UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	WASTEWATER ENGINEERING DESIGN
COURSE CODE	:	BFA 40403/BFA 4033
PROGRAMME	:	BACHELOR OF CIVIL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	JUNE 2015/JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS

THIS PAPER CONSISTS OF **FOUR (4)** PAGES

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Q1 (a) Draw and label a schematic diagram showing all the typical treatment processes and liquid flow paths in an entire conventional municipal wastewater treatment plant using complete-mix activated sludge to provide secondary treatment. Also show and label the residuals produced by certain processes.

(10 marks)

(b) A new subdivision of 3000 homes is planned, and a condition of the building permit is to determine the savings in water consumption (and wastewater flows) if the following water-efficient appliances are used: front-loading washing machines, ultra-low flush toilets, and ultra-low-flow showerheads. Use 5 residents per home and values for devices and appliances from Table Q1(b).

Table Q1(b) : Typical comparisons of water use without and with water conservation practices

Appliance/device	Unit water use, L/capita.d	
	No conservation	With conservation
Clothes washing	65	45
Toilet	74	35
Shower	50	40

(10 marks)

(c) A bar screen is inclined at a 60° angle from the horizontal. The bars have a diameter of 20 mm and a clear spacing of 25 mm. Determine the headloss when the bars are cleaned and the velocity approaching the screen is 1 m/s. Assuming the diameter of the clarifier to be 22 m and an average wastewater flow rate of 50 MLD, calculate the detention time, surface loading and weir loading rate of a clarifier having a wastewater depth of 3.5 m.

Given :Velocity through the opening, $V = vA_c/A_r$

Headloss, $h_L = 0.0729\ (V^2 - v^2)$

(5 marks)

Q2 (a) A small town produces 20,000 m3/day of wastewater on the average. The peak flow is 1.75 times the average. Design a grit-removal system consisting of two identical chamber 2.0 m deep to process the peak flow. The flow-through velocity is to be controlled at 0.2 m/s by a down-stream proportioning weir, and the settling velocity is to be maintained at 0.1 m/s. Determine also the design detention time.

(10 marks)

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(b) A residential community with a current population of 15,000 is planning to expand its wastewater treatment plant. In 20 years, the population is estimated to increase to 25,000 residents and 2000 day students are expected to attend a proposed private college. A new industry will also move in and contribute an average flowrate of 840 m^3/d and a peak flowrate of 1260 m^3/d. The plant will operate 8 h/d and will shut down one day per week. The present average daily wastewater flowrate is 6500 m^3/d and the infiltration/inflow has been determined to be non-excessive. Infiltration is estimated to be 100 L/capita.d at average flow and 150 L/capita.d at peak flow. Residential water use in the new homes is expected to be 10 percent less than the existing residences because of the installation of water saving appliances and fixtures. Compute the future average, peak and minimum design flowrates. For peak residential flowrates, use a peaking factor of 2.75 and assume the ratio of minimum to average flowrate is 0.35. Assume the wastewater flowrate for day school is 95 L/capita.d.

(15 marks)

Q3 (a) Sketch a graph showing the average variation of daily flow at a municipal wastewater treatment plant.

(5 marks)

(b) Define and explain the purpose of equalization basin.

(5 marks)

(c) Design an equalization basin for the following cyclic flow pattern as shown in Table Q3(c). Provide a 25% excess capacity for equipment, unexpected flow variations and solids accumulation. Assume L:B = 2.5:1.

Table Q3(c) : Cyclic flow pattern

Time (h)	Flow (m^3/s)	Time (h)	Flow (m^3/s)
1	0.275	13	0.425
2	0.220	14	0.405
3	0.165	15	0.385
4	0.130	16	0.350
5	0.105	17	0.325
6	0.100	18	0.325
7	0.120	19	0.330
8	0.205	20	0.365
9	0.355	21	0.400
10	0.410	22	0.400
11	0.425	23	0.380
12	0.430	24	0.345

(15 marks)

Q4 (a) Explain why there is an optimum hydraulic detention time for a primary settling tank.

(5 marks)

(b) Design a rectangular primary sedimentation tank for a town with a projected population of 45,000. Use a minimum of two tanks. Calculate the scour velocity, to determine if settled material will become resuspended. Estimate the BOD and TSS removal at average and peak flow. Use an overflow rate of 36 $m^3/m^2.d$ at average flow.

Given data:

Wastewater generation rate	= 400 L/capita.day
Channel width	= 5 m
Side water depth	= 3 m
Cohesion constant, k	= 0.05
Specific gravity, s	= 1.25
Acceleration due to gravity, g	= 9.81 m/s^2
Diameter of particles, d	= 100 μm = 100 x 10^{-6} m
Darcy-Weisbach friction factor, f	= 0.025
Empirical constant:	
BOD	a = 0.018
	b = 0.020
TSS	a = 0.0075
	b = 0.014

(20 marks)

- **END OF QUESTION** -