KATHMANDU UNIVERSITY
End Semester Examination
January/February 2024
1 2 FEB 2024

Marks Scored:

Level : B.Tech.
Year : III

Course : ENVE 302
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date :

SECTION "A"
[20Q. × 1 = 20 marks]

Choose and mark [X] the most appropriate answers from the given choices.

1. Conduit spanning from the source to the service reservoir is ______.
   [ ] transmission mains
   [ ] interruption chamber
   [ ] water treatment works
   [ ] collection chamber

2. Which of the following statements accurately describes the role of a Break Pressure Chamber (BPC) in distribution mains?
   [ ] The BPC increases the pressure rating of pipes to accommodate high-pressure systems, reducing overall costs.
   [ ] The BPC enables the use of low-pressure rating pipes in distribution mains, leading to cost optimization.
   [ ] The BPC minimizes the need for pipes in distribution mains, thereby reducing construction expenses.
   [ ] The BPC regulates water flow in distribution mains, resulting in improved system efficiency and increased costs.

3. The construction of an impounded reservoir typically required when _______.
   [ ] the rate of flow of the river in the driest period matches the demand for water.
   [ ] the rate of flow of the river in the driest period is less than the demand for water.
   [ ] the rate of flow of the river in the driest period exceeds the demand for water.
   [ ] there is no demand for water from the river during the driest period.

4. Which of the following characteristics is typically associated with a non-artesian aquifer?
   [ ] It is characterized by a confined water table and high-pressure conditions.
   [ ] It is primarily found in regions with excessive rainfall and high water demand.
   [ ] It often exhibits a fluctuating water table in response to variations in precipitation.
   [ ] It is commonly used for storing treated wastewater due to its exceptional purity.

5. Design year is :
   [ ] Base year + Base period
   [ ] Design period – Base year
   [ ] Survey year + Base year
   [ ] Base year + Design period

6. The concentration of Ca^{++}, Mg^{++} and Na^{++} in a given water sample is: 20 mg/L, 24.4 mg/L and 44 mg/L. Then, the total hardness of the sample is:
   [ ] 50 mg/L
   [ ] 100 mg/L
   [ ] 150 mg/L
   [ ] 250 mg/L

7. Three streams having discharge of $4 m^3/s$, $1 m^3/s$ and $5.5 m^3/s$ having pH value of 6.0, 7.0 and 8.0 meet at a single point. The pH measured downstream of meeting point (assume complete mixing occurs) is:
   [ ] 6.4
   [ ] 5.5
   [ ] 7.0
   [ ] 4.3

8. Check valve ________ in the pipeline.

[ ] releases the excessive water pressure [ ] releases the excessive air pressure
[ ] allows the flow only in one direction [ ] washes out the sediments deposited

9. Water distribution systems are sized to meet the ______.

[ ] average daily demand and fire demand
[ ] average hourly demand
[ ] maximum daily demand and fire demand
[ ] maximum hourly demand

10. The most common cause of acidity in waste is ____.

[ ] oxygen [ ] hydrogen [ ] nitrogen [ ] carbon dioxide

(For Q.N. 11 & 12) In planning a water supply scheme for a village, a source with an average discharge of 2 lps has been identified. The scheme requires a sedimentation tank with a capacity of 14.5 m^3 for water purification before distribution.

11. What is the Hydraulic Retention Time (HRT) of the sedimentation tank?

[ ] 8250 seconds [ ] 14.5 min [ ] 2.01 hours [ ] 0.004 days

12. Given the depth of the tank as 2.1 meters, the surface overflow rate is_____ m^3/m^2/day.

[ ] 10 [ ] 14.5 m^3/m^2/day [ ] 18.5 [ ] 24 m^3/m^2/day

13. For a sedimentation tank in a water treatment system, if the Flowing Through Period (FTP) is 2.4 hours and the Displacement Efficiency is 40%, what is the Detention Period (HRT)?

[ ] 0.96 h [ ] 1.71h [ ] 3.36 h [ ] 6.0 h

14. During a routine check, a water treatment plant measures a hydraulic head loss (h_L) of 30 cm in a bar screen. If the approach velocity (v) is 0.65 m/s and the velocity of flow through the openings (V) is observed to be 2.0 m/s, what is the value of empirical discharge coefficient (C)?

[ ] 0.61 m [ ] 0.607 [ ] 0.006 [ ] 60 m

15. The design parameter for flocculation is given by a dimensionless number G't, where G' is a velocity gradient and t is the detention time. Values of G't ranging from 10^4 to 10^5 are commonly used with t ranging from 10 to 30 min. The most preferred combination of G' and t to produce smaller and denser floc is:

[ ] large G' values with short t [ ] large G' values with long t
[ ] small G' values with short t [ ] small G' values with long t

16. Rate of filtration in slow sand filter is _____ $m^3/h/m^2$.

[ ] 0.1 to 0.2 [ ] 100 to 200 [ ] 1000 to 2000 [ ] 3000 to 6000

17. In the context of water treatment and bridging mechanisms, how does the molecular weight of bridging agents impact their effectiveness?

[ ] Higher molecular weight contributes to the formation of more stable and effective bridges
[ ] Higher molecular weight decreases the stability of bridges, reducing effectiveness
[ ] Lower molecular weight promotes the formation of stronger bridges, enhancing effectiveness
[ ] Molecular weight plays a negligible role in the effectiveness of bridging agents

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18. What can overdosing of activated silica lead to in the water treatment process?
[ ] Faster flocculation
[ ] Slowed flocculation and filtration problems
[ ] Improved filtration
[ ] Higher primary coagulant dose

19. Which of the following is considered as the major disadvantages of intermittent system of supply of water?
[ ] infiltration of impurities may occur through leaky joints
[ ] more number of valves required
[ ] consumers should store water
[ ] bigger pipes and pumps required

20. In network of pipes, __________.
[ ] the algebraic sum of discharges around each circuit is zero
[ ] the algebraic sum of head losses around each circuit is zero
[ ] the elevation of hydraulic grade line is assumed for each junction point
[ ] elementary circuits are replaced by equivalent pipes

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SECTION "B"
[7Q. × 5 = 35 marks]

Attempt *ANY SEVEN* questions. *Make logical assumptions wherever required. Some useful information/ formula are provided at the last page.*

1. Calculate the design water demand for the year 2102 B.S. for a rural village of Nepal. Use geometrical method for population forecasting. Census population is:

Census Year (B.S.)	2038	2048	2058	2068	2078
Population	8,500	10,050	14,000	18,400	22,800

Take 1 school with 80 boarders and 300 day scholars. Consider livestock demand also.

2. Determine the settling velocity of a discrete particle having the diameter of 0.11mm and specific gravity of 2.60 in water. The temperature of fluid is 21°C. Assume necessary data suitably.

3. Design a rectangular sedimentation tank (L:W = 3:1) to trap all particles larger than 0.04mm. The tapped flow is 10 MLD. Assume specific gravity=2.65 and temperature = 20°C. If the depth of the tank is 3.5m, calculate the detention time.

4. Draw plan and section of spring intake showing outlet, overflow and washout pipe. Also, discuss in brief on the protection measures of the spring intake with neat and clean diagram (plan and section).

5. Average water consumption rate in a village is 45lps. Design a Slow sand filter for a community having the population of 2500 at the base year 2080. Assume filtration rate suitably. Draw a plan and sectional view of your design with proper dimensions.

6. A flocculation chamber 30m long, 12m wide and 4.5m deep is to treat 75MLD of water. It is equipped with 12m long, 0.3m wide paddles supported parallel to & moved by four horizontal shafts which rotate at a speed of 2.5rpm. The center line of paddles is 1.8m from the shaft which is at mid depth of tank. Two paddles are mounted on each shaft opposite to each other. If mean velocity is one fourth of velocity of paddle, find:
   i. Power consumption
   ii. Time of flocculation
   iii. Value of G'

   Take $C_d = 1.8$ and $\vartheta = 1.31 * 10^{-6}$ m²/s (kinematic viscosity)

7. Discuss the difference between continuous and intermittent system of supply in water supply scheme.

8. Determine storage capacity of a service reservoir for a town containing 1 million population with 135 lpcd water demand. Assume uniform pumping from 6:00 to 18:00 hours. Variation in water demand is as tabulated below:

5:00 AM to 6:00AM	15% of days' supply
6:00 AM to 9:00 AM	25% of days' supply
9:00 AM to 12:00 PM	15% of days' supply
12:00 PM to 15:00 PM	10% of days' supply
15:00 PM to 18:00 PM	15% of days' supply
18:00 PM to 21:00 PM	20% of days' supply

SECTION "C"

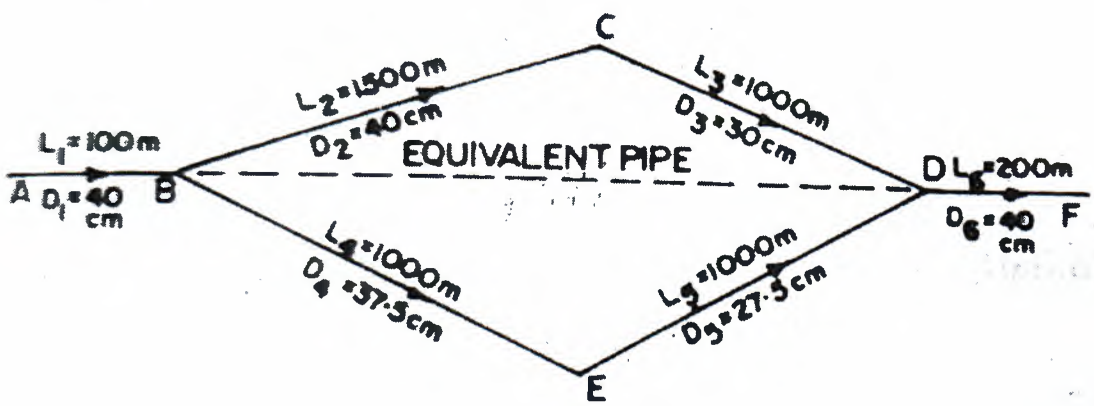
[2Q × 10 = 20 marks]

Attempt *ANY TWO* questions.

9. Define Coagulation, Flocculation and Coagulation Aids. Discuss the double layer compression theory for destabilization of colloids.

10. Design suitable diameter of continuous main transmission pipe PQ and QR. The average water requirement is 100lpcd. The storage tank is fixed at point P. The water is distributed only from the point Q for the population of 2000 and from the R for the population of 8000. The minimum pressure head of water is 10.0m. The reduced level (RL) of points P, Q and R are 625m, 575m and 550m respectively. Take Hazen William's coefficient as 100 and assume necessary data suitably.

11. Find the equivalent length of 30cm diameter pipe for the network shown below. Use Hazen Williams's formula.



List of useful Equations/Formula:

Population Forecasting

- Arithmetic method : $P_n = P_0 + nI$
- Geometric method: $P_n = P_0(1+r_g)^n$
- Incremental Increase method: $P_n = P_0 + nI + \frac{n(n+1)r}{2}$

Water Quality and Treatment

- Carbonate alkalinity $\left(\text{in } \frac{mg}{L} \text{ as } CaCO_3\right) = \frac{CO_3^{--}\ concentration}{0.6}$
- Hydroxide alkalinity $\left(\text{in } \frac{mg}{L} \text{ as } CaCO_3\right) = \frac{OH^{-}\ concentration}{0.34}$
- Bicarbonate alkalinity $\left(\text{in } \frac{mg}{L} \text{ as } CaCO_3\right) = \frac{HCO_3^{-}\ concentration}{1.22}$
- Hardness $\left(\text{in } \frac{mg}{L} \text{ as } CaCO_3\right) = \text{ion concentration } \left(\text{in } \frac{mg}{L}\right) \times \frac{\text{Equivalent weight of } CaCO_3}{\text{Equivalent Weight of ion}}$
- Equivalent weight of $CaCO_3$ is 50.
- Equivalent weights of principal cations Ca^{++}, Mg^{++} and Sr^{++} are 20, 12.2 and 43.8 respectively.
- Stoke's (Laminar) : $V_s = 418\,(S-1)d^2\,\frac{3T+70}{100}$
- Reynold's number, $R_e = \frac{V_s d}{\vartheta}$

S.N.	Law and Equation	Application for range of	
		Reynolds Number	Particle Size in mm, Specific gravity S=2.65 and Temperature T=20°C
1.	Stoke's (Laminar) $V_s = \frac{g d_p^2}{18\,\vartheta}(S-1)$	Up to 1	Up to 0.1
2.	Hazen's (Transition) $V_s = \sqrt{\frac{4\,g\,d_p}{3\,C_D}(S-1)}$ $C_D = \frac{24}{R_e} + \frac{3}{\sqrt{R_e}} + 0.34$	>1 to 2000	>0.1 to 1
3.	Newton's (Turbulent) $V_s = \sqrt{3.33\,g\,d_p\,(S-1)}$	>2000	>1

Temperature °C	**0**	**5**	**10**	**15**	**20**	**25**	**30**
Kinematic viscosity, v (Centistokes)	1.792	1.519	1.308	1.141	1.007	0.897	0.804

Water distribution

- Capacity of balancing reservoir = Maximum cumulative surplus + Maximum cumulative deficit + Total demand - Total inflow
-

Formulae	Head loss	K	n
Darcy Weisbach	$\frac{fLQ^2}{12.1\,d^5}$	$\frac{fL}{12.1\,d^5}$	2.0
Hazen William's	$\frac{10.68\,LQ^{1.85}}{d^{4.87}C^{1.85}}$	$\frac{10.68\,L}{d^{4.87}C^{1.85}}$	1.85
Manning's	$\frac{10.294\,n^2LQ^2}{d^{16/3}}$	$\frac{10.294\,n^2L}{d^{16/3}}$	2.0

- $\Delta Q = -\frac{\Sigma h_f}{n\,\Sigma \frac{h_f}{Q}}$

Design of Flocculation Chamber

- Power (P) = $G'^2\mu V$
- Also, Power (P) = $\frac{1}{2} C_d \rho_w A_b v^3$
- Kinematic viscosity $(\vartheta) = \frac{Dynamic\ Viscosity\ (\mu)}{Density\ of\ fluid\ (\rho)}$