M.E. (Civil) First Semester Examination, 2012

Sub: Physicochemical Processes in Environmental Engineering

(CE-914)

Full Marks: 70 **Time: 3 Hours**

PART-A

Assume any relevant data if necessary.
(Answer any three questions, Two marks reserved for neatness)

1. What is the importance of gas transfer in water or wastewater treatment? Describe with a neat sketch the gas transfer mechanism from gas phase to liquid phase. Describe briefly the different equipment used for gas transfer from air to liquid. Mention the factors on which gas transfer rate depends.

(11)

2. Name the factors affecting coagulation. Mention the functions of coagulant aid. Describe with neat sketch the stability of colloid. How they can be destabilized? Describe different types of flocculation mechanism.

(1+2+3+5=11)

3. Settling column analysis of a Type-I suspension is shown in the following table. Use the data to determine the percent removal of suspended solids in an ideal horizontal sedimentation basin operating at 2 $m^3/m^2/hr$. Samples are taken at 260 cm below the surface of the liquid in a batch sedimentation column. 'C' is the suspended solid concentration at time 't' taken from the sampling port and C_0 is the initial solid concentration.

Time (min)	0	15	30	45	60	90	120
C/C_0 at 260cm	1	0.95	0.80	0.75	0.66	0.50	0.20

(11)

4. (a) Describe how a column settling analysis can be carried out to evaluate the suspension removal efficiency of flocculent nature.
(b) Iso-removal curve for a suspension of type-II is shown in Fig. 1. Calculate the solid removal efficiency of the sedimentation basin of depth 2.5 m. if the surface loading rate is 0.5 $m^3/m^2/hr$.

(5+6 =11)

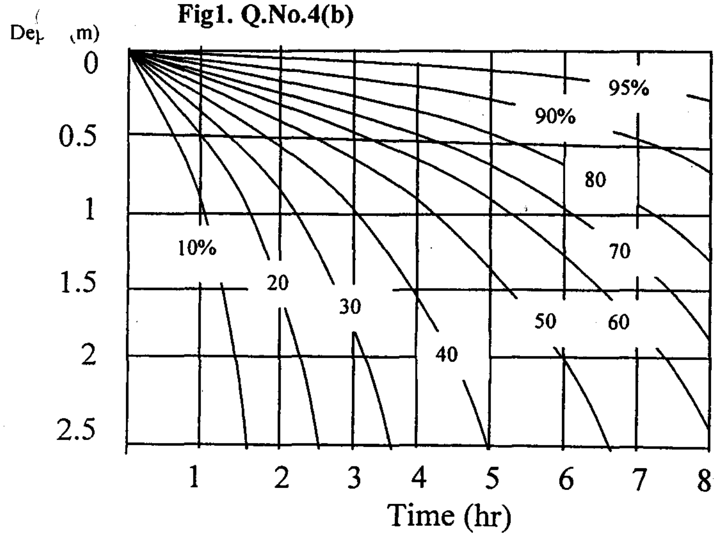
5. Following data are obtained from the sieve analysis of a river sand to prepare a filter bed.

Sieve size (mm)	1.41	0.84	0.71	0.59	0.5	0.42	0.297	0.250	0.210	0.149
Cum.(%) retain	1	5	20	36	54	72	87	96	98	100

(a) Calculate the upper and lower sand size of the river sand if the filter has co-efficient of uniformity = 1.70 and effective size = 0.4 mm
(b) How much river sand is required to prepare per kg of filter sand?

(6+5)=11

Fig1. Q.No.4(b)



PART – B

(Answer question 5 and any three from the rest)

5. Draw the flow diagram of a water treatment plant treating hard and odorous surface water indicating the purpose of each unit.

(5)

6. (a) The following raw water analysis has been provided for a groundwater supply.

Parameter	Concentration (mg/L)
Calcium	80
Magnesium	36
Sodium	23
Bicarbonate	299
Sulfate	120
Carbon dioxide	26

Assume that a final hardness of less than 100 mg/L as $CaCO_3$ is acceptable, provided the magnesium is less than 45 mg/L as $CaCO_3$. Two stage recarbonation has been adopted. Calculate the chemical requirements and draw a bar diagram of the finished water.

(b) Discuss the relative merits of two-stage and single-stage recarbonation after softening by chemical precipitation.

(8+2)

7. A laboratory adsorption column operating at a linear flow rate of 1.0 gpm/ft^2 was used to study the removal of phenol from a wastewater. The phenol concentration was reduced from 100 mg/L to 2 mg/L, with the bed depths and service times as tabulated below.

Use the BDST approach to predict the operating time for a 4 ft deep bed operating at a flow rate of 1.5 gpm/ft^2. Also predict the operating time for this column if the influent concentration of phenol increased from 100 mg/L to 140 mg/L at a flow rate of 1.5 gpm/ft^2.

Laboratory data

Bed Depth (ft)	Time to Breakthrough (hr)
2	85
4	250
6	400
8	545

(10)

8. (a) A strong base anionic resin of Cl^- form has been used to remove nitrate from water. The resin has the following characteristics.

$$K_{Cl^-}^{NO_3^-} = 4 \qquad \bar{C} = 1.3 \text{ eq/L}$$

The influent has the following characteristics

$[Cl^-] = 3$ meq/L

$[NO_3^-] = 1.5$ meq/L

Determine how much water can be treated per ft^3 of the resin before the bed is exhausted. Assume equilibrium for the resin.

(b) A spent resin column used to remove Ca^{2+} is to be regenerated in a batch process to the Na^{+} form. A strong brine (mostly NaCl) is contacted with the exhausted resin to replace Ca with Na. The composition of the brine (regenerant) after equilibrating with the exhausted resin is:

NaCl = 2 eq/L (117 g/L)
$CaCl_2$ = 0.2 eq/L (11 g/L)

For the resin

$$\bar{C} = 2eq/L \qquad K_{Na^{+}}^{Ca^{2+}} = 4$$

Determine the degree of column utilisation after regeneration is completed.

(5+5)

9. (a) Mention the factors on which affinity or selectivity sequence of a resin for an ion depends. Discuss a scheme of ion exchange process where chromium can be recovered from a plating rinse wastewater.

(b) What is an adsorption isotherm? Mention one of the commonly applied isotherms. Indicate one common technology for removal of fluoride from contaminated water.

(6+4)

10. (a) Why the chlorine disinfection efficiency is dependent on pH? Mention the relative merits and demits of disinfection of water supplies with ozone and chlorine.

(b) Briefly discuss the principle of reverse osmosis and electrodialysis.

(5+5)