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

(1st Semester)

AQUATIC ECOLOGY AND ENVIRONMENT

(Paper - I)

Time: Three Hours Full Marks : 100

Answer any ***four*** questions.

1. (a) A milk products industry discharges a wastewater to a stream. Characteristics of the wastewater and the stream are shown below.
   i. If no treatment at all is given to the wastewater what will be the lowest oxygen level in the stream as a result of the discharge?
   ii. If the stream is a trout fishery and the stream standards require a minimum DO of 5.0 mg/L, what is the maximum BOD_5 (20^0C) that can be discharged by the industry?

Parameter	Wastewater	Stream
Flow	1000 m^3/d	19, 000 m^3/d
BOD_5 at (20^0C)	1250 mg/L	2.0 mg/L
DO	0 mg/L	10.0 mg/L
Temperature at ^0C	50	10
k_1 at 20^0C	0.35 d^{-1}	-
K_2 at 20^0C	-	0.55 d^{-1}

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

$$\frac{dD}{dt}=K_DL-K_RD$$

Deduce the mathematically to establish the value of D_c and t_c when maximum deficit occurs in the oxygen sag curve equation. (15+10)

2. Design a WSP System having future population of 60000 with a supply of water 135 lpcd to treat wastewater generating from a town which has a BOD of 200 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 = 7.6, SS = 235 mg/l, COD = 310 mg/l, FC = $5x10^6$/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)

3. (a) Highlight discharge standard for treated sewage revised by Ministry of Environment & Forest and Climate Change, Govt. of India.
(b) State use based classification of surface water laid down by Central Pollution Control Board, Govt. of India.

(c) The BOD of a sewage incubated for one day at 30^0C has been found to be 110 mg/L. What will be the 5-day 20^0C BOD? Assume K_D at 20^0C = 0.1 per day.

(d) What are the different types of self-purification? What are the different types of waste products, describe them with example?

(6+8+5+6=25)

4. (a) Define DBU, what are the factors depend on, describe them?
(b) (i) The concentration of CO in a street intersection reaches the federal ambient standard of 35 ppm. Crewmen from the department of public works are repairing a break in the water line. Estimate the CO concentration in their blood after 1 hr of work and make conclusion as to their work performance. Assume α=2

(ii) How much exposure time (maximum) will be needed when a man doing some physical activity (α=2) is exposed if the ratio of CO and O_2 in the blood is found to be 1:12 for the CO in air breathed is 35 ppm_v?

(c) Write shot note on health Effects of HbCO at various levels in the blood.

(4+8+8+5=25)

5. (a) Estimate the quantity of total carbon (in gigatonne) in the atmosphere corresponding to a concentration of CO_2 of 1.5 ppm_v as well in global air having 325 ppm. Assume the total mass of air equals to 5.19 $x10^{21}$ gm. Density of air at 22^0 C and 780 mm of Hg pressure is 1.69 kg/m^3.

(b) Give a Schematic Diagram for Global Average Energy Flow in case of short and long wave side.

(c) Describe Nitrogen Cycle and Oxygen Cycle with diagram.

(d) California's air quality standard for nitrogen dioxide is 470 $\mu g/m^3$ at a temperature of 25^0C and 1 atmosphere of pressure. Express the concentration in ppm_v. (10+5+4+6=25)

6. (a) What are the physical and chemical compositions of solid wastes?

(b) Estimate the overall chemical composition of a solid-waste. Derive an approximate chemical formula for the organic portion of a solid waste sample with the composition given in Table.

(c) Explain the 'landfill' land disposal technique of hazardous Waste. (4+18+3=25)