University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2013
Program: B.Sc. Engineering (Civil)

Course Title: Environmental Engineering II — Course Code: CE 333

Time: 3.0 hours — Full Marks: 150(=5×30)

[Answer any 5 (Five) of the following 7 (Seven) questions]

[Assume reasonable values for any missing data]

1. (a) Is pour-flush a hygienic latrine? Justify your answer. 5

   (b) Design a simple pit latrine for a family of 9 persons for a design life of 4 years. GWT is 8 m below ground surface. After using the latrine for 1.5 years, the users want to upgrade the latrine into a single pit pour-flush latrine so that the same pit can be used repeatedly with regular desludging. Determine total life of the pit before emptying for the first cycle. Assume reasonable value for any missing data. I = 30 l/m^2-d, q= 9 lpcd. 15

   (c) Describe the four important processes that take place in a septic tank. 10

2. (a) An apartment building houses has 30 residents generating an average wastewater flow rate of 160 lpcd. Design a septic tank for the building that will be desludged every 3 years. For ensuring better effluent quality, it is recommended that the minimum hydraulic retention time for the tank be 1.0 (one) day. Due to space constraints, specific tank area has to be restricted within 12 m^2. Assume wastewater temperature within the tank to be 25°C. Check clear space depth. Draw a net sketch showing details of septic tank dimensions and depth of different zones. 20

   (b) Compare the following: 5+5

   (i) On-site and Off-site sanitation system

   (ii) Separate and Combined sewer system

3. (a) Discuss the changes in the design criteria for Small Bore Sewerage System (SBS) compared to the Conventional Sewage System? 10

   (b) What are the requirements that an ideal drain section should meet? 5

   (c) Where the manholes are usually located? 5

   (d) Design a facultative and maturation pond to treat 8,000 m^3/d of domestic sewage with a BOD_5 of 560 mg/L and Fecal Coliform of 3×10^7 FC/100 ml. The design temp is 25°C and the required effluent standards are: BOD_5< 50 mg/l, FC < 5000/100 ml. Assume the values of k_b and k as 2.6 d^{-1} and 0.3 d^{-1} in 20°C respectively. 10

4. (a) Describe the form of biological processes in a trickling filter along with the diagram. 10

(b) Discuss the metabolism of bacteria with necessary reactions. 5

(c) A city discharges 1.3 m^3/s of sewage into a stream whose minimum rate of flow is 8.1 m^3/s. The velocity of stream is 3.3 km/h. The temperature of the sewage is 20°C and that of the water of stream is 15°C. The 21°C BOD_5 of the sewage is 210 mg/l and that of the stream water is 2 mg/l. The sewage contains no DO while the stream is 95% saturated with dissolved oxygen. The values of de-oxygenation rate constant and re-oxygenation (re-aeration) rate constant at 20°C are $0.3d^{-1}$ and $0.7d^{-1}$ respectively. Use the temperature coefficient of 1.135 for K_1 and 1.024 for K_2. Determine - 15
The critical oxygen deficit, critical (minimum) DO and its location.

5. (a) Discuss the relationship among growth phase, F/M ratio, waste removal rate and biomass settling characteristics in a table. 8

(b) Describe the symbiosis of Bacteria and Algae. 5

(c) Describe pattern of pollution and self-purification of a stream and its effect on biological life. 10

(d) Compute the recirculation ratio to obtain 85% BOD removal (20 degree Celsius), using a depth of 6 feet and a hydraulic loading of 17 mgad at 20 degree Celsius. What efficiency would be expected at 29 degree Celsius? 7

6. (a) Discuss endogenous respiration. The exerted BOD_5 of wastewater is determined to be 165 ppm at 20°C. Determine its exerted BOD values for 9-day 25°C and 10-day 10°C. Assume k_1 (20°C) = 0.23 per day.k_1 (T degree Celsius) = k_1 (20 degree Celsius) $\Theta^{(T-20)}$; and $\Theta = 1.087$ 2+6

(b) What are the effects of pH, temperature and food source on bacterial activity and BOD_5? 6

(c) What are the advantages and disadvantages of disposal for sewage effluent on land by irrigation? 6

(d) Discuss the significance of Food-Microorganism (F/M) ratio in activated sludge process. 10

7. (a) Residential area (shown in figure 1) is severed by sewer P1. At present it has a total of 200 numbers 4 storied building with two flats on each floor. The average occupancy is 6 persons per flat. The per capita water demand is 210 liter per day. The segment of sewer (P1) between man holes MH1 and MH2 is servicing the area using the following data: 20
i) pipe length = 300m; ii) per capita waste water generation rate is 80% of water use
iii) peak factor = 2.9; iv) peak infiltration rate = 0.26 m^3/ha/day;
v) Area = 190 ha [Assume reasonable value for missing data.]
vi) Manning's roughness coefficient for sewer is 0.013. If a 450 mm diameter pipe is provided, will that be adequate? The nomograph is attached with this question paper.

(b) Discuss the following preliminary treatment methods: 10
Screening, comminutor, grit chamber and skimming tank.

Formulae:

1. $BOD_5 = L_0 - L_t = L_0(1-10^{-k_1 t})$
2. $k_{1\,(T\ \text{degree Celsius})} = k_{1\,(20\ \text{degree Celsius})}\,\Theta^{(T-20)}$
3. $L_e/L_f = 1/\{1+2.5\,(D^{0.67}/Q^{.5})\}$
4. $L_f = (L_i + RL_e)/(1+R)$
5. $L_e/L_i = 1/[(1+R)\{1+2.5\,(D^{0.67}/Q^{0.5})\}-R]$
6. $E_T = E_{20}\, 1.035^{(T-20)}$
7. $D_t = \dfrac{K_1 L_a}{K_2 - K_1}\left(e^{-K_1 t} - e^{-K_2 t}\right) + D_a . e^{-K_2 t}$
8. $t_c = \dfrac{1}{K_2 - K_1} \ln\left\{\dfrac{K_2}{K_1}\left(1 - \dfrac{D_a (K_2 - K_1)}{K_1 L_a}\right)\right\}$
9. $D_c = \dfrac{K_1}{K_2} L_a . e^{-K_1 t_c}$
10. $V = CPN$
11. $t_h = 1.5 - 0.3 \log (Pq)$
12. $V_h = 10^{-3} Pq t_h$
13. $t_d = 30\,(1.035)^{35-T}$
14. $V_d = 0.5 \times 10^{-3} P t_d$
15. $d_{sc} = 0.82 - 0.26A$
16. $V_i = QD / 4I$
17. $L_e = L_i / (1+kt)$, $k_T = k_{20}\ X\ (1.05)^{T-20}$,
18. $\lambda_s = 10 L_i Q/A$ (unit= kg/ha-d), λ_s (allowable) = 20T -120 (unit = kg/had),
19. $N_e = N_i / (1+k_b t)$, k_b (T degree Celsius) = k_b (20 degree Celsius) X $(1.19)^{T-20}$

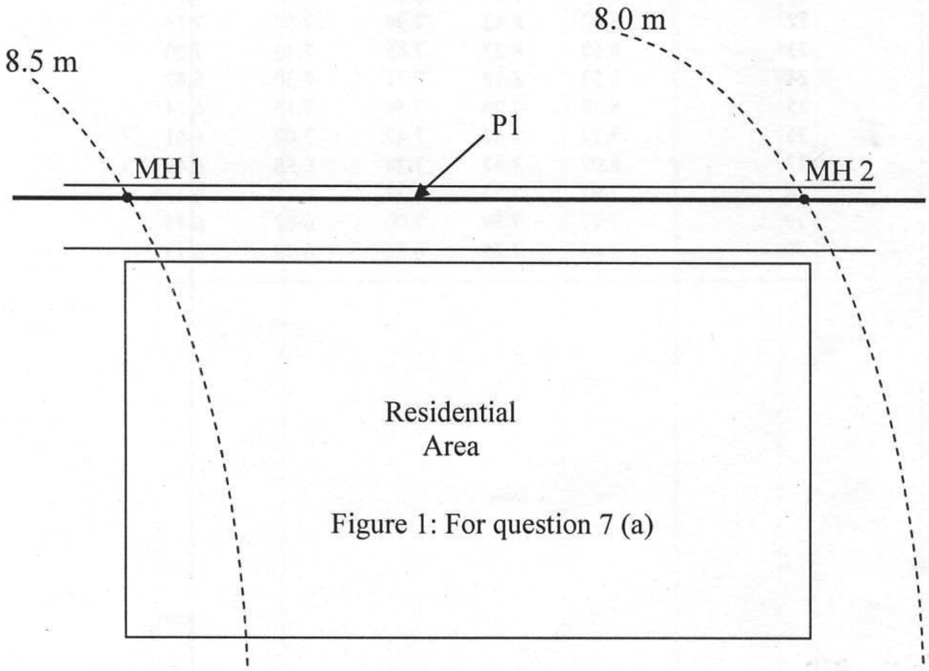
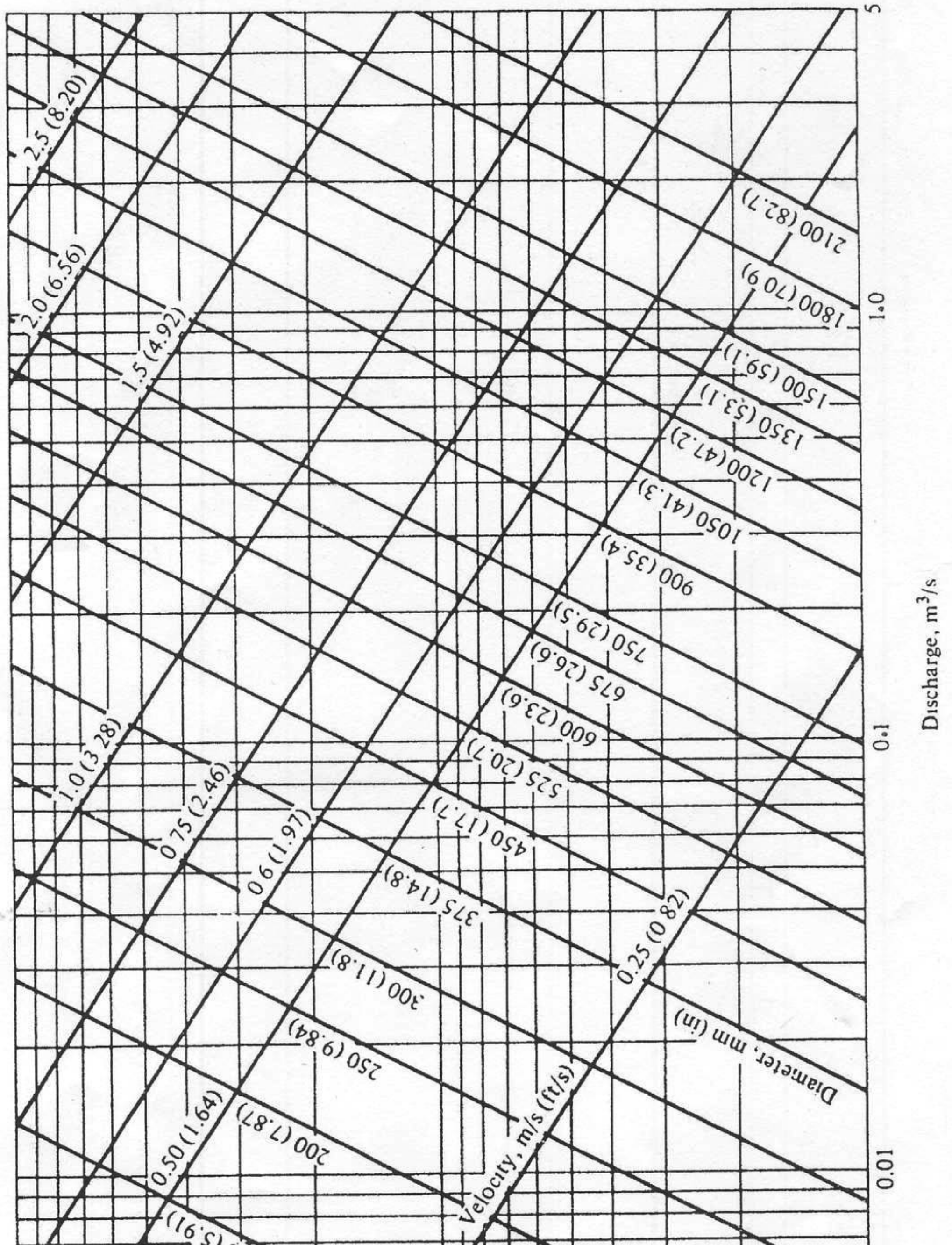


Figure 1: For question 7 (a)

Table: Equilibrium concentrations (mg/l) of DO as a function of temperature and chloride

Temperature, °C	Chloride concentration, mg/L				
	0	5,000	10,000	15,000	20,000
0	14.62	13.79	12.97	12.14	11.32
1	14.23	13.41	12.61	11.82	11.03
2	13.84	13.05	12.28	11.52	10.76
3	13.48	12.72	11.98	11.24	10.50
4	13.13	12.41	11.69	10.97	10.25
5	12.80	12.09	11.39	10.70	10.01
6	12.48	11.79	11.12	10.45	9.78
7	12.17	11.51	10.85	10.21	9.57
8	11.87	11.24	10.61	9.98	9.36
9	11.59	10.97	10.36	9.76	9.17
10	11.33	10.73	10.13	9.55	8.98
11	11.08	10.49	9.92	9.35	8.80
12	10.83	10.28	9.72	9.17	8.62
13	10.60	10.05	9.52	8.98	8.46
14	10.37	9.85	9.32	8.80	8.30
15	10.15	9.65	9.14	8.63	8.14
16	9.95	9.46	8.96	8.47	7.99
17	9.74	9.26	8.78	8.30	7.84
18	9.54	9.07	8.62	8.15	7.70
19	9.35	8.89	8.45	8.00	7.56
20	9.17	8.73	8.30	7.86	7.42
21	8.99	8.57	8.14	7.71	7.28
22	8.83	8.42	7.99	7.57	7.14
23	8.68	8.27	7.85	7.43	7.00
24	8.53	8.12	7.71	7.30	6.87
25	8.38	7.96	7.56	7.15	6.74
26	8.22	7.81	7.42	7.02	6.61
27	8.07	7.67	7.28	6.88	6.49
28	7.92	7.53	7.14	6.75	6.37
29	7.77	7.39	7.00	6.62	6.25
30	7.63	7.25	6.86	6.49	6.13



Nomograph for solution of Manning's equation for n = 0.013