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Seat No.	

T.E. (Chemical Engineering) (Semester - VI)
(Revised) Examination, November - 2017
CHEMICAL REACTION ENGINEERING - I
Sub. Code : 66890

Day and Date : Tuesday, 7-11-2017 **Total Marks : 100**

Time : 2.30 p.m. to 5.30 p.m.

Instructions : **1) Answer any three questions from each section.**

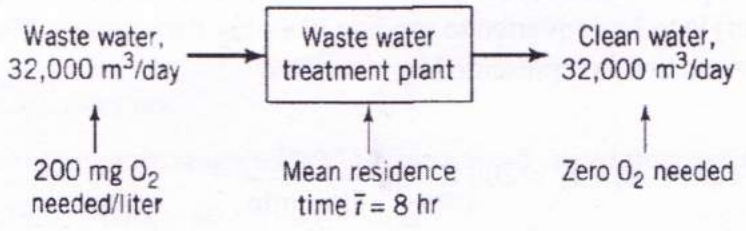
2) Assume suitable data if required.

SECTION - I

Q1) a) Consider a municipal water treatment plant for a small community shown in fig. Waste water, 32000 m^3/day, flows through the treatment plant with a mean residence time of 8 hr, air is bubbled through the tanks, and microbes in the tank attack and break down the organic material microbes

$$(\text{organic waste}) + O_2 \xrightarrow{\text{microbes}} CO_2 + H_2O$$

A typical entering feed has a BOD (biological oxygen demand) of 200 mg O_2/liter, while the effluent has a negligible BOD. Find the rate of reaction, or decrease in BOD in the treatment tanks. **[9]**



b) Milk is pasteurized if it is heated to 63°C for 30 min, but if it is heated to 74°C it only needs 15 s for the same result. Find the activation energy of this sterilization process. **[8]**

P.T.O.

Q2) a) The first-order reversible liquid reaction.

$$A \Leftrightarrow R,\ C_{A0} = 0.5\ \frac{mol}{liter},\quad C_{R0} = 0$$

takes place in a batch reactor. After 8 minutes, conversion of A is 33.3% while equilibrium conversion is 66.7%. Find the rate equation for this reaction. **[8]**

b) i) Write a note on testing kinetic models. **[8]**

ii) Temperature Dependency from Arrhenius' Law.

Q3) a) Derive a kinetic expression for Irreversible Reactions in Series

$$A \xrightarrow{k_1} R \xrightarrow{k_2} S$$

Draw the concentration profile of all reaction components. **[9]**

b) An ampoule of radioactive Kr-89 (half-life = 76 minutes) is set aside for a day. What does this do to the activity of the ampoule? Note that radioactive decay is a first-order process. **[8]**

Q4) a) An aqueous feed of A and B (400 liter/min, 100 mmolA/liter, 200 mmolB/liter) is to be converted to product in a plug flow reactor. The kinetics of the reaction is represented by **[8]**

$$A + B \rightarrow R,\ -r_A = 200\, C_A\, C_B\ \frac{mol}{liter.min}$$

Find the volume of reactor needed for 99.9% conversion of A to product.

b) Explain in detail Holding Time and Space Time for Flow Reactors. **[8]**

SECTION - II

Q5) a) Derive the performance equation of recycle reactor. **[8]**

b) The kinetics of the liquid phase decomposition of A is studied in two mixed flow reactors in series, the second unit having twice the volume of first one. At steady state with a feed containing 1 molA/lit (i.e. $C_{Ao} = 1$ mol/lit) and mean residence time of 96 seconds in the first reactor, the concentration of A in the first reactor is 0.5 mol/lit and in the second is 0.25 mol/lit. Find the kinetic equation for the decomposition of A. **[8]**

Q6) a) Discuss equal sized mixed reactors in series and show that for **[8]**

$$N \to \infty, \tau_p = \frac{1}{K} \ln \frac{C_o}{C}$$

b) Qualitative discussion about product distribution for parallel reactions. **[8]**

Q7) Consider the parallel decomposition of A as per the following scheme:

$r_R = 1.0$
$r_S = 2\,CA$
$r_T = C_A^2$

Determine the maximum concentration of desired product (For T is the desired product and $C_{Ao} = 5$) that can be obtained in i) Plug flow reactor ii) Mixed flow reactor. **[16]**

Q8) Write short notes on: **[18]**

a) The optimum arrangement of different sized mixed flow reactors in series.

b) Optimum temperature progression.

c) Instantaneous yield & Overall fractional yield.

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T.E. (Chemical) (Part-III) (Semester-VI) (Revised) Examination, November - 2017

MASS TRANSFER - II

Sub. Code : 66888

Day and Date : Friday, 03-11-2017 **Total Marks : 100**

Time : 2.30 p.m. to 5.30 p.m.

Instructions : 1) **Solve any three questions from each section.**
2) **Assume suitable data if required.**
3) **Figures to right indicate full marks.**

SECTION-I

Q1) a) Discuss Multicomponent distillation and selection of heavy and light key component. **[8]**

b) Discuss feed conditions in distillation, define 9 and derive feed line equation. **[8]**

Q2) a) 100 moles of an Acetonitrile-Nitromethane mixture is differentially distilled in a batch still at a pressure of 70kpa. The feed contains 74 mole % acetonitrile. Distillation is continued till the liquid left behind in the still contains 32% mole acetonitrile. The vapour-liquid equilibria for the system at this pressure are correlated as follows:

$Y^* = 1.05x + 0.13$ for $0.3<x<0.52$

$Y^* = 0.77x + 0.28$ for $0.52<x<0.80$

Where x and y* refer to the mole fractions of acetonitrile in liquid and gas respectively. Find the average composition of distillate collected. **[8]**

b) Explain stagewise procedure for multistage counter current extraction to find out number of equilibrium stage, sketch rectangular co-ordinate system for the same. **[8]**

P.T.O.

Q3) a) Explain Ponchon-Savrit method with neat diagram for design of distillation column. **[8]**

b) A laboratory examination is made of extraction of acetic acid from dilute aqueous solution of Ketone using a spray tower of 47mm diameter and height 1080 mm. The aqueous liquid is run into top of the tower and Ketone enters at the bottom at the rate of 0.0022 m^3/m^2s of tower cross section containing no acetic acid and leaves with concentration of 0.21kmol/m^3, the aqueous phase flow at the rate of 0.0013 m^3/m^2 sec. of tower cross section, and enters containing 0.68 kmol/m^3 of acid. Calculate the overall extraction coefficient based on driving force in Ketone phase. What is the corresponding value of K_{Ea}, H to E. Equilibrium relation under this condition may be taken as concentration of acid in Ketone phase = 0.548x concentration of acid in aqueous phase. **[8]**

Q4) Attempt any three of the following. **[3×6=18]**

a) Azeotropic and extractive distillation.

b) Co-ordinate systems in extraction.

c) Relative volatility and x-y data by knowing vapour pressure of components of mixture.

d) Extraction equipments.

SECTION-II

Q5) A cooling tower receives warm water at 43°c at a mass flow rate of 7000 kg/m^2n. A cooling range of 13°c is to be achieved by counter current contact with air. The air enters at a rate of 4200 kg/n.m^2 at a dry bulb temperature of 31°c and a humidity of $0.01516\frac{kg}{kg\ of\ dry\ air}$. The overall volumetric mass transfer coee. is $K_y a = 2500\frac{kg}{m^3\ (h)\ AY}$.

Determine height packed tower

Given data $T_L = 31°C$ and Humidity $Y_1^1 = 0.01516$

Enthalpy $H_1^1 = 70$ KJ/kg of dry air

T_L °C	30	3.45	33	34.8	36.5	38.2	39.7	41.5	43.1	45
H_1^1 KJ/ kg of dry air	64.3	75	87.2	101.2	114	127.5	138.7	152.6	165	179.6

[17]

Q6) a) Give details about classification of dryers. **[8]**

b) Brief about steps involved in crystallisation operation. **[8]**

Q7) Discuss about detailed process of design of Rotary Dryer. With material and Heat balance. **[16]**

Q8) Write notes on following (any three). **[17]**

a) Importance of characteristic curve of drying.

b) Various mechanisms of Leaching process and its application.

c) Working principle of Induced Draft cooling tower with neat sketch.

d) Wet bulb depression lone.

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T.E. (Chemical Engg.) (Part -III) (Semester - VI) (New Course) Examination, November - 2017

PROCESS DYNAMICS & CONTROL

Sub. Code : 66889

Day and Date : Monday, 06 - 11 - 2017 **Total Marks : 100**

Time : 2.30 p.m. to 5.30 p.m.

Instructions : **1) Attempt any three questions from each section.**
2) Assume suitable data if necessary.

SECTION - I

Q1) a) Define Laplace Transforms. Explain properties of Laplace transform with equations. **[6]**

b) A thermometer having a time constant of 10 sec is placed in a temperature bath 45°C. After the thermometer comes to equilibrium with the bath, the temperature of the bath is subjected to sinusoidal forcing function about its average temperature of 45°C with amplitude of 15°C. If period of oscillation is 30 sec/cycle, Determine the following **[10]**

i) Maximum and minimum temperature indicated by thermometer,

ii) Amplitude ratio

iii) Phase lag

iv) Plot the response of thermometer for sinusoidal change of the system.

Q2)a) Derive the transfer function for first order system by considering example of mercury in glass thermometer. State the assumption made. **[8]**

b) Two non interacting tanks are connected in series. The time constants are $\tau_2 = 1$ and $\tau_1 = 0.5$ and R_2=1. Sketch the response of the level in tank 2 if a unit-step change is made in the inlet flow rate to tank 1. **[9]**

P.T.O.

Q3) a) Explain the terms used to describe second order under damped responses with curve **[8]**

b) An ideal PD controller had the transfer function $\frac{P(s)}{\varepsilon(s)} = K_c(\tau_D s + 1)$ and an actual PD controller had the transfer function $\frac{P(s)}{\varepsilon(s)} = \frac{Kc(\tau_D s + 1)}{\left(\frac{\tau_D}{\beta}\right)s + 1}$

where β is a larger constant in an industrial controller. If a unit-step change in error is introduced into a controller having the second transfer function, show that $P(t) = K_c\left(1 + A\ e^{-\beta t/\tau_D}\right)$ where A is a function of β which you are to determine. As $\beta \to \infty$, show that the unit-step response approaches that for the ideal controller. **[9]**

Q4) Write short notes on following (Any-4). **[16]**

a) Positive and Negative feedback control system.
b) Single liquid level system.
c) Valve Characteristics.
d) Block diagram.
e) Transfer function and Time constant.
f) Damped vibrator as second order system.

SECTION - II

Q5) a) Show that the value of offset remain same for both, servo and regulator mechanism problem in case of proportional controller. **[9]**

b) Determine the transfer function Y(s) /X (s) for the block diagram shown in figure. **[8]**

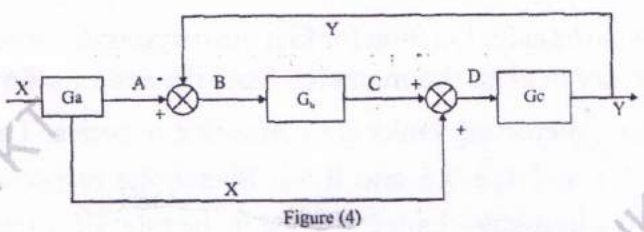

Figure (4)

Q6) a) Define stability of the control system, discuss theorems of Routh test and its limitations. **[8]**

b) For the characteristic equation, **[8]**

$$1 + \frac{Kc}{(s+2)(s+3)(s+4)} = 0$$

Determine the values of Kc for which the system is stable. Also find the root of characteristics equation for this value of Kc.

Q7) a) Explain in brief the concept of root locus and rules for plotting root locus diagram. **[8]**

b) For the control system shown in figure, $\tau_D = 5$ seconds. **[8]**

i)Sketch the root locus diagram for given system.

ii)If the system becomes unstable, find the value of Kc that just cause's instability also find the location of pairs on imaginary axis.

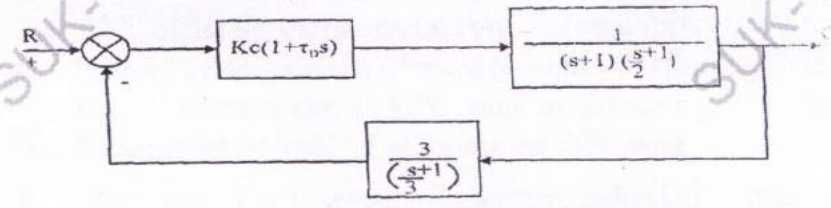

Figure (4)

Q8) a) Sketch the Bode diagram for the control system of open loop transfer function is given as, $G(s) = 4(2s+1) / (0.2s + 1)(10s + 1)$. **[9]**

b) Explain in brief about Bode stability criterion and Ziegler Nichols controller's settings. **[8]**

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