University of Technology
Building and Construction Engineering Department

Final Exam 2014-2015/FIRST ATTEMPT

Subject: Sanitary Engineering
Division: Dams & Water Eng. Bra.
Examiner: Mr. Walaa K. Ali

Year: Three
Time: 3 hours
Date: 31 / 05/2015

Answer ***FIVE*** Questions Only

Q1:

A: A residential area has a population density of 180 capita per hectare and an area of 200 hectares. If the average annual consumption of water is 220 liter per capita per day and the required fire flow rate is 226 m^3/ hr, determine the diameter of the watermain pipe feeding this area assuming that the velocity shall not exceed 1.8 m/sec. (10 points)

B: Find the diameter of a single stage trickling filter without circulation to treat 6000m^3/d of sewage of BOD of 160 mg/l. The final effluent should be 60 mg/l BOD. Number of filters is two and the depth of each filter is 1.5m. (10 points)

Q2:

A:

1. Explain why the chlorine dosage could be less if pH of the treated water is less than 7.5
2. List the three main filter problems.

(10 points)

B: A sewage pumping station with three installed pumps, two on duty and the third is standby. Each of them has a capacity of 600m^3/hr. The per capita contribution is 250 liter/day. If the present population is 30000 capita, determine in which year the pump station will reach its design capacity. Assume a peak factor of 2.5, annual rate of growth is 3%. (10 points)

Q3:

A: find the maximum area served by 600mm storm drainage sewer according to the following available data:

- Rainfall intensity is 40lit/sec-ha
- Pipe slope is 0.15% , n = 0.011
- Maximum partial depth of flow is 80%
- Average surface runoff coefficient = 0.4

(10 points)

B: determine the number of one ton chlorine cylinders in WTP according to the following data:

- Capacity of the plant is 2000 m^3/hr.
- Chlorine dosage is 10 mg/lit.
- One month supply must be kept on hand at all times.

(10 points)

Q4:

A: If a waste with BOD_5 of *160* mg/lit is discharged to a stream at an average temperature of *25*°C, what fraction of the BOD would be exerted in *10* days? K_1 = 0.25/day at 20°C (10 points)

B: A WWTP produces 800 kg of dry solids per day at a moisture content of 98%. The solids are 65% volatile with a specific gravity of 1.05, and 35% nonvolatile with a specific gravity of 2.5. Determine the sludge volume as produced and after dewatering which reduces the volatile solid contents by 10% and the moisture content to 60%. (10 points)

Q5:

A: State true or false: (10 points)

a) The growth of community with limited resources might be best predicted by declining growth method.

b) The amount of infiltration is not affected by the height of groundwater table.

c) COD test is better than BOD test in representation of what will occur in the stream.

d) Suspended solids can be determined by incineration.

B: Design an activated sludge process (determine V, r and O_2 requirement (kg/day)) to yield an effluent BOD_5 of *20* mg/lit and suspended solids of *20* mg/lit. The influent BOD_5 is *160* mg/lit and the waste flow is 6000 m^3/day. Assume Y= *0.65*, k_d= *0.05*/day, θ_c=12 days, MLVSS= 4000 mg/lit, VSS/SS=0.8, x_r=10000 mg/lit. Assume any required data. (10 points)

Q6:

A: A settling basin is designed to have a surface overflow rate of 24 m/day. Determine the overall removal obtained for a suspension with size distribution given, the specific gravity of the particles is 1.2 and the water viscosity is 1.027 x 10^{-3} Pa.sec.

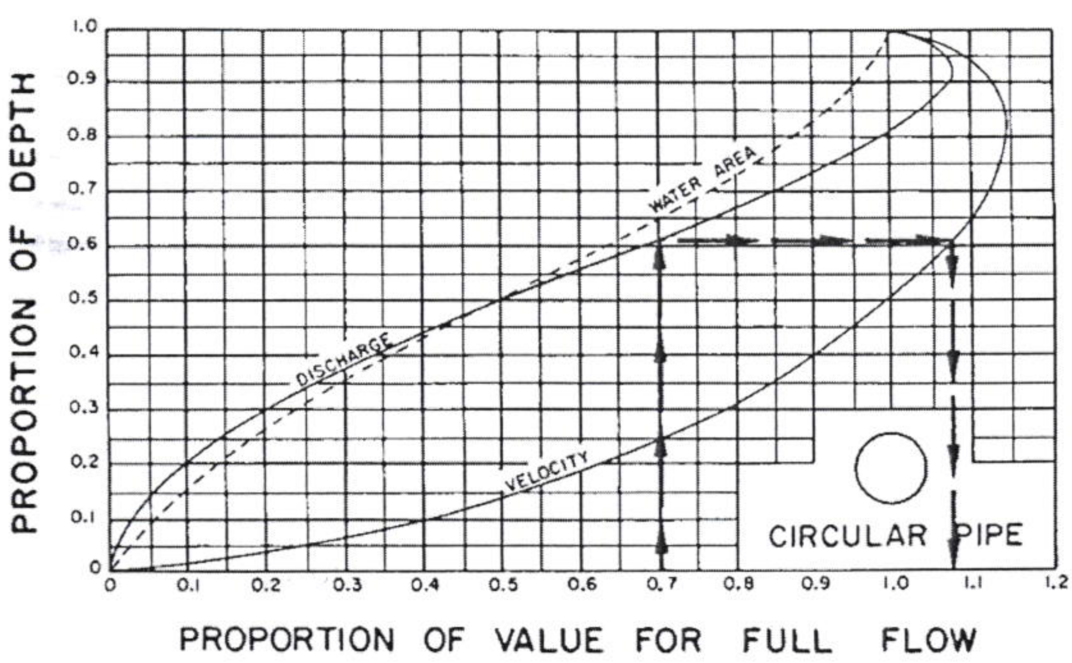
Particle size, mm	0.10	0.08	0.07	0.06	0.04	0.02	0.01
Weight fraction greater than size %	10	15	40	70	93	99	100

(10 points)

B: The storm-water runoff in a gutter at an inlet is 0.24m^3/min. The transverse slope of the gutter is 2% and the longitudinal slope is 0.5%, n=0.015. Determine the depth of water in the gutter at the curb line and the distance that the water will extend from the curb line.

$$Q = 22.61\frac{z}{n}\, s^{0.5}\, y^{8/3} \quad (m^3/min , m)$$

(10 points)



Q6 : A :

assume $N_R < 0.5$

$$\therefore V_s = \frac{g}{18\mu}(\rho_s - \rho)d^2$$

$$= \frac{9.8}{18 \times 1.027 \times 10^{-3}}(1200 - 1000)d^2$$

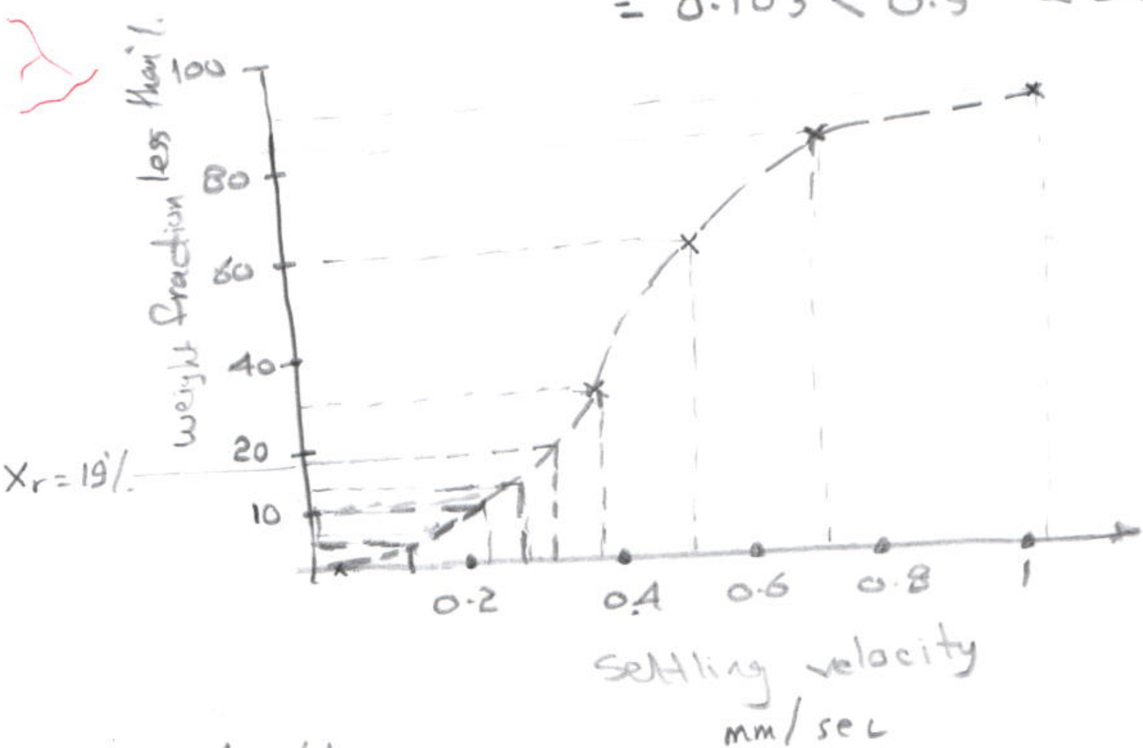
$$= 106\, d^2 \quad (V_s : mm/sec,\ d : mm)$$

weight fraction less than %	90	85	60	30	7	1	0
V_s mm/sec	1.06	0.68	0.52	.38	.17	.04	.011

check for N_R:

$$N_R = \frac{\rho V_s d}{\mu} = \frac{V_s d}{\nu} = \frac{1.06 \times 10^{-3} \times 0.1 \times 10^{-3}}{1.027 \times 10^{-6}}$$

$$= 0.103 < 0.5 \quad \therefore \text{o.k.}$$



$$V_{s_0} = 24\ m/d$$
$$= 0.28\ mm/sec$$

$$\%\ \text{removal} = (1 - 0.19) + 0.09 \times \frac{0.25}{0.28} + 0.1 + 0.05 \times \frac{0.12}{0.28}$$

$$= 0.81 + 0.08 + 0.021$$

$$= 0.91 \approx 91\%$$

Q_5:

B:

$$xV = \frac{YQ\theta_c(S_o - S)}{1 + k_d\theta_c}$$

$S_o = 160$ mg/lit

$S = 20 - 0.63 \times 20 = 7.4$ mg/lit

$$\therefore xV = \frac{0.65 \times 6000 \times 12(160 - 7.4) \times 1000}{1 + 0.05 \times 12}$$

$= 4.464 \times 10^9$ mg

$= 4464$ kg

$x = MLVSS = 4000$ mg/lit $= 4$ kg/m^3

$$\therefore V = \frac{4464}{4} = 1116 \text{ m}^3$$

$(Q + Q_r)x = Q_r x_r$

$$\therefore Q_r = \frac{Qx}{(x_r - x)} = \frac{6000(4)}{(10 - 4)} = 4000 \text{ m}^3/\text{d}$$

$$\therefore r = \frac{4000}{6000} = 67\%$$

$O_2 = 1.47(S_o - S)Q - 1.14 X_r Q_w$

$$\text{daily sludge production} = \frac{4464/0.8}{12}$$

$= 465$ kg/day

$$Q_w = \frac{\text{daily sludge production}}{X_r}$$

$$= \frac{465 \times 10^6}{10000 \times 1000} = 46.5 \text{ m}^3/\text{day}$$

$$\therefore O_2 = \frac{1.47(160 - 7.4) \times 6000}{1000} - \frac{1.14(10000) \times 46.5}{1000}$$

$= 1345.93 - 530.1$

$= 815.83$ kg/day

Q3 : A:

$Q = \frac{1}{n} A R^{2/3} S^{0.5}$

$A = \frac{\pi \times 0.6^2}{4} = 0.283\ m^2$

$R = \frac{D}{4} = 0.15$

$\therefore Q = \frac{1}{0.011} \times 0.283\ (0.15)^{2/3} \times (0.0015)^{0.5}$

$= 0.282\ m^3/sec$

as $\frac{d}{D} = 0.8 \Rightarrow \frac{q}{Q} = 0.98$

$\therefore$ q (design flow) $= 0.98 \times 0.282$

$= 0.276\ m^3/sec$

$= 276\ l/sec$

$R = CIA$

$\therefore 276 = 0.4\ (40)\ A$

$\therefore A = 17.25$ ha.

B: no. of cylinders $= \frac{2000 \times 1000 \times 24 \times 30 \times 10}{10^6 \times 1000}$

$= 14.4$ cylinders

$\therefore$ provide 15 cylinders

Q4:

A: $BOD_5^{20} = L\ (1 - e^{-0.25(5)}) = 160$

$\therefore L = 224.4$ mg/lit

$K_1^{25} = K_1^{20} \times 1.047^5 = 0.25 \times 1.047^5$

$= 0.315$ /d

$\therefore BOD_{10}^{25} = 224.4\ (1 - e^{-3.15})$

$= 214.78$ mg/lit

$$0.625 = \frac{1}{1 + 0.532\sqrt{\frac{2.084 \times 160}{VF}}}$$

$$\sqrt{\frac{2.084 \times 160}{VF}} = 1.128$$

$$VF = 262\ m^3$$

$$F = \frac{1+r}{(1+0.1r)^2} = 1$$

$$\therefore V = 262$$

$$A = \frac{V}{depth} = \frac{262}{1.5} = 174.7$$

$\therefore$ dia. of each filter $= 14.92^m$

$\simeq 15^m$

Q_2 / B:

$Q_{pump} = 600\ m^3/hr$

$Q_{peak} = Q_{pump} \times$ no. of duty pumps

$= 1200\ m^3/hr$

$Q_{av.} = Q_{peak}/P_f = 1200/2.5 = 480\ m^3/hr$

$= 11520\ m^3/day$

$\therefore$ max. pop. served $= \frac{11520}{0.25} = 46080$

$P_t = P_o(1+r)^n$

$\therefore 46080 = 30\,000\,(1.03)^n$

$1.536 = 1.03^n$

$\ln 1.536 = n \ln 1.03 \Rightarrow 0.429 = n\,(0.0296)$

$\therefore n = 14.5$ years