UNIVERSITY OF SWAZILAND
FACULTY OF HEALTH SCIENCES
DEGREE IN ENVIRONMENTAL HEALTH SCIENCES
(FINAL EXAMINATION)

TITLE OF PAPER	**: WATER DISTRIBUTION**
COURSE CODE	**: EHS 586**
TIME	**: 3HOURS**
TOTAL MARKS	**: 100**

INSTRUCTIONS:

- **QUESTION 1 IS COMPULSORY**
- **ANSWER ANY OTHER THREE QUESTIONS**
- **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
- **FORMULAE AND OTHER DATA IS PROVIDED**
- **NO FORM OF PAPER SHOULD BE BROUGHT IN OR OUT OF THE EXAMINATION ROOM**
- **BEGIN THE ANSWER TO EACH QUESTION IN A SEPARATE SHEET OF PAPER.**

DO NO OPEN THIS EXAMINATION PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR.

QUESTIONS 1

I.

Multiple choice: Write True or False against each letter corresponding to the following statements as they apply to water distribution.

a) The hydraulic grade line shows the elevation of the pressure head along the pipe .
b) For the flow of a real fluid through a pipe or other conduit, the velocity will not vary form wall to wall.
c) Energy losses in sudden transitions are due to the formation of eddies and pressure loss dissipation in the form of heat energy.
d) The maximum gauge pressure of water that can be measured by means of a piezometer tube 2m high is $19.62 \times 10^3\,Nm^{-2}$.
e) For steady conditions, total inflow to a junction is equal to total outflow from the junction.
f) For steady flow at any junction the algebraic sum of all the mass flows must not necessarily be zero.
g) When pressures are expressed as head, not essential that the mass density is given or the fluid named.
h) Fluids have the ability to flow and suffer deformation due to shear stress.
i) Pressure in a stationary liquid is the same all directions and is the same at all point in the same horizontal plane.
j) According to Pascal's Principle, pressure applied to an enclosed fluid is not transmitted with same magnitude to every portion of the fluid and walls of containers.

(20marks)

II

State five things that the design of a rural water distribution system involves.

(5 marks)

QUESTION 2

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

(10 marks)

b) Glycerine of viscocity 0.9 Ns/m^2 and density 1260 kg/m^3 is pumped along a horizontal pipe 65 m long of diameter d = 0.01 m at a flow rate of Q = 180 *l*/ min. Determine the flew Reynolds number and verify whether the flow is laminar or turbulent. Calculate the pressure loss in the pipe due to frictional effects and calculate the maximum flow rate for laminar flow conditions.

(10 marks)

c) 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).

(5 marks)

QUESTION 3

Using Bernoull's equation;

a) Calculate the head loss in a pipeline based on the following :

Z_1 = 4.5mm, p_1 = 280 kPa , v_1 = 1.2 m/s

Z_2 = 9.3 m, p_2 = 200kPa , = 1.2 m/s

(7 marks)

b) A rectangular open channel has a width of 4.5 m and a slope and a slope of 1 vertical 800 horizontal. Find the mean velocity of flow and the discharge when the depth of water is 1.2 m and if C in the Chezy formula is 49.

(9 marks)

c) A vertical circular tank is 1.25 m diameter is fitted with a sharp edge circular orifice 50 mm diameter in its base. When the flow of water into the tank was shut off, the time taken to lower the head from 2 m to 0.75 m was 253 seconds. Determine the rate of flow in l/s, through the orifice under a steady head of 1.5 m.

(9 marks)

QUESTION 4

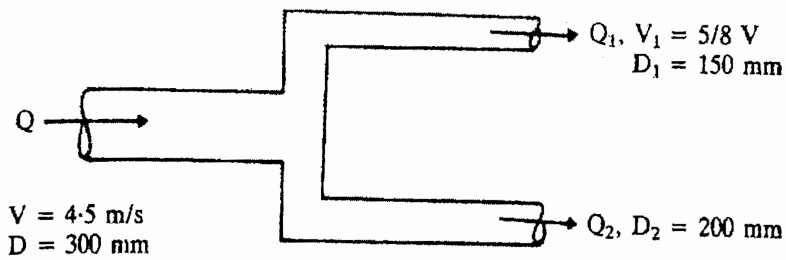
a) In the following pipe system, balance the flows:

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/m³/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

(16 marks)

(b) 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

(9 marks)

QUESTION 5

a) A pipe line 0.20m diameter and 50m long contains two 90^0 elbows and one gate value. Allowing for sharp pipe entry and exit loss calculate the equivalent pipe length and the total head loss when the flow rate is $0.2m^3/s$ and the value is fully open. Take the function factor; f = 0.005.

(12 marks)

b) Estimate the energy (head) loss along a short length of pipe suddenly enlarging from a diameter of 350mm to 700mm and conveying 300 liters per second of water. If the pressure at the entrance of the flow is $10^5\ N/m^2$, find the pressure at the exit of the pipe. What would be the energy loss if the flow were to be reversed with a contraction coefficient of 0.62?

(13 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. $F_S = V_S/\sqrt{gY_S}$

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

6. $\rho g y^2/2 + \rho q(V_1 - V_2) - \rho g Y_2^2 / F_X = 0$

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. $F_S = V_S/\sqrt{gY_S}$

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. $I = W/A$

22. $n = \frac{2\sigma \cos\theta}{R\rho g}$

23. $\frac{p_1}{\rho g} + \frac{v_1^2}{2g} = \frac{p_2}{\rho g} + \frac{v_2^2}{2g}$

24. $W = \rho g Q h_p$,

25. Turbine output = $\eta_t \rho g Q h_p$,

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

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

28. $Q = a_1 v_1 = a_1 v_2$

29. $h_L = (1/C_c-1)^2 V_1^2/2g$

30. $A = (b + Ny)y$

31. $P = b + 2y\sqrt{(1+N^2)}$

32. $\Delta Q = \frac{-\Sigma h}{2\Sigma h/Q}$

33. $SRI = 10 \log_{10} \frac{I_i}{I_t} = 10 \log_{10} \frac{1}{\tau} = T.L$