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B.Sc. Engg. (CEE)/ 4th Semester — 05 March, 2024 (Afternoon)

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

Mid Semester Examination — **Summer Semester: 2022-2023**
Course No.: CEE 4431 — **Full Marks: 75**
Course Title: Water Supply Engineering — **Time: 1.5 hours (2:30-4.00 PM)**

There are **03 (Three) Questions.** **Answer ALL the Questions**. The related CO-PO and the marks for each questions are also shown. Programmable calculators are not allowed. Do not write on this questions paper. The symbols have their usual meaning.

1(a) Groundwater is the preferred source of water supply in Bangladesh-explain why? List the impurities generally present in groundwater and propose a flow diagram for the treatment of the groundwater. CO1, PO1: **(06)**

(b) What are the differences between primary and secondary standards? CO1, PO1: **(06)**
A drinking water has the following characteristics:
Turbidity of water = 20 NTU, Fluoride = 2.5 mg/L, Fe = 1.2 mg/L, As = 65 µg/L, Nitrate = 20 mg/L and *E.coli* = 15 No. /100 mL.
List the health problems (short and long term) may arise from the drinking of this water.

(c) What are the differences between potable water and palatable water? CO1, PO1: **(05)**
What are the criteria of a safe water and list the impurities that must be removed from the raw water through water treatment in order to make water safe for drinking?

(d) The following is the population data of an urban area available from past census records. Determine the population of the area in 2041 by Least Square Parabolic method. CO1, PO1: **(08)**

Year	1961	1971	1981	1991	2001	2011
Population (Lakhs)	2.68	4.15	5.75	6.81	7.41	8.50

If the per capita water consumption in 450 lpcd, estimate the design capacity of the water treatment plant and the distribution network for water supply in the area for 2041. Also calculate the volume of water required for firefighting in 2041.

(e) (i) If coliform bacteria is not detected in a water sample, what can you conclude about the possibility of recent sewage pollution? If the coliforms are detected, will the water definitely cause disease among the people who drink it? Explain your answer. CO1, PO1: **(05)**
(ii) Why completely hardness free water is not desirable for drinking purpose?

2(a) The results of a settling column analysis are given below. The settling column is 2.0 m tall and the initial concentration of the well mixed sample is 220 mg/L. CO2, PO2: **(07)**

Time (min)	0	3	5	10	20	40	60
Conc. remaining (mg/L)	220	116	98	75	35	10	2

Calculate the removal efficiency of a settling basin that will receive this suspension, if the SOR is 435 m^3/m^2.day.

(b) (i) Aeration of groundwater prior to chemical softening can save a significant amount of chemical required for softening-explain how? CO2, PO2 **(04)**

(ii) Suppose that the depth of a sedimentation tank is reduced by 50%. Assume discrete particle settling, what is the effect on particle removal efficiency if the flow rate is unchanged? Explain your answer.

(c) A groundwater sample has the following ionic constituents in at 20^{O}C. CO2, PO2: **(08)**

Cations	Conc. (mg/L)	Anions	Conc. (mg/L)
Ca^{+2}	180	HCO_3^-	300
Mg^{+2}	65	CO_3^{-2}	40
Na^+	60	SO_4^{-2}	60
K^+	20	Cl^-	348
Fe^{+2}	0.5	NO_3^-	35

(i) Check the completeness of the chemical analysis using a bar diagram.

(ii) Classify the water in terms of hardness.

(iii) This water is required to soften by Caustic Soda (NaOH). Based on appropriate chemical reactions, calculate the amount of NaOH (in meq/L) required to remove all hardness from the water.

(d) The influent particles settling characteristics of a rectangular horizontal flow sedimentation basin is given below: CO2, PO2: **(07)**

Settling velocity, m/h	Number of particles in suspension, No./mL
0-0.4	460
0.4-0.8	578
0.8-1.2	891
1.2-1.6	1285
1.6-2.0	1748
2.0-2.4	1577
2.4-2.8	719

Calculate the particles counts at the outlet zone and the overall particle removal efficiency in this settling basin, if flow rate is 19,000 m^3/day and the length and width of the basin are 60 m and 8 m, respectively.

(e) A natural water with a flow rate of 3800 m^3/day is to be treated with an alum dose of 60 mg/L. Determine the chemical feed rate for the alum, the amount of alkalinity consumed by the reaction and the amount of precipitation produced in kg/day. CO2, PO2: **(04)**

3(a) Design a rapid mix and flocculation process to meet the following requirements: CO3, PO3: **(09)**

Flow Rate = 20,000 m^3/day

Rapid mix detention time = 30 sec and velocity gradient = 800/sec

Flocculator detention time = 3 stages at 12 min each

Flocculator velocity gradient: 1st stage = 50/sec, 2nd stage = 35/sec and 3rd stage = 20/sec.

Calculate the number of basins and basin geometry, also sketch the layout of your design. Assume water temperature is 20^{O}C ($\mu = 1.005 \times 10^{-3}$ kg/m-sec and density of water = 998.23 kg/m^3).

(b) (i) Design a rectangular setting basin for type-II setting to treat about 15,000 m^3/day of water. Flocculating particles are produced by coagulation and a column analysis indicates that an overflow rate of 20 m/day will produce satisfactory removal at a depth of 2.5m. CO3, PO3: **(06)**

(ii) A circular sedimentation tank is to be designed for a detention time of 4 hrs and a maximum SOR of 20 m^3/m^2.day. Determine the diameter and depth of the tank, if the average flow rate through the tank is 6 ML/day.