Marks Scored:

KATHMANDU UNIVERSITY

End Semester Examination

February/March, 2019

Level : B.Tech. Course : ENVE 432

Year : IV Semester : I

Exam Roll No. : Time: 30 mins. F.M. : 20

Registration No.: Date 11 MAR 2019

SECTION "A"

[10 Q. × 1 = 10 marks]

Make reasonable assumptions for any missing data or information. Circle the best answer(s). Note that there could be more than one correct answer.

1. The nitrogenous oxygen demand is caused by:
   a. Autotrophic bacteria b. Heterotrophic bacteria
   c. Parasitic bacteria d. Saprophytic bacteria

2. The population equivalent of a city with average industrial wastewater flow of 0.2 MLD containing 1500 mg/l of BOD and per capita contribution of BOD =100 g/day is:
   a. 3,000,000 b. 3,000 c. 13 d. 13,333

3. A 2% solution of a sewage sample is incubated for 5 days at 20°C. The depletion of oxygen was found to be 5 mg/l. BOD_5 of the sewage is:
   a. 10 mg/l b. 50 mg/l c. 750 mg/l d. 250 mg/l

4. Which of the following are condition(s) favoring dilution, for directly discharging the wastewater into receiving water bodies:
   a. the receiving water is not a source of drinking water
   b. the diluting water has high content of BOD
   c. the floating matter and settleable solids have been removed
   d. the wastewater does not contain industrial wastewater having toxic substances

5. The critical point of DO sag curve is NOT the:
   a. point of minimum DO b. point of maximum BOD
   c. point of maximum deficit d. point of maximum removal of BOD

6. The velocity of flow of wastewater approaching the bar screen is 0.5 m/s, the head loss through the screens when the screen is fully clean is 15 mm. What will be the velocity of flow through the screen, when the screen is half clogged?
   a. 1.0 m/s b. 0.68 m/s c. 0.81 m/s d. 1.36 m/s

7. A wastewater sludge has a solids concentration of 1,000 mg/l. This concentration in percentage is equal to (assuming the density of solids to be 1000 kg/m^3):
   a. 10% b. 1% c. 0.1% d. 0.01%

8. The MLSS concentration in an aeration tank is 2000 mg/l and the sludge volume after 30 min. of settling in a 1000 ml graduated cylinder is 176 ml. SVI for the given condition is:
a. 88 mg/l b. 88 ml/g c. 352 g/l d. 88 ml/mg

9. Which of the following is not dewatering technique:
a. Centrifuge b. Filter press c. Vacuum filter d. Rotatory drum

10. In an adsorption processes, stronger binding sites are occupied first and adsorption energy decreases .....until the adsorption process completes.
a. logarithmically b. linearly c. exponentially d. quadratically

SECTION "B"

[10 Q.× 0.5 = 5 marks]

11. Complete the reaction involved in assimilation of organic constituents in anaerobic treatment process:

Organic contaminants + ...⟶.....+.....+ .....

12. Complete the reaction involved in assimilation of organic constituents in aerobic treatment process:

Organic contaminants + ...+..... ⟶ ..... + ... + ...

13. During the 5 day period of BOD test ..... % of oxidation is completed, and within 20 days period, the oxidation is about ..... %.

14. Grit are the ..... solids which have specific gravity ranging from .....

15. The objective of the biological treatment of wastewater is to ..... and remove nonsettleable ..... solids.

16. In ..... system, the F/M and oxygen demand will be uniform throughout the tank.

17. In activated sludge processes, the functions of aeration are:

a. .....

b. .....

c. .....

18. Rock Filter is an example of ..... process.

19. The ..... assumes that a fixed number of adsorption sites is present on the adsorbent's surface.

20. Physical adsorption occurs due to ..... force.

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SECTION "C"
[10 Q. × 0.5 = 5 marks]

Define in one or two sentence(s).

21. Self-cleansing of river

22. Aeration period

23. Sludge age

24. Tapered aeration process

25. Mixed liquor

26. Jar test

27. Fixed film process

28. Unit operations

29. COD/BOD ratio

30. Endogenous respiration

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Time : 2 hrs. 30 mins. F.M. : 55

SECTION "D"

[5Q. × 4 = 20 marks]

(Refer last page for useful equations/formula. Make logical assumption for any missing data or information.)

Attempt *ALL* questions.

1. The 4 day 15°C BOD of a sample of sewage is 200 mg/l. Draw a graph of 5 day BOD as a function of temperature in the range of 10°C to 30°C in steps of 5°C. Take value of K (base 10) at 20°C as 0.1 day^{-1}.

2. Draw a schematic diagram of typical wastewater treatment plant showing different unit processes in preliminary processes, primary treatment and secondary treatment.

   Also, list out the objectives of each unit processes, the mechanism adopted and methods of disposal of waste from each unit processes as shown in the table below. [2+2]

Unit Processes	Objective(s)	Mechanism(s)	Methods of Disposal
Screening	To remove dead animals, bottles, cups, sanitary pads, etc.	Bar racks are placed to screen out the larger particles.	Landfilling or incineration.

3. The designed average flow of a municipal wastewater treatment plant is 0.438 m^3/s. Design an aerated grit chamber using the given conditions:

   Peak factor = 3

   Detention time of peak flow rate = 4.0 min

   Select width = 3 m and use depth-to-width ratio = 1.5:1

   Air supply: 0.44 m^3/min per meter of length

   Grit produced = 0.053 m^3 of grit per 10^3 m^3 of flow.

   Compute the air supply needed per second and also estimate the average volume of grit produced per day.

4. Making suitable assumptions, derive the mean cell residence time (θ_c) as a function of recycle ratio (r) and X_r/X ratio in a completely mixed-cellular recycle system; where 'X_r' is the concentration of solids in the returned sewage and 'X' is the microbial mass concentration.

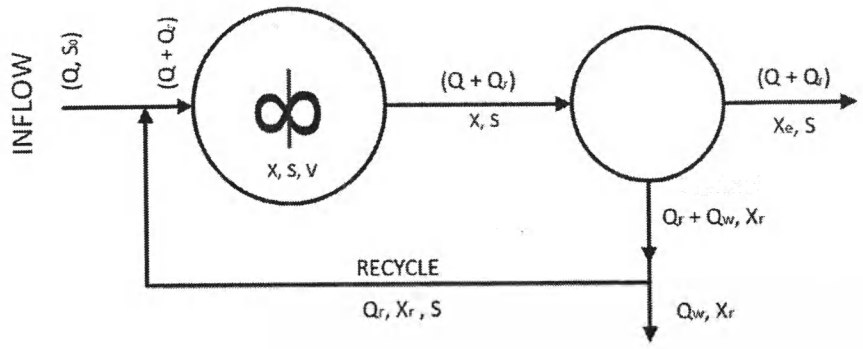

Fig: Completely mixed process of solids recycle

5. The daily sludge production of Guheswori WWTP is 200 m^3 which is planned to digest aerobically. A characterization study done prior to designing showed concentration of solids as 2.5% at 25°C. Determine the **a)** time of aeration and **b)** volume of the digester tank provided with the following conditions: Volatile suspended solid reduction is 38%, and the endogenous rate k_d is 0.25 day^{-1}. The non-degradable fraction of the sludge is 0.40. [2+2]

SECTION "E"

[5Q. × 7 = 35 marks]

6. A wastewater contains the following constituents:

   40 mg/l phenol (C_6H_5OH), 350 mg/l glucose ($C_6H_{12}O_6$), 3 mg/l S^{2-}, 50 mg/l methyl alcohol (CH_3OH), 100 mg/l isophorene ($C_9H_{14}O$) (nondegradable).

   a. Compute COD, TOC, and BOD_5 assuming the k_{10} for the mixed wastewater is 0.25 day^{-1}. [2+2+1.5]

   b. After treatment the soluble BOD_5 is 10 mg/l with a k_{10} of 0.1 day^{-1}. Compute the residual COD. [1.5]

7. A stream, saturated with DO, has a flow of 1.2 m^3/s, BOD of 4 mg/l and rate constant of 0.3 day^{-1}. It receives an effluent discharge of 0.25 m^3/s having BOD 20 mg/l, DO 5 mg/l and rate constant 0.13 day^{-1}. The average velocity of flow of the stream is 0.18 m/s. Calculate the DO deficit at point 20 km and 40 km downstream. Assume that the temperature is 20°C throughout and BOD is measured at 5 days. Take saturation DO at 20°C as 9.17 mg/l. [7]

8.

   a. What are intermittent sand filters? Explain its design and operation with neat and clean sketch. [4]
   b. Write short notes on sloughing (scouring of the slime/unloading of the filter). [3]

9. Average operation conditions of oxidation ditch for a community is as mentioned:

i. Population of the community = 6000 persons
ii. Organic load of sewage: 40 g BOD per capita per day
iii. Sewage flow: 160 liters/capita/day
iv. Permissible BOD of effluent: 20 mg/l
v. F/M = 0.1; MLSS = 3000 mg/l; SVI = 100

Based on the information provided:

a. Determine the inflow rate and influent BOD [1]
b. Calculate the volume of the ditch [1]
c. Determine the volumetric loading rate [1]
d. Determine the hydraulic retention time [1]
e. Determine the return sludge ratio [1]
f. Design the settling tank provided with the surface overflow rate (SOR) of 20 $m^3/m^2/day$ and detention time of 2 hours [2]

10. An experiment was conducted in KU laboratory to adsorb Pb^{2+} (Molecular weight 207.2 g/mol) by using Parsley as an adsorbent. 10 g of adsorbent was used to treat 1 L of contaminated water. Removal of different concentrations of Pb^{2+} is presented in the table below.

Initial Pb^{2+} concentration (mg/l)	3	5	7	9	11
Equilibrium concentration (mg/l)	0.6	1.25	2.77	4.21	5.88

a. Find the adsorption capacity of Parsley in each case. [2]
b. Find the equation of the curve obtained for Langmuir isotherm [plotted between C_e (x-axis) and C_e/q_e (y-axis)] and the equation of the curve obtained for Freundlich isotherm [plotted between log C_e (x-axis) and log q_e (y-axis)]. [2+2]
c. Also state with verification whether the adsorption process occurs by forming monolayer or multilayer. [1]

List of useful Equations/Formula:

- van't Hoft-Arrhenious relationship: $K_T = K_{20}\theta^{(T-20)}$; [θ=1.135 for 4-20°C , 1.056 for 21-30°C]
- Streeter- Phelps Equation: $D_t = \frac{K*L_0}{R-K}[10^{-K*t} - 10^{-R*t}] + D_0 10^{-R*t}$
- $t = \frac{X_0 - X_e}{k_d(X_e - X_n)}$
- $xV = \frac{YQ\theta_c(S_0 - S)}{1+k_d\theta_c}$
- $(Q + Q_r)x = Q_r x_r$
- $\frac{Q_r}{Q} = \frac{x_t}{\frac{10^6}{SVI} - x_t}$
- $T = \frac{L_a}{20} - 1$ $(American\ Public\ Health\ Association\ Formula)$
- $E = \frac{100}{1+0.44\sqrt{U}}$