M.E. (Civil) 1st Semester Final Examination, 2013
Physicochemical Process in Environmental Engineering
Time -3 hours (CE-914)

(Assume relevant data if necessary)

(Answer question **No.1)**

1. Mention the factors on which the choice of a water treatment depends. Draw the flow diagram of a water treatment plant treating hard and odorous surface water indicating the purpose of each unit. (10)

Part – A

(Answer any two questions)

2. (a) When nitrate removal is the primary treatment objective, what is the maximum volume of water that can be processed per litre of a SBA resin if the total resin capacity is 1.3 eq/L and $K_{Cl}^{NO_3} = 4$? Assume that the water has the following composition :Ca^{++} = 1.0 meq/L; Mg^{++} = 1.0 meq/L; Na^{+} = 2.5 meq/L; Cl^{-} = 3.0 meq/L; SO_4^{2-} = 0.0 meq/L; NO_3^{-} = 1.5 meq/L.

b) If the ionic background of the water is changed so that sulphate concentration is 3.0 meq/L and chloride concentration is 0.0 meq/L, what is the maximum volume of water that can be processed per liter of resin? Assume that $K_{NO3}^{SO4} = 0.04$.

(c) Mention some generalised rules which indicate the affinity of an ion for a resin. What may be the advantages/disadvantages for choosing a resin with a high affinity for the ion to be exchanged? Distinguish between strong-acid cation-exchange resin and weak-acid cation exchange resin.

(5+4+6)

3.(a) What is adsorption isotherm? Mention one isotherm equation. How the isotherm may be used to select a suitable batch of activated carbon for practical application?

b)What is mass transfer zone (MTZ) in an adsorption column? On what factors does the length of MTZ depend?What are carbon utilisation rate (CUR) and empty bed contact time (EBCT)? Does CUR depend on EBCT? What are breakthrough concentration and degree of column utilisation?

c) How an exhausted activated carbon may be regenerated?

(5+7+3)

4.(a) What criteria are considered suitable for a good disinfectant? What are the common factors that affect efficiency of a disinfectant? Compare between free chlorine and combined chlorine for disinfection of water supply. For disinfection of water with chlorine, show the graph representing the residual chlorine for varying dosages of applied chlorine and explain the nature of such a curve.

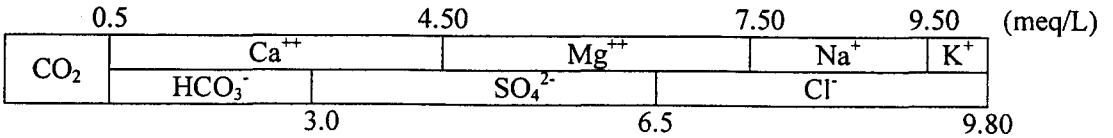
b) Explain the electrodialysis method of desalination of brackish water. Compare different membrane processes for removal of contaminants from water.

(9+6)

5. a) Why excess lime is added in lime-soda process of softening? What is recarbonation and under what conditions is recarbonation necessary in a water treatment system?

b) What is split treatment for softening? Draw a flow diagram of a two-stage softening with split treatment.

c) A water treatment plant processes 24500 m^3/d of water with the ionic characteristics shown below and is to be softened by split treatment approach in which 1 meq/L of Mg^{2+} is acceptable in the finished water.



The values are in meq/L

P.T.O

Determine the quantities of chemicals (kilograms per day) required to soften this water. Also draw a bar diagram of the finished water. Calculate the dry mass of the solids in the sludge.

(4+3+8)

Part-B

(Answer any two questions)

6. a) Describe how a settling column analysis can be carried out to evaluate the suspension removal efficiency of discrete nature.
   b)Deduce the final expression for percent solid removal from above analysis.
   c) Calculate the solid removal from a type-II suspension as shown in Table1. Assume the retention time is 90 minutes and initial solid concentration is 200mg/l. Data in Table1 is the solids concentration at respective time and depth.

(5+3+7)

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

Sieve size (mm)	1.40	0.83	0.71	0.57	0.51	0.43	0.295	0.250	0.210	0.147
Cum % of retain	1	5	20	35	54	70	85	96	97	100

a) Calculate the upper and lower sand size of the river sand if the filter has co-efficient of uniformity is1.75 and effective size is 0.45 mm.
b) Calculate the head loss during backwash if the depth of the sand filter is 90 cm and specific gravity of sand is 2.65 and porosity is 0.40
c) What will be the final height if the sand bed if backwash is done at double the initial porosity? How much river sand is required to prepare per kg of filter sand?

(5+5+5)

8. What do you mean by colloid? With a neat sketch describe colloid stability. Describe how it can be destabilized. Describe different flocculation mechanism. Describe role of alkalinity in alum flocculation.

(1+4+3+4+3)

9. a) With a neat sketch briefly describe gas transfer mechanism. Describe different types of equipment used for gas transfer at liquid-air interface.

b) Show that for a low soluble gas the transfer rate depends on liquid film resistance where as for high soluble gas the rate of transfer depends on gas film resistance.

(3+4+8)

Table 1: Solids concentration in (mg/l)

Time (min) → / ↓depth(ft)	Sampling time (min)					
	10	30	45	60	90	120
0.5	*80*	*50*	*30*	*22*	*15*	*8*
1	*100*	*70*	*48*	*35*	*25*	*15*
1.5	*115*	*85*	*66*	*47*	*35*	*22*
2	*124*	*94*	*75*	*57*	*43*	*28*
2.5	*130*	*100*	*82*	*63*	*50*	*35*
3	*135*	*105*	*87*	*68*	*57*	*40*
3.5	*140*	*110*	*90*	*72*	*61*	*42*

Question No.6(c)