UNIVERSITY OF JOHANNESBURG

PROGRAM : DIPLOMA : ENGINEERING : CIVIL

SUBJECT : **WATER AND WASTEWATER TREATMENT 2B**

CODE : **CEW2B11**

ASSESSMENT : WINTER EXAMINATION (SUPPLEMENTARY PAPER)

DATE 20th JULY 2015

DURATION : (SESSION 1) 08:00 - 11:00

WEIGHT : 40:60

TOTAL MARKS : 80

ASSESSOR : G.K. NKHONJERA

MODERATOR : PROF. F.M. ILUNGA

NUMBER OF PAGES: PAGES: 6 including the cover page and Annexures.

INSTRUCTIONS : ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED.

1. This paper contains 5 questions
2. PLEASE ANSWER **ALL** QUESTIONS
3. Make sure that you understand what the question requires before attempting it.
4. Any additional material is to be placed in the answer book and must indicate clearly the question number, your name, and Student number.
5. Answers without calculations will not be considered.

ANSWER ALL QUESTIONS

QUESTION 1 [10]

1.1 With respect to any wastewater treatment plant, state the major objectives of the following processes:

a) Coagulation. (2)
b) Screens. (2)

1.2 State, in your own words, how the following may affect the quality of drinking water.

a) Coliform bacteria. (2)
b) Colour of water. (2)
c) Lead. (2)

QUESTION 2 [10]

2.1 Explain any TWO ways in which the recirculation of flow in trickling filters may be beneficial. (2)

2.2 A trickling filter with a diameter of 15 m and a depth of 1.8 m receives wastewater with BOD concentration of 120 mg/L. If the flow rate is 4000 m^3/d and that the recycled flow is twice the incoming flow rate, determine the following:

a) Organic loading to the filter. (4)
b) Hydraulic loading of the filter. (4)

QUESTION 3 [20]

3.1 From your own understanding so far, name the TWO most important nutrients to be considered in wastewater treatment. (2)

3.2 Explain why it so necessary to treat wastewater before discharging it into a natural environment. (3)

3.3 Explain the difference between AEROBIC and ANAEROBIC decomposition in terms of the following:

a) Oxygen environment. (2)
b) Duration. (2)
c) Offensive nature. (2)

3.4 A single-stage trickling filter is to be constructed to treat wastewater by reducing an applied BOD of 125 mg/L to 25 mg/L. The wastewater flow rate to be treated is 12096 m^3/d. The recirculation ratio for this filter is 12.0, while the filter depth can be taken as 1.83 m. Assuming that the NRC equation applies, determine the size (diameter) of the filter. (9)

QUESTION 4 [20]

4.1 Name any THREE gases that can result from the decomposition of organic matter present in wastewater. (3)

4.2 With respect to wastewater treatment, in what way are the following different from each other.

a) Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD). (2)

b) Organic constituents and inorganic constituents. (2)

c) Total Solids and Volatile Solids. (2)

4.3 A circular sedimentation tank with a diameter of 15 m is designed to treat a flow of water of 3500 m^3/d. The water entering the tank contains a substantial number of clay particles with a density of 1.07 g/cm^3 and a particle diameter of 0.05 mm. Assuming that discrete type of particle settling prevails under this condition, determine the following: (*Take the viscosity of water,* $\mu = 1.005 \times 10^{-3}\ Ns/m^2$).

a) Overflow rate of the tank. (5)

b) Particle settling velocity. (3)

c) Percentage of these particles that will be removed from the tank. (3)

QUESTION 5 [20]

5.1 Explain, in your own words, what you understand by the following terms as applied in water treatment technology:

a) Headloss. (1)
b) Filter run. (1)

5.2 Briefly, discuss any TWO reasons why the following components are important in any sand filtration processes:

a) Coarse Gravel. (2)
b) Under-drain piping system. (2)

5.3 With respect to the operation of sand as the filter material, state how the following affect the filtration process in a water treatment plant.

a) Particle size of filter material. (2)
b) High turbidity of the water to be treated. (2)

5.4 With the aid of a well labelled illustration, explain the principles of operation of a SLOW SAND FILTER in a simple but conventional water treatment works. (10)

GOOD LUCK TO YOU ALL

APPENDIX A

COMMON FORMULAS

1	Newton's Law formula $$V_s = \sqrt{\frac{4g(\rho_s - \rho)d}{3C_D\rho}}$$ Where: $$C_D = \frac{24}{N_R} + \frac{3}{\sqrt{N_R}} + 0.34$$	Stoke's Law formula $$V_s = \frac{g(\rho_s - \rho)d^2}{18\mu}$$ Overflow rate $$V_o = \frac{Q}{A_s}$$
2	Basin Volume, $$\forall = Qt_d$$ Percentage removal, P, $$P = \frac{V_s}{V_o} \times 100$$	Weir loading, WL $$WL = \frac{Q}{Length}$$
3	NRC Equation for efficiency (Single-stage filter) $$E = \frac{1}{1 + 4.12\left(\frac{QC_{in}}{\forall F}\right)^{1/2}}$$	Recirculation ratio $$R = \frac{Q_r}{Q}$$ Recirculation factor $$F = \frac{1+R}{(1+0.1R)^2}$$
4	Organic loading to the filter $$OL = \frac{QC_{in}}{\forall}$$	Hydraulic loading of the filter, $$HL = \frac{Q(1+R)}{A_s}$$

Where:

- N_R = Reynolds number, dimensionless
- C_D, = Drag coefficient, dimensionless
- v = Kinematic viscosity, m^2/s ; $v = \mu/\rho$
- μ = Dynamic viscosity, Ns/m^2
- ρ = Density of fluid, kg/m^3
- ρ_s = Density of the particle, kg/m^3
- d = Size of the particle (m)
- V_s = Settling velocity (m/s)
- V_o = Overflow rate (m/s or $m^3/s.m^2$)
- h_L = headloss (m)
- $\forall$ = Volume of the tank (m^3)
- WL = Weir loading ($m^3/d.m$)
- Q = Flow rate, usually in m^3/s or ML/d or m^3/d
- P = Percentage removal of suspended solids (%)
- t_d = detention time (hrs)
- E = filter efficiency (decimal)
- C_{in} = Influent BOD (mg/L)
- F = recirculation factor
- R = recirculation ratio.
- Q_r = recirculation flow
- OL = organic loading ($kg/d.m^3$)
- HL = hydraulic loading ($m^3/d.m^2$)