Q8) a) What is co-generation? Explain the methods of co-generation. **[9]**

b) Explain Energy conservation Act of Govt. of India. **[9]**

Q9) Discuss energy conservation in sugar Industries. **[16]**

OR

Q10) What are energy consuming units in Petrochemical Industries and give the comments on energy conservation. **[16]**

Q11) Explain in detail about : **[16]**

a) Energy economics and cast-benefit analysis.

b) Sankey Diagram.

OR

Q12) Write short notes on : **[16]**

a) Energy Policy and its impact.

b) Optimizing the Energy Input requirement.

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

P1288

[3564]-289
B.E. (Chemical Engineering)
PIPING DESIGN AND ENGINEERING
(2003 Course) (Elective-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 books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of electronic pocket calculator is allowed.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Discuss the procedure in determining pipe size for specified pressure drop and flow? **[8]**

b) Define economic velocity? Explain briefly the considerations in economic velocity for following piping systems **[6]**

i) Hot liquid flow
ii) Slurry flow.

c) Explain Restriction orifice sizing. **[4]**

OR

Q2) a) Determine the pressure drop for flow of 200 lit/sec. of gasoline ($\rho = 680$ kg/m^3, $\mu = 2.92 \times 10^{-4}$ N.S/m^2) through a 30 cm diameter pipe. The pipe is 500 m long and has an equivalent roughness magnitude of 0.20 mm.
(Given, f = 0.0181) **[8]**

b) Give the comparison between Head balancing and quantity balancing methods for analysing piping network? **[6]**

c) State the responsibilities of piping engineer? **[4]**

Q3) a) State and explain various types of pipe fittings. **[8]**

b) Discuss the different sections of ASME B31 code for pressure piping? **[8]**

OR

Q4) a) Discuss the various types of Gaskets and their selection criteria? **[8]**

P.T.O.

b) Explain the desirable properties of piping materials for low temperature and high temperature services. **[8]**

Q5) a) State and explain the factors considered in selecting valves. **[4]**

b) What are the steps followed during sizing of control valve? **[8]**

c) What is difference between safety valve and relief valve? **[4]**

OR

Q6) a) What is the nominal size of a portable compressor. Unit required for compressing 1,600,000 standard cubic Ft. of gas per 24 hours at a temperature of 85°F from 40 Psig pressure to 600 Psig pressure? The altitude above sea level is 2,500 Ft. The N value of gas is 1.28. The suction temperature of stages other than the first stage is 130°F. **[12]**

b) Discuss Rupture disc sizing using the resistance to flow method? **[4]**

SECTION - II

Q7) a) Explain the types of two phase flow and their characteristic linear velocity. **[8]**

b) How to calculate NPSHa and NPSHr? How to increase NPSHa? **[4]**

c) Explain correct pump piping arrangement with the help of submergence laws for centrifugal pump. **[4]**

OR

Q8) a) Discuss steam pipe sizing based on the flow rate and maximum velocity of the steam or pressure drop. **[8]**

b) Find the volumetric efficiency of a reciprocating pump with the following conditions:

Type of pump : 3 inch dia. plunger × 5 inch. stroke triplex.

Liquid pumped : Propane.

Suction pressure : 242 Psig.

Suction Temp. : 70°F.

Discharge Pressure : 1911 Psig.

Discharge Temp : 80°F

C : 127.42 Cu in.

d : 35.343 Cu in.

S : 0.02

For Propane :

T_c = 666 R, P_c = 642 lb/in^2, $\frac{\rho_1}{\omega_1} = 4.803$ and ω = 0.1048. **[8]**

Q9) a) Develop the typical piping layout considerations for distillation systems and reactors. **[10]**

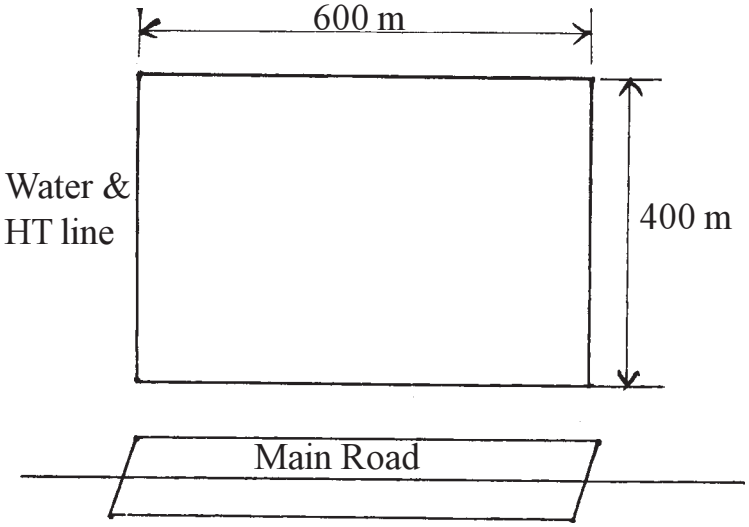
b) From a properly made P & ID, piping engineer should obtain all essential details required for piping. Make a list of all such essential details which should be available from a properly prepared P & ID. **[8]**

OR

Q10) Develop and draw a plot plan for a chemical plant with following facility. Explain the consideration applied by you.

Process plant 30 × 20 m	Boiler House 6 × 6 m
WTP 5 × 5 m	ETP 8 × 5 m
Fuel storage (class B) 20 × 20 m	Pump house 5 × 8 m
Green belt 10 m each side	Two poles blocked 6 × 6 m
Fire fighting tank 10 × 15 m	Raw material tank farm 20 × 25 m

Assume other facilities required approximately show pipe rack. **[18]**



Q11) a) Write the note on insulation material selection criteria. **[4]**

b) Calculate the critical radious of insulation for asbestos [K = 0.17 W/mk] surrounding a pipe and exposed to room air at 20°C with h = 3.0 W/m^2K. Calculate the heat loss from a 200°C, 5.0 cm diameter pipe when covered with the critical radious of insulation and without insulation. **[8]**

c) How to optimize the piping cost? **[4]**

OR

Q12) a) Derive the expression for critical thickness of insulation. **[8]**

b) Write a note on insulation for hot and cold services. **[4]**

c) Discuss major considerations applicable to design the piping system for pneumatic conveying of solids. **[4]**

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

P1215 [3564]-284

B.E. (Chemical Engg.)

PROCESS MODELING AND SIMULATION

(2003 Course)

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

Instructions to the candidates :

1) ***Answer any 03 questions from each section.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Your answers will be valued as a whole.***
6) ***Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***
7) ***Assume suitable data, if necessary.***

SECTION - I

Q1) 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 is interrelated. **[8]**

OR

Q2) 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]**

Q3) a) What is process model.

b) Why develop a process model.

c) How to determine the form of a model? Give the typical forms of model. **[16]**

OR

Q4) a) Explain the terms - lumped parameter system and distributed parameter system. Give example of each. **[8]**

b) Explain various difficulties encountered during the mathematical modelling of the process. **[8]**

P.T.O.

Q5) Develop the model equation for a direct heated counter current rotary dryer (continuous dryer) in which simultaneous heat and mass transfer takes place between gas phase and solid phase. In this dryer three zones exists, (i) Preheating zone (ii) Evaporation zone (iii) Reheating zone. In evaporation zone actual removal of water from wet solids takes place and solid surface remain at temperature equal to wet bulb temperature of gas. **[18]**

OR

Q6) Derive and discuss mathematical model for batch reactor with heating phase and cooling phase. Draw a neat diagram of batch reactor and draw batch profiles. **[18]**

SECTION - II

Q7) Derive a dynamic model for batch distillation column with another side column as shown in fig. A multi - component system is being separated. State the assumptions clearly. **[18]**

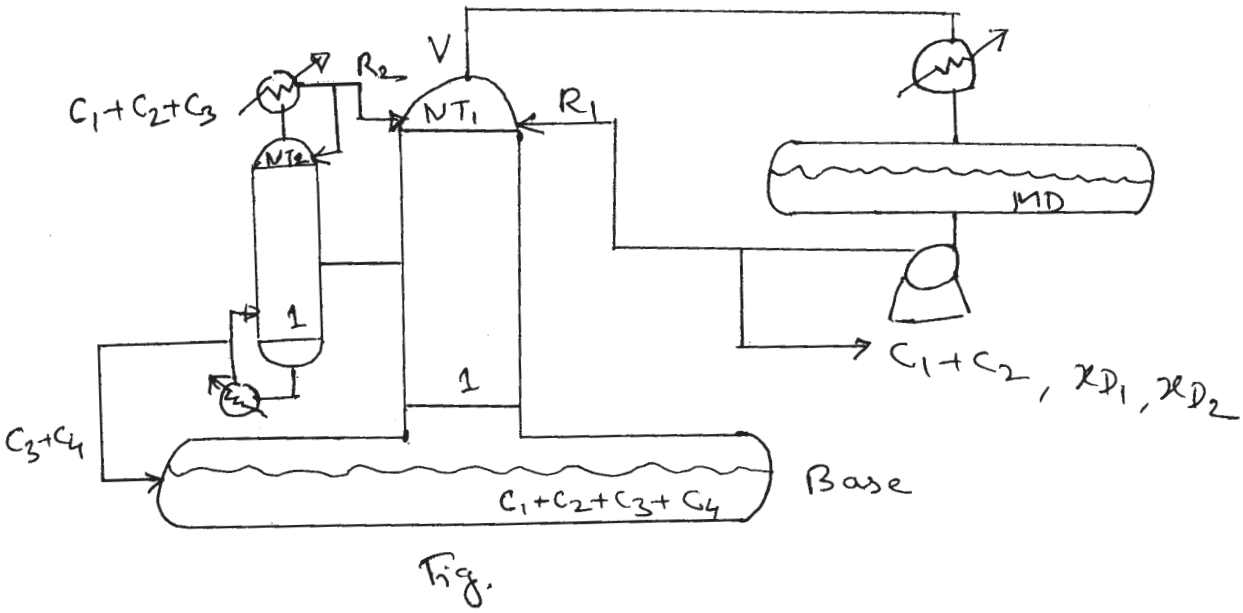

Fig.

OR

Q8) Develop the state model for an ideal binary mixture of component A and B to be separated into two product streams using conventional distillation. **[18]**

Q9) Consider a Chemical reactor in which the reaction A $\rightarrow$ B occurs. the volumetric flow rate and concentration of the inlet stream are q_i and C_{Ai} respectively. The tank has level h and cross - sectional area A.The outlet concentration is C_A and the reaction rate per unit volume is $r = KC_A$. The outlet stream is split into a product stream with flow rate q and a recycle stream with a flow rate q_r. The ratio of recycle and product flow rates is denoted as C. the flow rate of the outlet stream is linearly related to the level with resistance R. Assume constant density and isothermal operation. Derive the dynamic model equation describing the tank level h and outlet concentration C_A. **[16]**

OR

Q10)a) Consider the following dynamic model of a constant volume, isothermal continuous stirred tank reactor,

$$\frac{dVC_A}{dt} = q\,(C_{Ao} - C_A) - V\,(K_1\,C_A - K_3\,C_A^2) = f_1(C_A, q, C_{Ao})$$

$$\frac{dVC_B}{dt} = -q\,C_B + V\,(K_1\,C_A - K_2\,C_B) = f_2\,(C_A, C_B, q).$$

where C_A and C_B are the concentrations of component A & B respectively, V is the reactor volume, q and C_{Ao} are the volumetric flow rate and concentration of inlet stream, respectively. K_1, K_2 and K_3 are reaction constants. Assume both q and C_{Ao} vary with respect to time. Find linear deviation model.

b) Consider the following dynamic model

$$\frac{dx_1}{dt} = -x_1 + (1 + x_1)u(t - t_0) = f(x_1, u(t - t_0))$$

$$\frac{dx_2}{dt} = x_1^2 - x_2 = f_2(x_1, x_2)$$

Find the deviation model at the point $x_1 = x_2 = u = 0$.

[16]

Q11)a) What is process simulation? Explain in detail.

b) Give the scope of process simulation with a example.

c) Differentiate between modular and equation oriented approach.

d) Give the types of process simulation problems.

[16]

OR

Q12) You are working as a consultant to ABC Pvt. Ltd., a water company. ABC is developing a new technique for water treatment, for which bicarbonate in water needs to be removed before hand. ABC Pvt. Ltd., has sub-contracted you to investigate the most appropriate way for stripping CO_2 from water. Your group has decided to solve the problem through establishing a model for the CO_2 stripping process. You have carried out an experiment using Titration and off-Analysis (TOGA) sensor, from which you have obtained some data for model calibration and validation. You are now undertaking the first step in model establishment.

a) Prepare a model definition for this scenario in the form of modeling goal statement.

b) Set out key controlling factors for the problem.

c) Provide labelled diagram of the balance volumes and any relevant flows.

d) What data might be necessary? What data have you got? In case more data are required, how would you obtain those?

e) State all assumptions.

f) For economic reasons, your client is considering not to control the pH during stripping, briefly discuss what impact this may have on the above steps.

g) Develop mathematical model.

[16]

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

P1305

[3564]-272

B.E. (Chemical)

CHEMICAL REACTION ENGINEERING - II

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

Instructions to the candidates :

1) ***Answer 3 questions from Section I and 3 questions from Section II.***
2) ***Answers to the two sections should be written in separate 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

Q1) a) In case of shrinking core model derive the rate expression for the case of chemical reaction resistance is rate controlling step for solid as reactant. **[9]**

b) Spherical particles of zinc blende of size R = 1 mm are roasted in an 8% oxygen stream at 900ºC and 1 atm. The stoichiometry of the reaction is:

$$2ZnS + 3\ O_2 \text{ - - - - - - - - - - - - - - - - - - —> } 2ZnO + 2SO_2$$

Assuming that the reaction proceeds by the shrinking core model calculate the time needed for complete conversion of a particle and the relative resistance of ash layer diffusion during the operation. Data : Density of solids = 4.13 gm/cm^3 = 0.0425 mol/cm^3. Reaction rate constant k" = 2cm/sec. For gases in the ZnO layer, D_e = 0.08 cm^2/sec. Note that film resistance can safely be neglected as long as growing ash layer is present. **[8]**

OR

Q2) Uniform sized spherical particles of UO_3 are reduced to UO_2 in a uniform environment with the following results:

t, hr	0.180	0.347	0.453	0.567	0.733
X_B	0.45	0.68	0.8	0.95	0.98

If the reaction follows shrinking core model, find the rate controlling mechanism and a rate equation to represent this reaction. **[17]**

P.T.O.

Q3) Air with gaseous A bubbles through a tank containing aqueous B. Reaction occurs as follows:

$A(g \text{ -- } \rightarrow 1) + 2B\ (1) \text{ ------- } \rightarrow R(1),\ -r_A = kC_A C_B^2 \quad k = 10^6\ m^6/mol^2.hr.$

For this system $k_{Ag}.a = 0.01$ mol/hr.m^3.Pa, $f_1 = 0.98$, $k_{A1}.a = 20\ hr^{-1}$, $H_A = 10^5$ Pa.m^3/mol (very low solubility), $D_{A1} = D_{B1} = 10^{-6}\ m^2/hr$, $a = 20 m^2/m^3$.

For a point in the absorber reactor where $P_A = 5*10^3$Pa and $C_B = 100$ mol/m^3.

a) Locate the resistance to reaction (what % is in the gas film, in the liquid film, in the main body of liquid).

b) Locate the reaction zone.

c) Determine the behavior in the liquid film (whether pseudo first-order reaction, instantaneous, physical transport, etc).

d) Calculate the rate of reaction (mol/m^3.hr). **[17]**

OR

Q4) a) In case of fluid-fluid reactions derive rate expression for fast reactions.**[8]**

b) In case of fluid-fluid reaction taking place in the tower reactor the inlet partial pressure of reactant is 0.002 atm and outlet partial pressure is 0.003 atm. The concentration 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. $k_{1A}.a = 0.1$ / hr, $H_A = 125*10^{-5}$ atm m^3/mol, $G = 1*10^5$ mol/hr m^2, $C_T = 56000$ mol/m^3, $L = 7*10^5$ mol/hr.m^2, JI = 1 atm. Determine the height of the tower. **[9]**

Q5) a) Compare physical and chemical adsorption. **[6]**

b) An 8.01 g sample of Glaucosil is studied with N_2 adsorption at - 195.8ºC. The following data are obtained. The vapour pressure of N_2 at -195.8ºC is 1 atm. Estimate the surface area of the sample. **[10]**

P mm Hg	6	25	140	230	285	320	430	505
V cm^3 0°C, 1 atm	61	127	170	197	215	230	277	335

OR

Q6) a) Write short note on catalyst poisoning. **[6]**

b) Low temperature (-195.8ºC) nitrogen adsorption data were obtained for an Fe-Al_2O_3 ammonia catalyst. The result for 50.4 g sample were:

P mm Hg	8	30	50	102	130	148	233	258	330	442	480	550
V cm^3 0ºC, 1 atm	103	116	130	148	159	163	188	198	221	270	294	365

Estimate the surface area for this catalyst. **[10]**

SECTION - II

Q7) An experimental rate measurement on the decomposition of A is made with a particular catalyst. Is it likely that film resistance t 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? The data is as given below: **[18]**

Data

For the spherical particle:

d_P = 2.4 mm, L = R/3 = 0.4 mm, $D_C = 5^* 10^{-5}$ m^3/hr.m cat, k_{eff} = 1.6 kJ/hr.m cat.K.

For gas film surrounding the pellet:

h = 160 kJ/hr.m^2.cat. K, k_g = 300 m^3/hr.m^2 cat.

For the reaction:

ΔHr = –160 kJ/mol A, C_{Ag} = 20 mol/m^3, $-r_{Aobs}'''$ = 10^5 mol/hr.m^3 cat.

Assume that the reaction is of first order.

OR

Q8) Derive the expression for effectiveness factor in case of cylindrical pore. State clearly the assumptions made if any. Explain the Thiele's modulus and its importance. **[18]**

Q9) a) Explain steps involved in solid catalyzed reaction with neat diagram.**[6]**

b) For the following reaction mechanism derive the rate expression for the case of surface reaction as rate controlling step. **[10]**

A + S <– -------> A.S

B + S <– -------> B.S

A.S + B.S <– -------> C.S + S

C.S <– ----> C + S.

OR

Q10)a) In case of fluid - fluid reaction taking place in the tower reactor the inlet partial pressure of reactant is 0.01 atm and outlet partial pressure is 1^*10^{-6} atm. The concentration of liquid phase reactant entering is 0.35 mol/1. Following operating parameters have been determined. k_{Ag}. a = $6^* 10^{-5}$ mol/sec. cm^3.atm, k_{1A}.a = 0.03/sec, k_{1B}.a = 0.02/sec, H_A = 115 atm. cm^3/mol, G = $3^* 10^{-3}$ mol/sec.cm^2, C_T = 56000 mol/m^3, L = $6.6^* 10^{-3}$ mol/sec.cm^2, JI = 1 atm. Determine the height of the tower. **[10]**

b) Explain the procedure to determine rate controlling step in case of solid catalyzed reactions. **[6]**

Q11)a) Substrate A and enzyme E flow through a mixed flow reactor (V = 6 liter). From the entering and leaving concentrations and flow rate find a rate equation to represent the action of enzyme on substrate. **[8]**

C_{E0} mol/lit	C_{A0} mol/lit	C_A mol/lit	v lit /hr
0.02	0.2	0.04	3
0.01	0.3	0.15	4
0.001	0.69	0.60	1.2

b) Discuss design of fermentor design with emphasis on air velocity and agitation speed. **[8]**

OR

Q12)a) Explain Michaelis-Menten kinetics. Discuss how to determine the parameters of the model. **[8]**

b) Compare relative merits and demerits of fluidized and packed bed reactors. **[8]**

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

P1300 **[3564]-271**

B.E. (Chemical)

PROCESS DYNAMICS AND CONTROL

(2003 Course)

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

Instructions to the candidates :

1) ***Answers to the two sections should be written in separate books.***
2) ***Figures to the right indicate full marks.***
3) ***Use of electronic pocket calculator is allowed.***
4) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) Explain the components of a typical feedback control system with the help of a suitable example. **[9]**

b) A mercury thermometer with a time constant of 40 seconds is showing steady state temperature in a bath at 40 ºC. At time $t = 0$ it is shifted to a bath at 70 ºC, left there for 1 minute, after which it is shifted to a bath at 20 ºC. After additional 1 min in this bath, it is shifted back to the bath at 70 ºC. Find the temperatures indicated by the thermometer at times $t = 40, 60, 90, 120, 150, 180$ and 600 seconds. **[9]**

OR

Q2) a) A system has the following transfer function. Find the response of the system to a unit impulse input. Sketch the response. **[9]**

$$G(s) = \frac{6}{\left(10s^2 + 7s + 1\right)}$$

b) A first order system $G(s) = \dfrac{1}{\left(\tau s + 1\right)}$ is given a sinusoidal input of the form $x(t) = A \sin(\omega t)$. Derive the expression for the output of the system $y(t)$. **[9]**

Q3) Write short notes on (any two): **[16]**

i) History of process control.

ii) Integrating and non-integrating processes.

iii) Systems with inverse response.

P.T.O.

OR

Q4) The following reaction takes place in a CSTR. **[16]**

$$A + B \rightarrow 2C$$

Rate of reaction of A : $r_A = -k\, C_A\, C_B$.

The relevant variables are as follows:

k : Rate constant for the reaction (m^3 / (mol.s)).

ΔH_R : Standard heat of reaction at the temperature T.

C_P : Specific heat of the reactor liquid (this can be assumed to be constant).

ρ : Density of the reactor liquid (assumed to be constant).

F_0, F : Inlet and the outlet flowrates (m^3/s).

C_{A0}, C_{B0} and C_{C0} : Inlet concentrations of A, B and C respectively.

C_A, C_B and C_C : Outlet concentrations of A, B and C respectively.

V : Volume of the reactor.

T : Temperature in the reactor.

T_S : Temperature of steam.

A_H : Heat transfer area.

U : Overall heat transfer coefficient.

Write a dynamic mathematical model of the system. State clearly the assumptions made.

Q5) a) Write the time-domain and Laplace-domain equations of a PID controller and explain the significance of each term in brief. **[8]**

b) A first order system with the process transfer function given below is controlled using a proportional controller. Derive the time response for a unit step change in setpoint R. Find the expression for the offset produced by the controller. Assume that the measuring element and the final control element are fast-acting. **[8]**

$$G_P(s) = \frac{K}{(\tau s + 1)}.$$

OR

Q6) a) A pure capacitive process with the transfer function given below, is controlled using a proportional controller. Derive responses of this system to i) unit step change in load ii) unit step change in setpoint. What are the offsets in the two cases? **[8]**

$$G_P(s) = \frac{A}{s}.$$

b) A first order system with the process transfer function given below is controlled using a proportional controller. Derive the time response for a unit step change in load L. Find the expression for the offset produced by the controller. Assume that the measuring element and the final control element are fast-acting. **[8]**

$$G_P(s) = \frac{K}{(\tau s + 1)}.$$

SECTION - II

Q7) a) Sketch the root locus diagram for the following open loop transfer function under proportional control. Is the control system always stable?

$$G(s) = \frac{8}{(s+1)\cdot(s+2)(s+4)}$$ **[9]**

b) A process with the following transfer function is controlled using a proportional controller. Find the ultimate gain and ultimate period of oscillations using Routh test. Based on these values estimate the Ziegler-Nichols controller tuning settings for a PID controller. **[9]**

$$G(s) = \frac{24}{(s+2)\cdot(s+3)(s+4)}$$

OR

Q8) a) Plot the Bode plot for a control system with the following open loop transfer function. Estimate the controller gain K_C for a proportional controller using a gain margin of 1.7. **[12]**

$$G(s) = \frac{1}{(10s+1)} e^{-2s}$$

b) Explain in brief any one PID controller tuning methods. **[6]**

Q9) Explain in detail any one of the following: **[16]**

i) Feedforward control system,

ii) Cascade control system.

OR

Q10) Write short notes on (any two): **[16]**

a) Selective control.

b) Ratio control.

c) Split-range control.

Q11) Describe the control systems used for the control of any two of the following:

a) Distillation column.

b) Surge vessel.

c) Boiler. **[16]**

OR

Q12) Write short notes on (any four): **[16]**

a) Control design form.

b) pH control.

c) Plantwide control.

d) Process control symbols.

e) Control of compressors.

f) Control of turbines.

Total No. of Questions : 08] **[Total No. of Pages : 2**

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B.E. (Chemical)

PROCESS DYNAMICS AND CONTROL

(1997 Course)

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

Instructions to the candidates:

1) ***Answer any 3 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.***

SECTION - I

Q1) a) What are the incentives for chemical process control? **[8]**

b) Discuss the design elements of control system. **[8]**

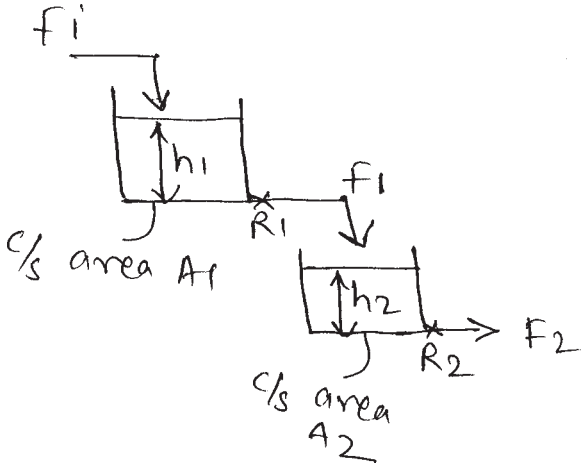
Q2) Define transfer function and derive the transfer function for a stirred tank heater. Write zeros and poles of transfer function. **[16]**

Q3) Write short notes on **[16]**

a) Pure capacitive process.

b) Underdamped Response characteristics.

Q4) Consider two non-interacting tank system shown below : **[18]**



Derive the transfer function between h_2 and Fi.

P.T.O.

SECTION - II

Q5) A first order process is controlled by proportional controller. Derive the close-loop response and determine the **[16]**

a) Order of Response.

b) Offset.

c) Closed-loop time constant and gain.

Q6) Draw a neat sketch and explain the working of **[16]**

a) Cascade control.

b) Split-range control.

Q7) Draw the Bode plot for PI controller. **[16]**

Q8) Write short notes on : (Any three) **[18]**

a) Z - transform.

b) Nyquist stability criteria.

c) Root Locus Analysis.

d) ON-OFF controller.

Total No. of Questions : 8] **[Total No. of Pages : 2**

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[3564]-79

B.E. (Chem.)

PROCESS MODELING & SIMULATION

(1997 Course)

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

Instructions to the candidates :

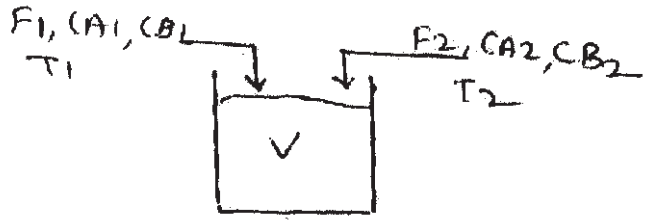
1) ***Answer any 3 questions from each section.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***

SECTION - I

Q1) Define modeling and explain the types of model and give the scope and applications of modeling. **[16]**

Q2) Discuss the steps in Model Building. **[16]**

Q3) For a given mixing system;

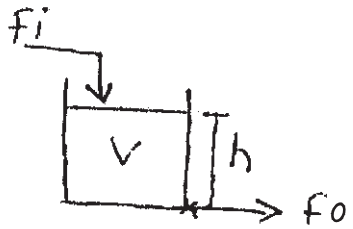


Derive the total and component mass balance and energy balance. **[18]**

Q4) Discuss the various Numerical methods used to solve the model equations. **[16]**

SECTION - II

Q5) a) For a given Liquid level system:



P.T.O.

Given information is;

Cross section area of tank = A

Volume of Liquid in tank = V

and effluent flow; $F_o \propto h$.

Derive the model equation showing the relation between Liquid level h and input flow rate F_i. **[12]**

b) What are different simulators used to simulate the model equation? Write the simulation code using any of the simulation tool for a sample model equation. **[6]**

Q6) Write the total mass balance, component mass balance for three - isothermal constant hold-up CSTRs in series.
Assume suitable kinetics- **[16]**

Q7) Consider an ideal binary distillation column and write all the model equations to describe the system. **[16]**

Q8) Differentiate between: **[16]**

a) Lumped Parameters and distributed parameters.

b) Steadystate and unsteadystate model.