M.E. (Water Resources & Hydraulic Engineering) Exam. (6 Semester), 2025

(1st Semester)

WATER WORKS ENGINEERING

(Program Core 2)

Time: Three Hours | Full Marks :100

Answer any ***four*** questions.

1.(a) A column analysis for a flocculating suspension is run in the apparatus shown below. The initial suspended solid concentration is 260 mg/l. The resulting matrix is shown below. What will be the overall removal efficiency of a settling basin that is 4.2 m deep with a detention time of 1 hr 50 min?

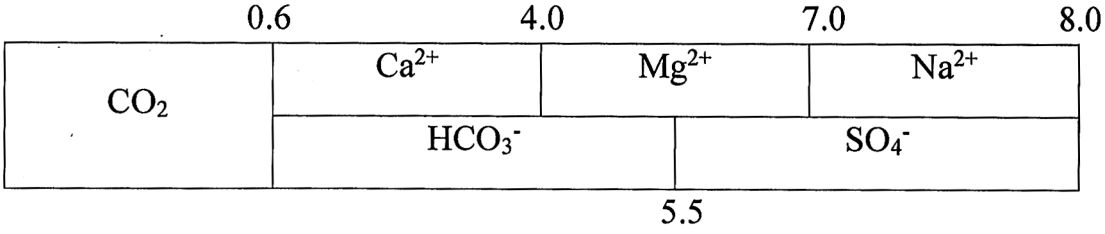
Depth (m)	Time of Sampling(min)					
	30	60	90	120	150	180
0.7	133 *	83	50	38	30	23
1.4	180	125	93	65	55	43
2.1	203	150	118	93	70	58
2.8	213	168	135	110	90	70
3.5	220	180	145	123	103	80
4.2	225	188	155	133	113	95

* Result of suspended solid concentration of sample Ci in mg/l

(b) What are the key design parameters for an ideal sedimentation tank used for Type II settling?

20+5=25

2) a) A water sample with the ionic characteristics shown below is to be softened to the minimum possible hardness by the lime-soda ash-excess lime process. Calculate the required chemical quantities in mili-equivalents per litre.



b) Find the settling velocity of a spherical particle with $d=5x10^{-3}$ cm and G=2.65. Assume Re<1. Also, find the rising velocity of the particle of the same diameter but G=0.8. Assume Kinematic viscosity @20°c as 1.012×10^{-2} cm²/s

c) Find out the settling velocity of a discrete particle when 24 <Re<50 and Cd=(24/($Re^{3/4}$)).

12+8+5=25

3. (a) How does the flow rate differ between SSF and RSF, and what impact does it have on treatment efficiency?

(b) Water from the clariflocculator at 17°c is passed through the Rapid Sand Filter bed. The rate of filtration is 6000 ltr/hr/m^2. The filler bed is 0.75 m deep and is composed of non-uniform sand (sp. gravity 2.65) stratified so that the smallest particles are on top and the largest on the bottom. The porosity and shape factor are 0.48 and 0.85 throughout the depth of the bed. The size distribution of sand is given in the following table. Determine the head loss through the filter bed during filter operation.

US Sieve (no.)	Particle Size range (mm)	Mass fraction in size range (%)
14-20	1.0	0.87
20-28	0.71	8.63
28-32	0.54	21.30
32-35	0.46	28.10
35-42	0.38	23.64
42-48	0.32	7.09
48-60	0.27	3.19
60-65	0.23	2.16
65-100	0.18	1.02

7+18=25

4. (a) What are the key design criteria and variables for constructing a Horizontal Roughing Filter (HRF)?

(b) It is proposed to construct HRF and SSF for the treatment of the surface water of an impounding reservoir. The domestic water supply scheme is expected to cater to the present population of 10000 and to supply water @ 70 lpcd. Design the HRF and SSF units and draw a layout plan.

Laboratory analysis of raw water shows the following.

pH = 7.6

Suspended solids: 200 mg/l

Total Hardness: 120 mg/l

Chloride: 40 mg/l

Total coliform: 3600/100 ml.

Fecal Coliform: 1800/100 ml

Gravel size (mm)	Filtration rate (m/hr)	Efficiency(%)		
		Filter length- 1 m	Filter length- 2 m	Filter length- 3 m
5	0.75	8.0	2.3	0.6
	1.0	15.9	6.4	2.5
	1.5	34.8	20.5	12.1
10	0.75	27.7	13.0	6.7
	1.0	38.1	23.5	14.5
	1.5	60.3	46.9	36.4
15	0.75	39.0	24.3	15.2
	1.0	51.9	37.4	27.0
	1.5	72.9	62.2	53.1
20	0.75	48.5	33.7	23.5
	1.0	61.0	47.6	37.2
	1.5	80.1	71.7	64.2

7+18=25

5. a) What do you mean by water stability? Differentiate between corrosive water and scaling water.

b) A marble test is conducted on a water sample. The beginning alkalinity is 90 mg/l as $CaCO_3$. The ending alkalinity is 120 mg/l as $CaCO_3$. Is the water scaling or corrosive? Discuss any optional treatment needs.

c) Differentiate between "Clearwell" and "Clear Water Reservoir".

d) Why is the peak factor considered for designing a water supply distribution network?

e) The hourly time-demand data for a distribution system are given here. The water is pumped into an elevated storage reservoir at a constant rate of 1069.32 m^3/h. Determine the reservoir capacity by using the deficiency method.

Time	Demand (LPM)	Time	Demand (LPM)
1 am	7125	1 pm	24586
2	7220	2	24548
3	6992	3	24472
4	6821	4	24776
5	6978	5	25498
6	7296	6	27037
7	12236	7	34238
8	19000	8	33060
9	21090	9	20216
10	22876	10	8436
11	23636	11	8018
12 noon	24016	12 midnight	7600

4+5+2+2+12 = 25

Table Values of $pK_2 - pK_s$ with Respect to Temperature and Total Dissolved Solids (TDS)							
TDS, mg/L	$pK_2 - pK_s$						
	0°C	10°C	20°C	30°C	40°C	50°C	80°C
	2.45	2.23	2.02	1.86	1.68	1.52	1.08
40	2.58	2.36	2.15	1.99	1.81	1.65	1.21
80	2.62	2.40	2.19	2.03	1.85	1.69	1.25
120	2.66	2.44	2.23	2.07	1.89	1.73	1.29
160	2.68	2.46	2.25	2.09	1.91	1.75	1.31
200	2.71	2.49	2.28	2.12	1.94	1.78	1.34
240	2.74	2.52	2.31	2.15	1.97	1.81	1.37
280	2.76	2.54	2.33	2.17	1.99	1.83	1.39
320	2.78	2.56	2.35	2.19	2.01	1.85	1.41

6. a) Define the term non-conventional water treatment technology?
   b) Write short note on Reverse osmosis (RO)
   (b) Determine the volume of hydrogen cation and strongly basic anion exchanger bed to demineralize 100 m^3/d water that has following chemical quality

Cations	Anions
Ca^{2+}= 145 mg/L	HCO_3-=258 mg/L
Mg^{2+}=18 mg/L	SO_4^{2-}=220 mg/L
Na^{+}=130 mg/L	Cl^{-}=214 mg/L
K^{+}=50 mg/L	NO_3=50 mg/L

The ion exchange capacities of hydrogen cation and anion exchange resins are 80,000 and 50,000 g $CaCO_3/m^3$ cycle respectively. Also calculate the required quantities of regeneration chemicals. The regeneration cycle is once per day.

2+5+18=25