NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
DEPARTMENT OF CIVIL AND WATER ENGINEERING
PART III SUPPLEMENTARY EXAMINATIONS- JULY 2011

WASTEWATER ENGINEERING -TCW3104

Instructions:
*Answer any **FOUR** questions*   Total marks: 100
                                                     Time: 3 hours

QUESTION 1

a. From first principles derive the Phelps equation: $BOD_t = BOD_u (1-e^{-kt})$. Given the following parameters: BOD_u=50mg/l, θ =1.05, temperature =35^0C, K_{20} = $0.23d^{-1}$, calculate the BOD_5 for the wastewater. (10)

b. With the aid of a neat sketch describe the processes which take place in a conventional wastewater treatment works. (10 marks)

c. Describe an ideal wastewater treatment process that would reduce the quantity of nutrients in municipal wastewater effluents. (5 marks)

QUESTION 2

For the following operating data for a conventional activated sludge treatment plant: wastewater flow = $35000m^3$/d, volume of aeration tank= 10900 m^3, BOD_{in} =250mg/l, BOD_{eff} = 20mg/l, MLSS=2500mg/l, effluent suspended solids = 30mg/l, waste sludge suspended solids = 9700mg/l, quantity of waste sludge = $220m^3$/d;

Calculate:

a. Aeration period   (7 marks)
b. Food to microorganism ratio (F/M)   (8marks)
c. Percentage efficiency of BOD removal   (5 marks)
d. Sludge ages (days)   (5marks)

QUESTION 3
a. Explain the factors to consider in choosing an excreta disposal technology for a community. (5 marks)

b. A community at the moment relies on an ordinary pit latrine for its excreta disposal. The latrine has a superstructure which has neither roof nor a door. Considerable odour and fly problems are being experienced. Suggest some design improvements to the latrine which will help minimize the problems. Sketch the new design and explain how it must be operated and maintained to achieve the desired objectives. (20 marks)

QUESTION 4

a. Describe the processes involved in surface water self-purification. (5 marks)
b. Describe 'nutrients' in relation to water quality and pollution. How do they affect water bodies and what conditions increase these effects? (10 marks)
c. Suggest measures that can be put in place to control the effects of nutrients in surface water bodies. (10 marks)

QUESTION 5

Calculate the pond sizes for a waste stabilization pond system which includes anaerobic treatment based on the following data:

- Population served from high density area   10500
- BOD contribution   40g/person. day
- Assumed raw sewage bacteria content 5×10^7 FC/100ml
- Minimum mean monthly temperature 19^0C
- Effluent quality required less than   100FC/100ml
- Volumetric BOD loading for anaerobic ponds 250g/m^3.d
- $K_{b(20)}$ 2.6 day^{-1}

(25 marks)

Useful Formulae

$$N_e = \frac{N_i}{1 + k_b \theta}$$

$$k_{b(T)} = k_{b(20)} 1.19^{T-20}$$

$$N_e = \frac{N_i}{\left[\left(1 + k_b \theta_a\right)\left(1 + k_b \theta_f\right)\left(1 + k_b \theta_m\right)\right]^n}$$