KATHMANDU UNIVERSITY
End Semester Examination
May/June, 2022

Marks Scored:

Level : B.E.
Year : III
Course : CHEG 322
Semester : II

Exam Roll No. :
Time: 30 mins.
F. M. : 10

Registration No.:
Date :

SECTION "A"
[20Q. × 0.5 = 10 marks]

Encircle the most appropriate option.

1. Out of five Rs' of resource effectiveness, what does Rectify mean?
   a. Treatment before disposal
   b. Modification before use
   c. Disposal of waste
   d. Reuse without any further operation

2. In water engineering, the particle size of filters and is expressed using the uniformity coefficient $UC = D_{60}/D_{10}$, what does D_{60} mean?
   a. 60% of the particle (sieve) size are retained
   b. 60% of the particle (sieve) are smaller than that size
   c. 60% of the particle (sieve) are settled particles
   d. 60% of the particle (sieve) are suspended particles

3. Coefficient of permeability of compacted waste may be determined as $K = C_d^2\gamma/\mu$. What does C_d^2 mean?
   a. Constant or compressibility factor
   b. Constant or shape factor
   c. Constant or permeability factor
   d. Constant or Cunningham correction factor

4. In design and operation when packaging or compacting solid waste in a landfill, it is of value computing size of reduction in volume. How do you calculate volume of reduction?
   a. $F = V_0+V_c$ b. $F=V_0\times V_c$ c. $F= V_0/V_c$ d. V_c/V_0

5. What is alkalinity?
   a. Total acid concentration in the reactor
   b. Total base concentration in the reactor
   c. Ability to buffer proton fluctuation
   d. Total alkaline concentration in the reactor

6. How is alkalinity represented?
   a. $CaCO_3$ equivalent
   b. H_2SO_4 equivalent
   c. NH_4^+ equivalent
   d. Cl^- equivalent

7. Nitrification is performed by
   a. Anaerobic autotrophic chemolithotrophs
   b. Aerobic autotrophic chemolithotrophs
   c. Anaerobic heterotroph chemolithotrophs
   d. Aerobic heterotroph chemolithotrophs

8. Denitrification is performed by
   a. Facultative anaerobic autotrophic
   b. Facultative aerobic autotrophic
   c. Facultative anaerobic heterotrophs
   d. Facultative aerobic heterotrophs

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

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

11. What is ThCOD of $C_3H_6O_2$ in g O_2/g $C_3H_6O_2$?
   a. 0.5 b. 1.5 c. 2.5 d. 3

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. Which of the following is a type of incinerator?
   a. Moving grate b. Rotary grate c. Fluidized grate d. Fixed grate

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

16. Why is peak heating phase in composting important?
   a. To recover heat for other use b. To kill pathogens and weed seeds
   c. To improve bacterial activities d. To keep birds away from the pile

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. What happens in preliminary wastewater treatment?
   a. Grit removal b. Sedimentation
   c. Equalization of flow d. BOD removal

20. What is the chemical formula of cell mass?
   a. $C_5H_7O_2N$ b. $C_7H_5O_2N$ c. $C_5H_7N_2O$ d. $C_7H_5N_2O$

KATHMANDU UNIVERISTY
End Semester Examination
May/June, 2022

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 *ANY FIVE* questions.

1. a. Define gasification and pyrolysis. [1+1]

   b. You have been hired as a waste management expert in Dhulikel municipality. List what should you consider during waste management.
   Also, newly elected mayor is planning to install an incineration plant to manage municipal waste (only). You have been asked to evaluate his plan. Please write in points, why his plan might not be the best option and also suggest why composting can be a better alternative? [2+2+2]

2. 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
   i. HRT [1]
   ii. Reactor volume [7]

3. a. Anaerobic digestion has different rate limiting steps (slowest steps) depending upon the feed types. Give an example of feed type for each limiting step. [2+2]

   b. Find the missing values in the given tables (i and ii). Explain what you observed with the help of an each graph, [1+1+2]

(i)	Industrial wastewater	Municipal wastewater
Ultimate BOD (mg/l)	457	243
BOD decay constant (k) (day^{-1})	0.115	0.345
BOD_5 (mg/L)	?	?

(ii)	Wastewater at 20 °C	Wastewater at 10 °C
Ultimate BOD (mg/l)	?	?
BOD decay constant (k) (day^{-1})	0.2615	0.0737
BOD_5 (mg/L)	50	21

4. The town of Chovar has filed a complaint with the environment department that the town of Dhobhighat is restricting its use of Bagmati river because of the discharge of raw sewage. The environment department water quality criterion for the Bagmati river is 5 mg/L of DO. Chovar is 15.55 km downstream. Saturated DO concentration at 16 °C is 9.95 mg/L. Temperature correction factor (θ) for k_d is 1.135 and for k_r is 1.024. [2+3+3]

i. What is the DO at Chovar?

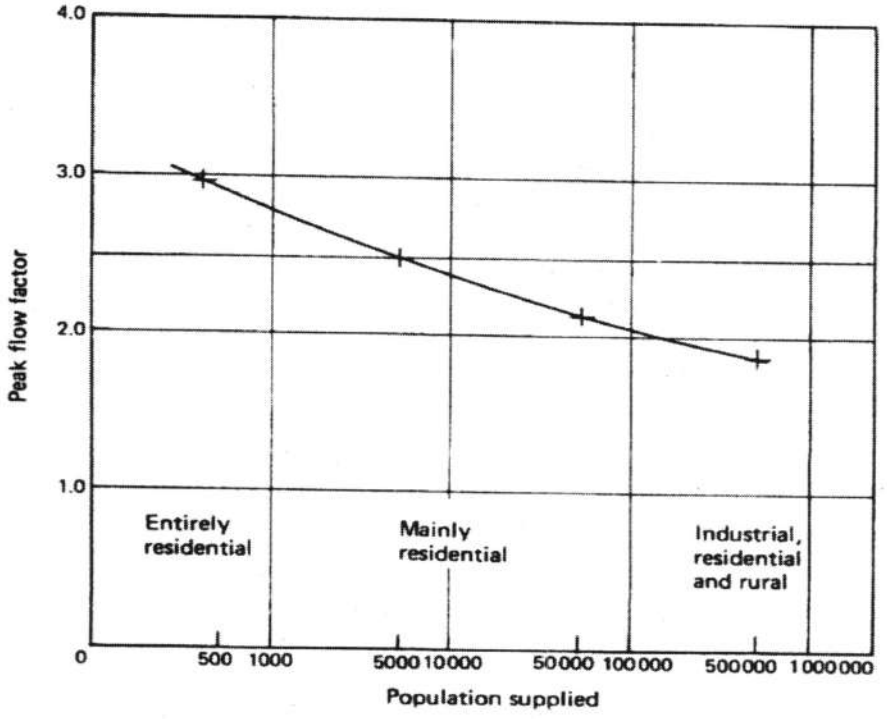
ii. What is the critical DO?

iii. Where (at what distance) downstream does the critical DO occur?

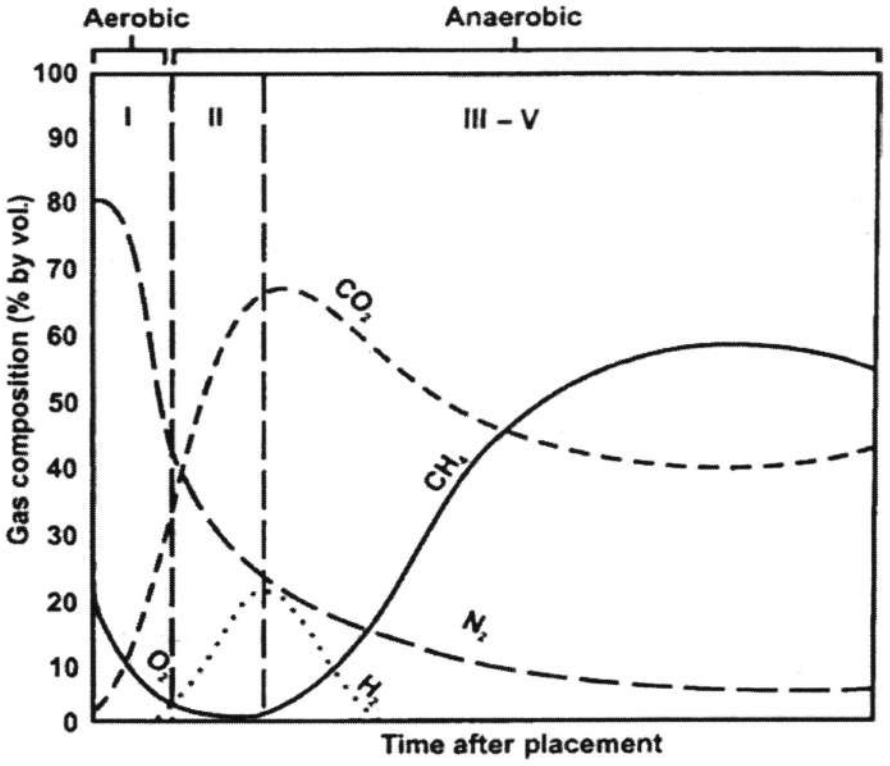
The following data pertain to the 7-day, 10-year low flow at Dhobhighat.

Parameter	Wastewater	Bagmati river	Units
Flow	0.1507	1.08	m^3/s
UBOD	144.17	11.4	mg/L
Dissolved oxygen	1	7.95	mg/L
Velocity		0.390	m/s
k_d at 20 °C		0.4654	day^{-1}
k_r at 20 °C		0.5212	day^{-1}
Temperature	16	16	°C

5. a. Explain the following graph. [3]



b. Explain what happens in the phases I to V during landfill. [5]



6. a. In a waste management system, out of 100 MT of MSW, 9.21% of recyclable materials are sorted out at source and rest of the garbage is went for final disposal. At 25°C, gaseous pollutants like methane is generated as 47.7% (v/v) and CO_2 is generated as 47% (v/v). Landfill gas generation per ton is 150 m^3. If methane is 21 times more potential GHG than CO_2, the certified GHG emission as CO_2-equivalent from 100 MT of MSW will be how much MT? [6]

b. List chemical properties of solid wastes. [2]

Important formulas:

$$D = \frac{k_d L_a}{k_r - k_d}\left(e^{-k_d t} - e^{-k_r t}\right) + D_0 e^{-k_r t}$$

$$t_c = \frac{1}{k_r - k_d} \ln\left[\frac{k_r}{k_d}\left(1 - \frac{D_0(k_r - k_d)}{k_d L_a}\right)\right]$$

$$D = S - C$$

$$BOD_t = UBOD\,(1 - e^{-kt})$$