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B.Sc. Engg. (CEE)/ 4th Sem. 15 May, 2024 (Group B)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COPERATION (OIC)
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination **Summer Semester: 2022-2023**
Course No.: CEE 4431 **Full Marks: 150**
Course Title: Water Supply Engineering **Time: 3.0 hours**

There are 7 **(Seven)** questions. **Questions 1, 6 and 7 are compulsory**. Answer any **3 questions from Q2, 3, 4 and 5.** The related CO-PO and marks are shown in the right. Programmable calculators are not allowed. Do not write on this question paper. The symbols have their usual meaning.

1(a) Sitalakhya river is passing through industrial zones, several municipalities are also located at the catchment of the river. The river is also used for navigation purpose. List the major impurities that may present in the river water. Prepare a checklist for the investigation of the river water as water supply source to Dhaka City. CO1, PO1: (08)

(b) Mention the unit treatment process/processes for removal of the following impurities in water. CO1, PO1: (05)
(i) Dissolved inorganic substances in water
(ii) Taste and odor
(iii) Fe/Mn and As in ground water
(iv) Colloidal and suspended particles in water
(v) Hardness of water.

(c) Why is population projection important in planning a water supply system? The population of a city obtained from the census data is given below. Estimate the population of the city by the end of **2031** by Arithmetic method and Geometrical Progression method. What will be the recommended volume of water required for firefighting in 2031? CO1, PO1: (09)

Year	1951	1961	1971	1981	1991	2001	2011
Population	25000	27500	34100	41500	47050	54500	61000

(d) (i) In a Jar test, rapid and through mixing is done initially and then gentle mixing is done for about 15 to 20 minutes. Explain why? CO1, PO1: (08)
(ii) Why does addition of alum in water treatment decrease pH of water?
(iii) Recarbonation of water after lime-soda softening is necessary, why is such recarbonation done?
(iv) Why the displacement efficiency is always less than one? What should be this efficiency in case of an ideal settling basin?

2(a) Water from PSF and RWH may contain pathogenic microorganisms. What are the major sources/causes of microbial contamination of harvested rainwater and PSF water? What disinfection strategies can be adopted for the disinfection of water from PSF and RWH? CO2, PO2: (06)

(b) (i) The performance of a circular basin is higher than a horizontal flow rectangular basin. Explain the reasons with settling diagram. CO2, PO2: (04)
(ii) Why is secondary disinfection required? What are the two most commonly used secondary disinfectants?

(c) List the chemical species that are included in the terms free available chlorine, chloramine, and total chlorine. Which of these chlorine forms is more effective disinfectant? CO2, PO2: (04)

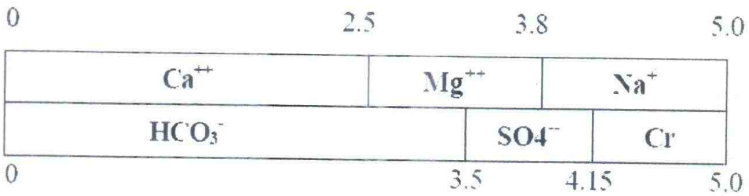
(d) Based on a hydraulic analysis, it was found that the travel time for water to be carried to the most distant customer is 26 hours in a city area. A laboratory study of the decay of chlorine in the filtered water yielded the results shown below. What **dose of chlorine** is required to maintain a residual of 0.5 mg/L of chlorine at the most distant customer's tap? The decay of chlorine in water can be expressed as $C_t = C_0 e^{-kt}$ CO2, (06)

Time, h	Chlorine residual, mg/L
0	1.1
1	1.02
3	0.90
6	0.76

3(a) What are the causes of alkalinity in water? Explain the type of hardness present in water under the following conditions: CO2, PO2: (05)

i. When alkalinity = hardness
ii. When alkalinity > hardness and pH < 8.3
iii. When alkalinity < hardness

(b) The bar graph of a well water in meq/L is shown below. Determine: CO2, PO2: (07)
(i) Total hardness and alkalinity of the water in mg/L as $CaCO_3$.
(ii) The softening chemicals required (kg/day) to remove the carbonate hardness, if the capacity of the treatment plant is 20,000 m^3/day.



(c) Explain the principle of ion exchange softening process. What are the limitations of this process? In ion exchange softening process, some raw water is by-passed and then added to the treated water-explain why? CO2, PO2: (05)

(d) Which type of tubewell will you suggest for the following cases of ground water table: CO2, PO2: (03)
(i) 5.5 m below the ground surface
(ii) 20.0 m below the ground surface
(iii) 50.0 m below the ground surface.

4(a) What are the effect of water pH, DO condition and alkalinity on the oxidation of Fe? A rural TW water contains excessive amount of Fe and Mn. Propose a flow diagram for the co-removal of Fe and Mn and list the chemical(s) need to be used in the process. CO2, PO2: (06)

(b) A treatment plant is to process 25,000 m^3/day of water. The rapid mixing plant will blend 40 mg/L of alum with the flow and have a detention time of 2 min. The tank to have square cross section with vertical baffles and a flat blade impeller. Determine the following: CO2, PO2: (06)
(i) Quantity of alum added (kg/day)
(ii) Dimensions of the rapid mixing tank
(iii) Power inputted (kilowatts) necessary for a G value of 850 sec^{-1}. The water temperature is 15°C and $\mu = 1.139 \times 10^{-3}$ N.s/m^2.

(c) The results of a chlorine demand test on a raw water at 20°C and 15 minutes contact time are provided below: CO2, PO2: (08)

Chlorine dosage (mg/L)	1	2	3	4	5	6	7	8	9	10	11
Residual chlorine (mg/L)	0.5	1.0	2.0	3.0	4.0	3.5	2.5	2.0	3.0	4.0	5.0

(i) Draw the chlorine demand curve
(ii) What is the break-point chlorine dosage?
(iii) What is the chlorine dosage necessary to achieve a residual of 1.0 mg/L free available chlorine?

5(a) What are the causes of formation of THMs in drinking water? State the strategies that can be followed in controlling THMs formation in the treated water. CO2, PO2: (04)

(b) State the characteristics of UV disinfection of water. Will secondary disinfection be necessary for water disinfected by UV radiation and why? CO2, PO2: (04)

(c) Outline the procedure for pressure and leakage testing of a newly constructed pipeline as per AWWA guideline. CO2, PO2: (03)

(d) What are the outcomes of undertaking Water Safety Plan (WSP)? Describe different categories of likelihood and impact of determining risk scores for WSP. CO2, PO2: (04)

(e) Drinking water is supplied to a Pourashava from ground water extracted via a deep tubewell and through a piped distribution with good quality control measures in place. The ground water contains high concentrations of both iron (10 mg/L) and Arsenic (1.0 mg/L). There is risk of ingress of contamination when there is low/no pressure in the system. Ignoring any control measures, calculate "raw risk" score and category for these three hazardous events: (i) high Fe concentration in ground water, (ii) high As concentration in ground water; and (iii) ingress of contaminants to the distribution system. CO2, PO2: (05)

Use rating of likelihood as almost certain (5), likely (4), possible (3), unlikely (2), Rare (1) and rating of impact as Insignificant (1), Minor (2), Moderate (3), Major (4), Catastrophic (5) with justification.

6(a) The ionic constituents of the well water as shown in **Q. 3(b)** is to be treated by ion exchange softening process. Design of an ion exchange system (volume of the resin and tank configuration) used to treat the well water to allow continuous operation if the regeneration time is 2 hours. CO3, PO3: (14)

The resin has an exchange capacity of 95 kg/m^3 when operated at a flow rate of 0.35 m^3/m^2.min. Calculate also NaCl requirement for regenerating of ion-exchange system, if regeneration is accomplished using 140 kg of sodium chloride per cubic meter of resin in 10% solution.

(b) DWASA has planned to construct a treatment plant based on Meghna river water to process 75,500 m^3/day. Pilot-plant analysis on mixed media filter indicates that a filtration rate or 15 m/hr can be acceptable in design. CO3, PO3: (07)

(i) Assuming a surface configuration of approximately 5.5m x 8m, how many filter units will be required to treat the water? Allow two units out of service for back washing.

(ii) The backwash velocity required to expand the filters is 36 m/h. Each back-wash period requires 15 min, and the water is wasted for the first 10 min of each filter run. Determine the net production of each filter, if the filter is back washed once a day.

(c) Results of sieve analysis of an aquifer material is given below: CO3. (14)

Sieve No.	Sieve Size (mm)	% material retained
4	4.75	0
8	2.36	0
16	1.18	0
30	0.60	0.3
40	0.425	1.2
50	0.30	20.8
100	0.15	69.4
200	0.075	7.2
Pan	-	1.1

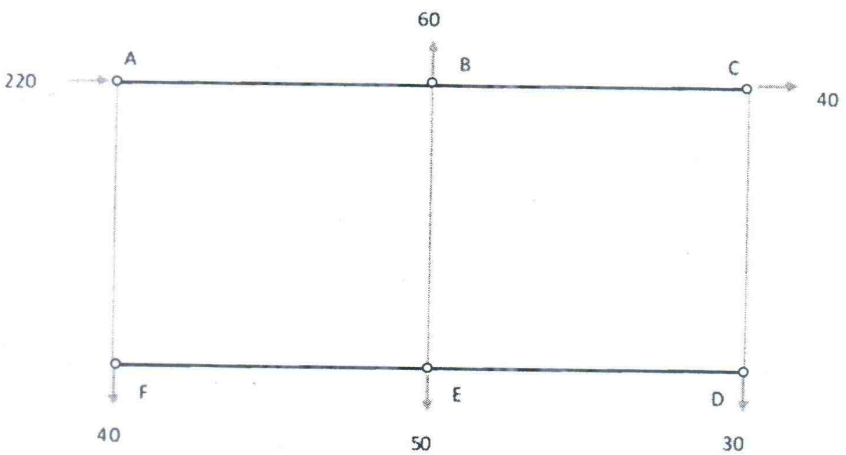
For this aquifer, is gravel pack necessary for shrouding? If yes, design the gravel pack and the slot size of the strainer to be used for the tubewell. The diameter of the well strainer is 150 mm and the opening of the strainer is 20% of the total surface area of the strainer, calculate the yield of this tubewell, if the length of strainer is 25m. Assume an entrance velocity = 0.02 m/sec.

7(a) For the pipe network as shown below, the head loss in the pipe is given by CO3, PO3: (15)

$$h_f = f\frac{L}{D}\frac{Q^2}{2gA^2}$$

Where, f is the friction factor, L is the length of pipe, D is the diameter of the pipe, A is the area of the pipe and Q is the flow rate through the pipe. The water supply and demand at each nodal point are also shown. Using the Hardy Gross method, design the pipe network (**flow in each pipe**). Use at least 02 iterations. All flows are in L/sec.

Pipe	AB	BC	CD	DE	EF	AF	BE
Length (m)	600	600	200	600	600	200	200
Dia (mm)	250	150	100	150	150	200	100
f	0.0157	0.0174	0.0205	0.0189	0.0172	0.0162	0.0205



7(b) Calculate the minimum capacity of the storage tank required for a family of 15 persons to be supplied with 12 lpcd of rainwater. The yearly rainfall intensity is 2500 mm and the rainfall distribution is such that at least 40% of the rainwater must be stored for uninterrupted water supply throughout the year. Also calculate the minimum catchment area required, if the runoff coefficient is 0.85. CO3, PO3: (05)

7(c) Design a sedimentation basin to treat water of 18,900 m^3/day for an overflow rate of 30 m/d, detention time of 4.0 hrs and 250 m^3/m.day weir loading rate. Use a rectangular basin with length to width ratio of 4 to 1. CO3, PO3: (05)