UNIVERSITY OF SWAZILAND

Faculty of Health Science

Department of Environmental Health Sciences

Final Examination 2009

Title of paper: WATER DISTRIBUTION

Course code: EHS 586

Time allowed: 3 hours

Marks allocation: 100 Marks

Instructions:

1) Read the questions and instructions carefully
2) Answer ANY FOUR (4) questions
3) Each question is weighted 25 marks
4) Write neatly and clearly
5) Begin each question on a separate sheet of paper

This paper is not to be opened until the invigilator has granted permission

QUESTION 1

I.

a) For steady condition, total inflow to a junction is equal to total outflow from the junction.

b) For continuity of flow in any system of fluid flow, the total amount of fluid entering the system is equal to the amount leaving the system'

c) In a fluid at rest pressure in all directions at a point is not equal.

d) Absolute pressure is equal to gauge pressure minus atmospheric pressure.

e) Energy losses in sudden transitions are due to the formation of eddies and pressure loss dissipation in the form of heat energy.

f) A fluid moving through a pipeline is not subjected to energy losses from various sources such as continuous resistance exerted by the pipe walls.

g) For the flow of a real fluid through a pipe or other conduit, the velocity will not vary from wall to wall.

h) The hydraulic grade line shows the elevation of the velocity head

i) The velocity of a stream of fluid which has a steady volume rate of flow depends on the cross-sectional area of the stream.

j) For steady flow of a frictionless fluid along a streamline, the total energy per unit volume remains constant from point to point.

(20 marks)

II.

State five factors that affect water wastage through leakage

(5 marks)

QUESTION 2

(a) A conical tube is fixed vertically with its smaller end upwards. The velocity of flow down the tube is 4.5 m/s at the upper end and 1.5 m/s at the lower. The tube is 1.5 m long and the pressure head at the upper end is 3 m of liquid. The loss of energy expressed as head in the tube is $0.3(v_1 - v_2)$ /2g where v_1 and v_2 are velocities at the upper and lower end. Calculate the pressure head at the lower.

(6 marks)

(b) State four things that the design of a rural water distribution system involves.

(5 marks)

(c) State the importance of a reconnaissance and topographic surveys.

(5 marks)

(d) A venturi meter having a throat diameter d_2, of 100 mm is fitted into a pipeline which has a diameter d_1, of 250 mm through which oil of specific gravity 0.9 is flowing. The pressure difference between the entry and throat tappings is measured by a U-tube manometer, containing mercury of specific gravity 13.6, and the connections are filled with the flowing in the pipeline. If the difference of level indicated by the mercury is 0.63 m, calculate the theoretical volume rate of flow through the meter.

N.B $Q = \{a_1/(m^2 - 1)^{1/2}\}\sqrt{\{2gh((\rho_{man}/\rho) - 1)\}}$

(9 marks)

QUESTION 3

a) It is proposed to use a notch to measure the flow of water from a reservoir and it is estimated that the error in measuring the head above the bottom of the notch could be 1.5 mm. For a discharge of 0.28 m^3/s, determine the percentage error which may occur, using a right-angled triangular notch with a coefficient of discharge of 0.6.

(8 marks)

b) A rectangular channel 1.2 m wide leads from a reservoir to a rectangular notch 0.9 m wide with its sill 0.2 m above the bottom of the channel. Assuming that the velocity of approach is neglected, the discharge over the notch is given by $Q = 1.84\ BH^{3/2}$, calculate the discharge when the head over the bottom of the notch H is 0.25 m, (neglect the velocity of approach).

(4 marks)

c) In the following pipe system, balance the flows:

Loop	Pipe	Q (l/s)	$h_{L\,(m)}$	h_L/Q ($m/m^3/s$)
1	AB	120	11.48	95.64
	BE	10	3.39	338.77
	EF	-60	-40.42	673.75
	FA	-100	-8.36	83.66

Loop	Pipe	Q (l/s)	$h_{L\,(m)}$	h_L/Q ($m/m^3/s$)
2	BC	50	28.40	567.98
	CD	10	3.39	338.77
	DE	-20	-4.94	246.78
	EB	-24.23	-18.34	756.77

(13 marks)

QUESTION 4

(a) A vertical test tube has a 2cm column of oil with a density of 800 kg/m^3 floating on an 8cm column water. What is the pressure at the bottom of the tube due to the liquids in it.

(7 marks)

(b) A cross section of a dam wall that is 4m high, one side of the wall is inclined at 60^0 from the bottom. The length of the wall is 90 m.

i) Calculate the absolute pressure exerted on the wall

ii) Calculate the total thrust on the wall, and

iii) Calculate the pressure at the bottom of the reservoir

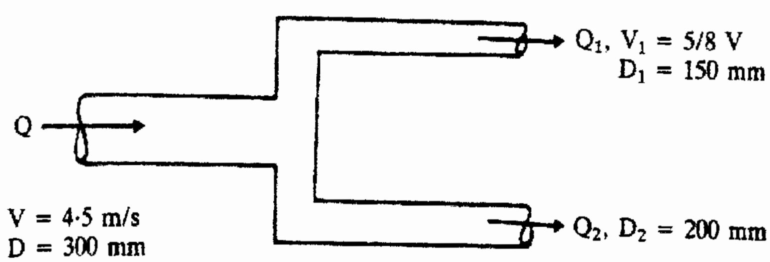
(13 mark)

(c) In a U-tube manometer, a column of water 40 cm high supports a 31 cm column of an unknown liquid. What is the density of the unknown liquid?

(5 marks)

QUESTION 5

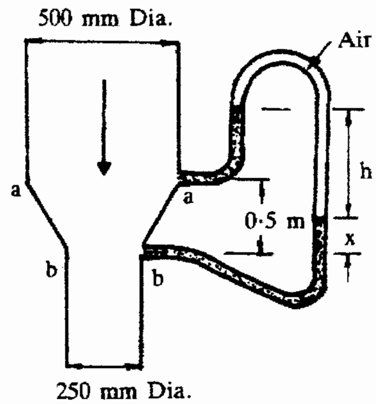
(a) A pipeline of 300 mm diameter carrying water at an average velocity of 4.5 m/s branches into two pipes of 150 mm and 200 mm diameters. The average velocity in the 150 mm pipe is 5/8 of the velocity in the main pipeline. Determine the average velocity of flow in the 200 mm pipe and the total flow rate in the system in l/s.



Branching pipeline

(13 marks)

(b) A 500 mm diameter vertical water pipeline discharges water through a constriction of 250 mm (See figure below). The pressure difference between the normal and constricted sections of the pipe is measured by an inverted U-tube. Determine (i) the difference in pressure between these two sections when discharge through the system is 600 l/s, and (ii) the manometer deflection, h, if the inverted U-tube contains air.



Flow through a vertical constriction

(12 Marks)

FORMULARS

1. $Cd = 0.61$ and $T = \int dt = \frac{ZA\,(H_1^{1/2} - H_2^{1/2})}{Cda\sqrt{2g}}$

2. $Q = 2/3\ Cd\ \sqrt{2g}\quad b(H_1^{3/2} - H_2^{3/2})$

3. $Y_i = Y_S/2\ (\sqrt{1+8\beta f_S^2} - 1)$

4. $F_{S=} V_S/\sqrt{g}Y_S$

5. $(Y + V/2g) - (Y + V/2g)$

6. $\rho gy^2/2 + \rho q(V_1 - V_2) - \rho gY_2^2/ F_X = 0$

7. $Y_G = Y_s\ \sqrt{1+2F_s^2}\ (1 - Y_S/ Y_2)$

8. $Q = AV$

9. $Q = A/n\ R^{2/3}\ S_0^{1/2}$

10. $Y_i = Y_S/2\ (\sqrt{1+8\beta f_S^2} - 1)$

11. $F_{S=} V_S/\sqrt{g}Y_S$

12. $p_1/\rho g + v_1^2/2g = p_2/\rho g + v_2^2/2g + 0.03\ (p_1/\rho g - p_2/\rho g)$

13. $Q = 1.84BH^{3/2}\ [(1+ \alpha\ v^2/2g\ H)^{3/2} - (\alpha\ v^2/2g\ H)^{3/2}]$

14. $k=[(1+ \alpha\ v^2/2g\ H)^{3/2} - (\alpha\ v^2/2g\ H)^{3/2}]$

15. $h= (v^2/2g)(1+ A_1/A_2)^2 = v^2/2g\ (A_1/A_2 - 1)^2$

16. $W = \sum_{i=1} \frac{p^{2rms(1)}S_i}{\rho C}$, where $\rho C = 420$ RAYLS.

17. $S.I.L = 10\log_{10}(I) + 120$

18. $L_p= 10\log(p_1/p_0)^2$ or $(p_1/p_0)^2 = 10^{Lp/10}$

19. $L_p(\text{total}) = 10\log(p_{total}/p_0)^2$

20. $I = W/A$

21. $L_W = 10\log W/W_0$

22. $Q_1 = 1.84\ BH^{3/2}$

23. $Q = Cd\ 8/15\ \sqrt{(2g)}(\tan\square/2)H^{5/2}$

24. $\Delta Q = \dfrac{-\sum h}{2\sum h/Q}$