UNIVERSITY OF SWAZILAND
Faculty of Health Sciences
Department of Environmental Health Science

Diploma in Environmental Health Science

MAIN EXAMINATION PAPER MAY 2012

TITLE OF PAPER   : URBAN WATER TREATMENT TECHNOLOGY

COURSE CODE   : EHS:213

DURATION   : 2 HOURS

MARKS   : 100

INSTRUCTIONS   : THERE ARE FIVE QUESTIONS IN THIS EXAM

                      : ANSWER ANY FOUR OUT OF THE FIVE QUESTIONS

                      : EACH QUESTION CARRIES A MAXIUM MARK OF 25%

                      : NO PAPER SHOULD BE BROUGHT INTO OR OUT OF THE

                          EXAMINATION ROOM

Question One (25 Marks)

A) The following analysis has been completed on filtered water from a surface water treatment plant. Check the accuracy of the analysis to determine if it is sufficiently accurate.

Cation	Concentration, mg/L	Anion	Concentration, mg/L
Ca^{2+}	54.6	HCO_3^-	172.5
Mg^{2+}	11.2	SO_4^{2-}	37.7
Na^+	13	Cl^-	33.8
K^+	10	NO_3^-	2

.... [10 Marks]

B) State whether or not each of the following substances below affect i) the colour of water ii) the turbidity of water.

        b.1. Organic dyes

        b.2. Humic substances

        b.3. Iron

        b.4. Suspended particles   .... [5 Marks]

C) Which water quality parameters are altered and influenced by biological processes taking place in the water? State also how they are influenced ....[5 Marks]

D) Describe the sources of occurrence and the effect on water quality caused by the presence in excess quantities of each of the following chemicals in water? ....[5 Marks]

        i. Sodium

        ii. Carbon dioxide

        iii. Hydrogen sulphide

        iv. Aluminum

Question Two (25 Marks)

A. State five advantages and three disadvantages of providing storage facility in the form of reservoirs and ponds to water. ....[5 Marks]

B. State four advantages that make roughing filters suitable for application to water treatment in developing countries. ....[5 Marks]

C. Describe five mechanisms of filtration process by which suspended solids are removed from water during filtration. ....[5 Marks]

D. Which of the following substances does not contribute to an increase or decrease in the alkalinity of water: i) Hydroxide ii) Hydrogen iii) Bicarbonate iv) Ammonia and v) Sodium. ....[5 Marks]

E. Draw a sketch of an infiltration gallery that abstracts water from a river indicating the necessary provisions. .... [5 Marks]

Question Three (25 Marks)

A. Describe with the help of chemical oxidation and reduction equations the electrochemical mechanism of corrosion of iron pipe exposed to aerated water. ....[5 Marks]

B. Describe the factors contributing to stability of colloidal particles including a discussion of source of surface charge, electrical double layer and zeta potential. ....[5 Marks]

C. Discuss the four principal mechanisms by which coagulation in water treatment involving destabilization of colloidal particles.. ....[5 Marks]

D. A coagulation process is to be designed for a water treatment with a flow of 0.25 m^3/sec. A jar test done on a 1.5 litre sample indicated 5ml and 7ml dosages of a 1.5% alum solution gave equally good lowest turbidity. Determine the amount of alum required daily in kg, the alkalinity required and the daily sludge production. ....[10 Marks]

Question Four (25 Marks)

A.   Describe the three principal mechanisms of flocculation and the effects of particle number, velocity gradient and time of flocculation..   ....…......[5 Marks]

B.   Discuss with the help of a sketch how a sludge blanket clarifier operates in indicating also the possible operational problems that may arise.   ……...…...……......……........[5 Marks]

C.   Calculate the terminal velocity of a sand particle in water at 10^0C. Assume the sand particle has a diameter of $20\mu m$ and a density of 2650 kg/m^3. Take the coefficient of dynamic viscosity of the water , $v = 1.3*10^{-6}$ m^2/sec.   ………….....................…......[5 Marks]

D.   Discuss the effect on the settling efficiency of a sedimentation tank if to an existing tank the depth was modified and was doubled while other dimensions and the flow rate remained the same.   Use a calculation to prove your point..................…... ….......[5 Marks]

E.   Discuss the following primary performance criteria for the design of filters: i) Effluent water quality   ii) Filter run length   iii) Filtration rate and iv) Filter media …......[5 Marks]

Question Five (25 marks)

A. Discuss the principle of operation of a declining rate filter. Indicate the advantages of declining rate filter over a traditional rapid sand filter. ....[5 Marks]

B. Discuss Chik's Law for the disinfection of water explaining how temperature and contact time affect the extent of disinfection that can be achieved. ....[5 Marks]

C. Ammonia is added to pure water in the laboratory to reach a concentration of 1mg of NH_3-N /Liter. Estimate the chlorine dose needed to reach break point whereby all ammonia is converted to nitrogen gas. ....[5 Marks]

D. Describe the advantages and disadvantages of using chlorine dioxide for the disinfection of water. ....[5 Marks]

E. Discuss the advantages and disadvantages of using i) Ozone   ii) Ultra violet radiation for the disinfection of water. ....[5 Marks]