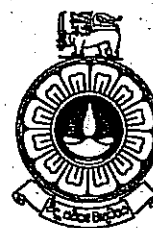**THE OPEN UNIVERSITY OF SRI LANKA**
Department of Civil Engineering
Diploma in Technology - Level 4

CEX 4234 - WATER SUPPLY AND SEWERAGE ENGINEERING

FINAL EXAMINATION   - 2011/2012

Time Allowed: Three Hours   *Index No.* ·

Date: 01st March, 2012   Time: 0930 - 1230

Answer any <u>FIVE</u> questions. All questions carry equal marks.

1) a) Explain using a neat diagram how a common hand pump (reciprocating type) works.

b) Explain using a neat diagram how a centrifugal pump works.

A centrifugal pump is to be used to supply water from Reservoir X to Tank Y, as shown in Figure 1. The characteristics of the pump are given in Table 1. The water is to be supplied using a pipe, AB , as shown in the figure. The pipe AB has a length of 500 m, a diameter of 5 cm and a friction factor of 0.25 . The difference between the elevations of the free surfaces of Reservoir X and Tank Y is 10 m .

c) Calculate the discharge through the pump. State all your assumptions and explain your answer.

Pump Head (m)	20	16	12	8	4
Discharge (litre/s)	0	1	1.5	1.75	2

Table 1
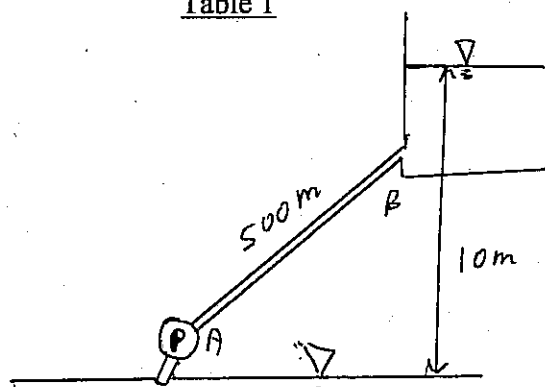

Figure 1

2) a) Explain the purpose of the Jar Test carried out in Water Treatment Plants.

b) Why is rapid mixing followed by slow mixing in the Jar Test?

c) Explain, using chemical equations, why Alum is used in water treatment.

d) The old Water Treatment Plant at Raddolugama uses a Pulsator Clarifier. Explain, using a neat diagram, how the Pulsator Clarifier works.

The new Water Treatment Plant at Raddolugama uses a Horizontal Baffled Tank. The plan view of this tank is shown in Figure 2.
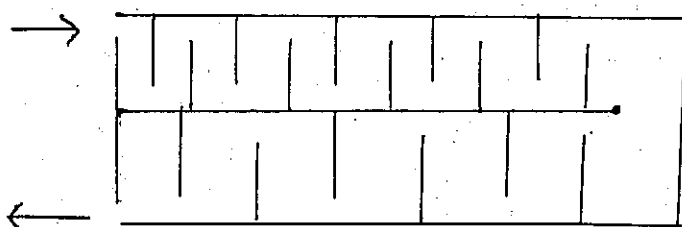

Figure 2

e) Explain the purpose of this tank in the Water Treatment Plant.

f) Explain why the spacing between the baffles is greater in the second stage of the tank than in the first.

3) A Wastewater Treatment Plant of the "Activated Sludge" type is used to treat the wastewater from the Raddolugama Housing Scheme.

a) Identify, using a neat schematic diagram, the main components of this treatment plant. Indicate the flow of wastewater and other materials between these components on the diagram.

b) Explain, briefly, the function of the main components of this treatment plant identified above.

c) Explain the meaning and the importance of the term "Activated Sludge".

d) Explain the meaning of the term "mixed liquor suspended solids" (MLSS) and discuss its significance in the operation of this treatment plant.

e) What regular measurements are carried out during the operation of the plant?

4) a) Provide brief definitions for the following terms with regard to water quality

      i)   pH
      ii)   Alkalinity
      iii)   Hardness

b) Why are Alkalinity and pH of the raw water measured in a water treatment plant?

c) Explain, briefly, how you measured the Alkalinity of water in the laboratory class.

d) If dissolved Calcium Carbonate (CaCO$_3$) was the source of the Alkalinity in the sample you used in the laboratory class, explain using equations the chemical reactions that took place during your measurement of the Alkalinity.

e) What will happen if the water supplied from a Water Treatment Plant contains excessive amounts of hardness?

f) Why is the conductivity of raw water measured?

5) a) Explain, using a neat diagram, how a Domestic Water Meter works.

b) List three materials used to make pipes for the distribution of water.

c) Compare the advantages and disadvantages of the materials listed in section b).

The Hazen-Williams equation is given by $v = 0.85Cr^{0.63}s^{0.54}$ (for SI units) while the Darcy-Weisbach equation is given by $h_f = f\dfrac{Lv^2}{2gd}$.

d) Identify and define the variables and constants in the Hazen-Williams formula.

e) Identify and define the variables and constants in the Darcy-Weisbach formula.

f) Express the Hazen-Williams equation in the same form as the Darcy-Weisbach equation for a pipe of circular cross-section and explain the relationship between the two equations.

6) A horizontal flow grit chamber has rectangular cross-section, with length, L, width, W and depth D. The chamber is to be designed to remove sand particles of a given settling velocity, v. The peak flow rate is Q.

a) Obtain relationships between the given quantities and the following parameters.

      i)   Residence (detention) time
      ii)   Surface overflow rate
      iii)   Weir loading rate

b) Explain the physical significance of the surface overflow rate in the design of sedimentation tanks.

c) Circular sedimentation tanks can be used with horizontal flow and with vertical flow. Using neat diagrams explain the differences between horizontal flow circular sedimentation tanks and vertical flow circular sedimentation tanks with respect to

      i)   Inflow arrangements
      ii)   Flow path
      iii) Outflow arrangements
      iv) Sludge removal

7) a) What is the main difference between flow in a water distribution system and a normal sewerage collection system?

b) What are the reasons for the difference identified in section a)?

c) List three materials used to make pipes for the distribution of water.

d) Compare the advantages and disadvantages of the materials listed in section b).

e) Why is pumping necessary in sewerage systems?

f) Give a neat, labeled diagram of a wet well in a sewerage pumping station.

g) Explain, briefly, what factors you would consider in the selection of the volume of a wet well in a sewerage pumping station.