KATHMANDU UNIVERSITY
End Semester Examination
June/July, 2023

Marks Scored:

Level : B.E.
Year : III

Course : CHEG 322
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : 17 JUL 2023

SECTION "A"
[20Q. × 0.5 = 10 marks]

Encircle the most appropriate answer.

1. The chemical most commonly used to increase speed of sedimentation of sewage is
   a. Sulphuric acid
   b. Copper sulphate
   c. Lime
   d. Sodium permanganate

2. Facultative bacteria are able to work in
   a. Presence of oxygen only
   b. Absence of oxygen only
   c. Presence as well as in absence of oxygen
   d. Presence of water

3. The correct relation between theoretical oxygen demand (TOD), Biochemical oxygen demand (BOD) and Chemical oxygen demand (COD) is given by
   a. TOD > BOD > COD
   b. TOD > COD > BOD
   c. BOD > COD > TOD
   d. COD > BOD > TOD

4. Which of the following causes a decrease in per capita consumption?
   a. Use of metering system
   b. Good quality of water
   c. Better standard of living of the people
   d. Hotter climate

5. The rate of BOD exerted at any time is
   a. Directly proportional to BOD satisfied
   b. Directly proportional to BOD remaining
   c. Inversely proportional to BOD satisfied
   d. Inversely proportional to BOD remaining

6. If the sewage contains grease and fatty oils, these are removed in
   a. Grit chamber
   b. Detritus tanks
   c. Skimming tanks
   d. Sedimentation tanks

7. Composting and lagooning are the methods of
   a. Sludge digestion
   b. Sludge disposal
   c. Sedimentation
   d. Filtration

8. Enhanced biological phosphorus removal is performed by
   a. Anaerobic autotrophic
   b. Aerobic autotrophic
   c. Anaerobic heterotrophs
   d. Aerobic heterotrophs

9. What is limiting nutrient for eutrophication in the sea?
a. Nitrogen b. Phosphorus c. Sulphur d. Calcium

10. For the same solid content, if the quantity of sludge with moisture content of 98% is X, then the quantity of sludge with moisture content of 96% will be
a. X/4 b. X/2 c. 2X d. 4X

11. The dissolved oxygen level in natural unpolluted waters at normal temperature is found to be of the order of (in mg/L)
a. 1 b. 10 c. 100 d. 1000

12. What does Tanner's triangle assess?
a. Compactness of waste
b. Permeability of waste
c. Voidness of waste
d. Combustibility of waste

13. What are key variables in characterizing as fuel?
a. Moisture, inorganic, organic
b. Moisture, ignitability, organic
c. Moisture, ignitability, inorganic
d. Ignitability, organic, inorganic

14. Activated carbon is used for
a. Disinfection
b. Removing hardness
c. Removing odors
d. Removing corrosiveness

15. What does RDF mean?
a. Residual derived fuel
b. Refuse derived fuel
c. Reuse derived fuel
d. Recycle derived fuel

16. In a BOD test, 1 ml of raw sewage was diluted to 100 ml and the dissolved oxygen concentration of diluted sample at the beginning was 6 ppm and it was 4 ppm at the end of 5-day incubation at 20 °C. The BOD of raw sewage will be
a. 100 ppm b. 200 ppm c. 300 ppm d. 400 ppm

17. What is the best way to maintain CN ratio in composting?
a. Co-composting
b. Dilution
c. Increase water content
d. Increasing temperature

18. What is the recommended moisture content of finished compost?
a. 15% b. 30% c. 50% d. 70%

19. Activated sludge process is an example of
a. Anaerobic suspended growth process
b. Anaerobic attached growth process
c. Aerobic attached growth process
d. Aerobic suspended growth process

20. Blue baby disease found in infants is due to excessive _____ in drinking water.
a. Color b. Sulphates c. Carbonates d. Nitrates

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Level : B.E.
Year : III
Time : 2 hrs. 30 mins.

Course : CHEG 322
Semester : II
F. M. : 40

SECTION "B"
[5Q. × 8 = 40 marks]

Attempt *ALL* questions.

1.

a. Why is the Biochemical Oxygen Demand (BOD) determined over a duration of 5 days? Explain with a graph. [3]

b. What is the Nereda® process and what removal processes does it perform? [2]

c. List at least five resources that can be recovered or generated from wastewater. [3]

2.

a. What is the ANAMMOX process? Show schematic diagram. [3]

b. Design and explain a biological nutrient (nitrogen and phosphorus) removal activated sludge wastewater treatment plant. Schematic diagram only. [5]

3.

a. A municipal wastewater treatment facility operates at a flow rate of 1,500 m^3/hr. Residual chlorine reaches the end of the chlorine contact chamber at a concentration of 1.2 mg/l as Cl_2. At what mass rate must $NaHSO_3$ be added to the effluent to accomplish complete dechlorination. Express your answer in kg/d. [4]

b. Explain what the sludge volume index (SVI) is and its practical relevance. [2]

c. What is the difference between municipal wastewater treatment and industrial wastewater treatment? [2]

4.

a. Different samples of waste collected in a city have been taken and analyzed. It has been found that it can be divided into four categories which are Food Waste, Paper, Cardboard and Plastic. Amount of potentially critical elements against each category can be found in the table below.

Component	Wet mass in kg	Dry mass in kg	Moisture in kg	Composition in kg					
				C	H	O	N	S	Ash
Food Waste	16	5	11	2.40	0.32	1.88	0.13	0.02	0.26
Paper	46	43	3	18.70	2.58	18.92	0.13	0.08	2.58
Cardboard	11	10	1	4.40	0.59	4.46	0.03	0.02	0.51
Plastic	11	10	1	6.00	0.72	2.38	0.00	0.00	1.00

Find

i. Approximate formula of solid waste [4]

ii. Energy contents of solid waste per Kg. (Assume that Ash is already removed before incineration) (BTU/lb =145C +610(H - 1/8 O) + 40S +10N) [2]

b. What is a logical priority in managing hazardous waste? Be creative. [2]

5.

a. A mesophilic (35 °C) UASB reactor treating hydrolysate operating at organic loading rate (OLR) of 10 $kgCODm^{-3}d^{-1}$ has methane production of 126 Nm^3h^{-1}. The COD value of the hydrolysate feed is 4 gCOD/L. Assuming 75 % COD removal which ends up as produced methane, calculate a) HRT and b) Reactor volume. [3]

b. What is organic loading rate (OLR) in anaerobic digestion? What happens when you have high OLR? [2]

c. What are the differences between high rate reactors and low rate reactors. Also give two examples of each. [3]