M.E. (Water Resources & Hydraulic Engineering) Examination, 2024

AQUATIC ECOLOGY AND ENVIRONMENT

(Paper - I)

Time: Three Hours | Full Marks : 100

Answer any ***four*** questions.

1. (a) A wastewater treatment plant disposes off its effluent in a surface stream. Characteristics of the stream and effluent are shown below: *Assume Sat. DO= 9.17 mg/L (20^0C)*

The sewage discharge of a town is 1.72 m^3/s. If the sewage is discharged into a river, whose minimum discharge is 7240 l/s. If the minimum dissolved oxygen to be maintained in the river is 4.4 mg/l, determine the degree of sewage treatment to be done with the following data

Temperature of sewage = temperature of river = 20^0C, value of K_d=0.12/day and K_r=0.35/d, BOD_5 at 20^0C of sewage = 260 mg/l, BOD_5 at 20^0C of river= 1.5 mg/l, dissolved oxygen in sewage =0, dissolved oxygen at saturation in river =85%

(b) The rate of change of oxygen deficit in a river can be expressed using standard notation as

$$\frac{dD}{dt} = K_d \text{ x } L - Kr \text{ x } D$$

Deduce the mathematically to establish the value of t_c and D_c for oxygen sag curve equation

(13+12=25)

2. (a) What is DBU? Classify the different types of streams sanitation and quality criteria.

(b) Explain briefly different types of waste products. What is self-purification of stream? Classify different types of self-purification and describe them in brief.

(c) The concentration of CO in a street intersection reaches the federal ambient standard of 120 ppm_v. Supervisor from the department of public works are repairing a break in the water line. Estimate the CO concentration in their blood after 1hr of work and make conclusion as to their work performance. Assume (α=2)

(d) Write shot note on Carbon cycle.

(6+8+8+3=25)

3. (a) Estimate the quantity of carbon and oxygen (in gigatonne) in the atmosphere corresponding to a concentration of CO_2 of 1.2 ppm_v. Assume the total mass of air equals to 5.78 $x10^{21}$ gm. Density of air at 28^0 C and 860 mm of Hg pressure is 2.82 kg/m^3.

   (b) National Ambient Air Quality Standard (NAAQS) for Carbon Monoxide and Ammonia (CO and NH_3) are 50 mg/m^3 and 500 $\mu g/m^3$ respectively at a temperature of 28°C and 1.5 atmosphere of pressure. Express the concentration in ppm_v for both. (13+12)

4. Design a WSP System having future population of 80000 with a supply of water 135 lpcd to treat wastewater generating from a town which has a BOD of 250 mg/L. The expected treated effluent has to be maintained as per the norms prescribed by the NGT as given below. The design temperature is 25^0C. Following information are available for the design:

   Characteristics of wastewater:

   pH = 7.7, SS = 240 mg/l, COD = 390 mg/l, FC = $4x10^6$/100 ml

   Solar radiation:

   Winter: Maximum = 170 cal/cm^2 day

   Minimum = 110 cal/cm^2 day

   Sky clearance factor = 0.7

   Wastewater temp = 25^0C

   Average ambient temperature = 20^0C

   K_p for pond at 25^0C = 0.15/day

   Expected treated effluent characteristics:

   pH = 6.5 to 8, BOD ≤ 10 mg/l, FC ≤ 230 MPN/100 ml

   Assume any other value for the design, if required.

Table Design values of permissible volumetric BOD loadings on and percentage BOD removal in anaerobic ponds at various temperatures

Temperature (°C)	Volumetric loading (g/m^3d)	BOD removal (%)
<10	100	40
10-20	$20T$ -100	$2T$ +20
20-25	$10T$ + 100	$2T$ + 20
>25	350	70

T = temperature, °C.

Table Variation of design BOD loading on facultative ponds in India with latitude

Latitude (°N)	Design BOD loading (kg/ha day)
36	150
32	175
28	200
24	225
20	250
16	275
12	300
8	325

Table Values of the first order rate constant for faecal coliform removal at various temperatures (calculated from equation 4.15)

T(°C)	k_T(day^{-1})	T(°C)	k_T(day^{-1})
11	0.54	21	3.09
12	0.65	22	3.68
13	0.77	23	4.38
14	0.92	24	5.21
15	0.09	25	6.20
16	1.30	26	7.38
17	1.54	27	8.77
18	1.84	28	10.46
19	2.18	29	12.44
20	2.60	30	14.81

(25)

5. (a) What are the important steps in the EIA with EMP Process to be followed?

(b) In a BOD determination, 6mL of waste water containing no dissolved oxygen is mixed with 294 mL of dilution water containing 8.6 mg/L of dissolved oxygen. After a 5day incubation at 20°C, the dissolved oxygen content of the mixture is 5.4 mg/L. Calculate the BOD of the waste water.

(c) The 5-day 20°C BOD of waste water is 210mg/L. What will be the ultimate BOD? What will be the 10day BOD? If the sample had been incubated at 30°C. What would be the 5-day BOD have been (k_d = 0.23d^{-}1)?

(8+8+9=25)

6.(a) What is the importance of Chemical Composition of solid waste, and what do you mean by Proximate analysis?

(b) What do you mean by hazardous wastes? Based on what characteristics a waste can be termed as hazardous?

(c) Write down two classifications of materials comprising municipal solid waste and two general sources of municipal solid waste?

(d) Determine the moisture content of a 120 kg solid waste sample. Composition given in Table.

(e) Determine the total and unit energy content in a 160 kg solid waste sample with the composition given in Table 1.What is the content on a dry basis and on an ash-free dry basis?
Assume moisture content of the waste is 21.5%, and ash content is equal to 5%. Energy content of municipal solid wastes is given in Table.

(f) What is *modified Dulong formula.*

(g) Explain the 'landfill' land disposal technique of hazardous Waste.

(4+3+2+5+5+2+4=25)

Table

Component	Food wastes	Paper	Cardboard	Plastics	Garden Trimming
Percent by mass	28	22	15	30	5