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:

- **ANSWER ANY FOUR QUESTIONS**
- **QUESTION 1(I) IS MULTIPLE CHOICE**
- **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
- **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.

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

(20marks)

II.

Briefly describe the design of open channels

(5 marks)

QUESTION 2

a) If 54.5 dm^3 of water are discharged from a vessel in 25 seconds, find the rate of discharge in m^3/s and the velocity of the discharge if the discharge passed through an opening of 50 mm diameter.

(10 marks)

b) A 20 mm diameter pipe forks, one branch being 10 mm in diameter and the other 15 mm in diameter. If the velocity in the 10 mm pipe is 0.3 m/s and that in the 15 mm pipe is 0.6 m/s , calculate the flow rate in cm^3/s and the velocity in m/s in the 20 mm pipe

(15 marks)

QUESTION 3

Using Bernoull's equation;

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

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

22 = 9.3 m, p2 = 200 kPa , = 1.2 m/s

(6 marks)

b) If a 250 mm water main is carrying a flow of 60 l/s, what is the velocity of flow and head loss for (i) C 100 and C = 140?

Table 1 correction Factors to determine Head losses from Nomograph for Hazen Williams formular at values of C other than C 100.

(5 marks)

Table 1: Corrected h_L= K x h_L at C = 100

C	K	C	K
80	1.51	120	0.71
100	1.00	130	0.62
110	0.84	140	0.54

c) Calculate the head loss in a 600 mm – diameter , 1500m long smooth – walled concrete (Σ = 0.001) pipeline carrying a water flow of 0.30 m^3/s.

(6 marks)

d) A pump discharge line consist of 60 m of 300 mm new cast iron pipe, three 90° medium-radius bends, two grater values and one swing check value. Compute the head loss through the line at a velocity of 1.0 m/s.

Table 2: Approximate Minor Head loss losses in fittings and values

Fitting or valve	Loss coefficient	Equivalent length (Diameters of pipe)
Tee (run)	0.60	20
Tee (branch)	1.80	60
90 ° bend		
- Short radius	0.90	32
- Medium radius	0.75	27
- Long radius	0.60	20
45° bend	0.42	15
Gate valve (open)	0.48	17
Swing check valve (open)	3.7	135
Butterfly valve (open)	1.2	40

(8 marks)

QUESTION 4

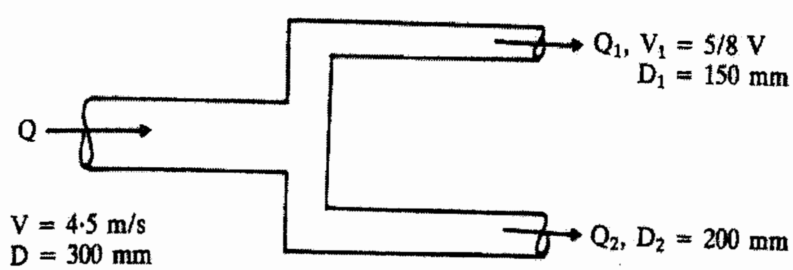
a) In the following pipe system, balance the flows:

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/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

(16marks)

(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

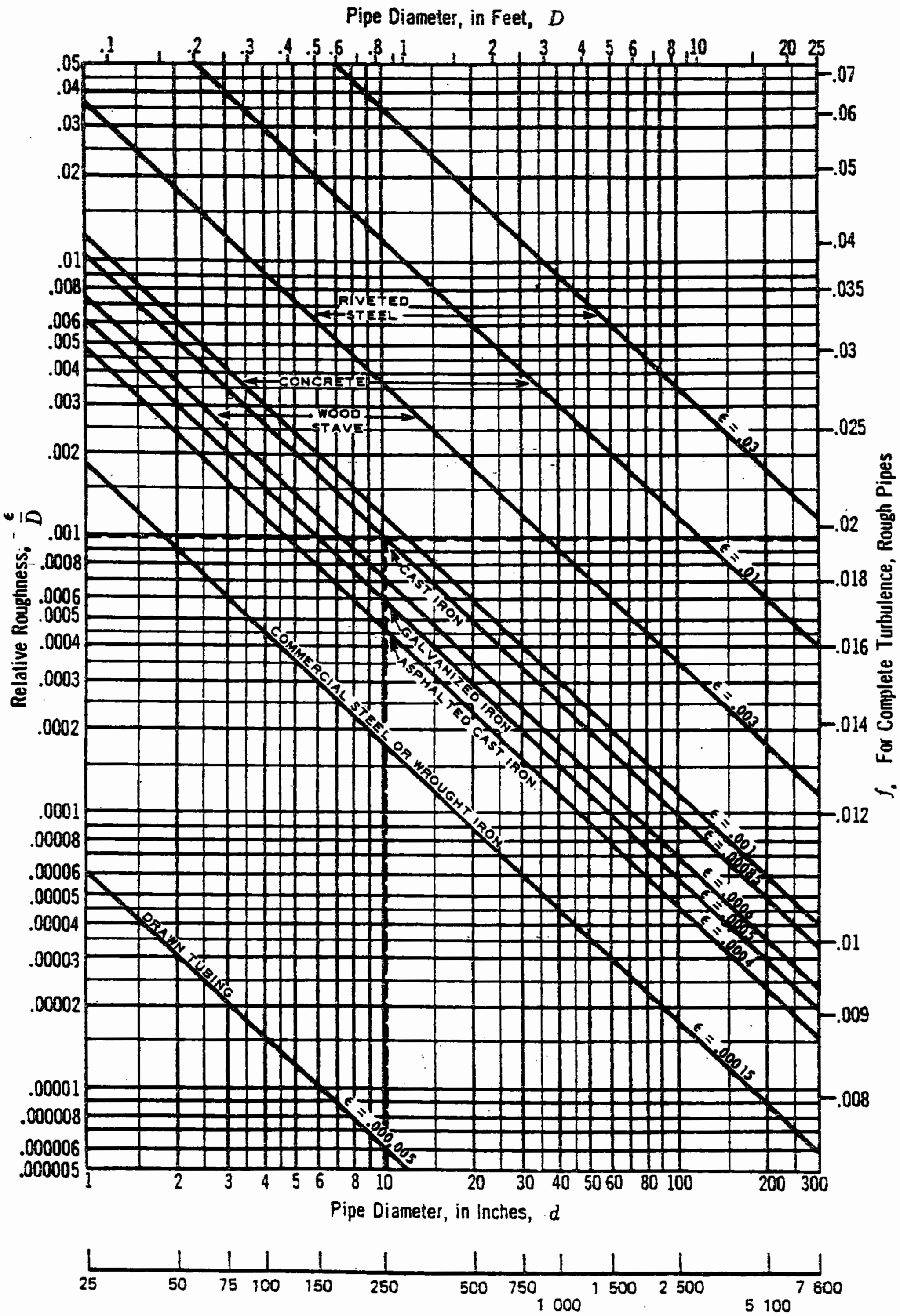
a) A pipe line 0.20m diameter and 50m long contains two 90^0 elbows and one gate value. Allowing for sharp pipe entry and exit loss calculate the equivalent pipe length and the total head loss when the flow rate is o.2m^3/s and the value is fully open. Take the function factor; f = 0.005.

(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)

FIGURE 8



Pipe Diameter, in Feet, D
.1 .2 .3 .4 .5 .6 .8 1 2 3 4 5 6 8 10 20 25
Relative Roughness, $\frac{\epsilon}{D}$
.05 .04 .03 .02 .01 .008 .006 .005 .004 .003 .002 .001 .0008 .0006 .0005 .0004 .0003 .0002 .0001 .00008 .00006 .00005 .00004 .00003 .00002 .00001 .000008 .000006 .000005
f, For Complete Turbulence, Rough Pipes
.07 .06 .05 .04 .035 .03 .025 .02 .018 .016 .014 .012 .01 .009 .008
RIVETED STEEL
CONCRETE
WOOD STAVE
CAST IRON
GALVANIZED IRON
ASPHALTED CAST IRON
COMMERCIAL STEEL OR WROUGHT IRON
DRAWN TUBING
ε = .03
ε = .01
ε = .003
ε = .001
ε = .00085
ε = .0006
ε = .0005
ε = .0004
ε = .00015
ε = .000,005
1 2 3 4 5 6 8 10 20 30 40 50 60 80 100 200 300
Pipe Diameter, in Inches, d
25 50 75 100 150 250 500 750 1 000 1 500 2 500 5 100 7 600

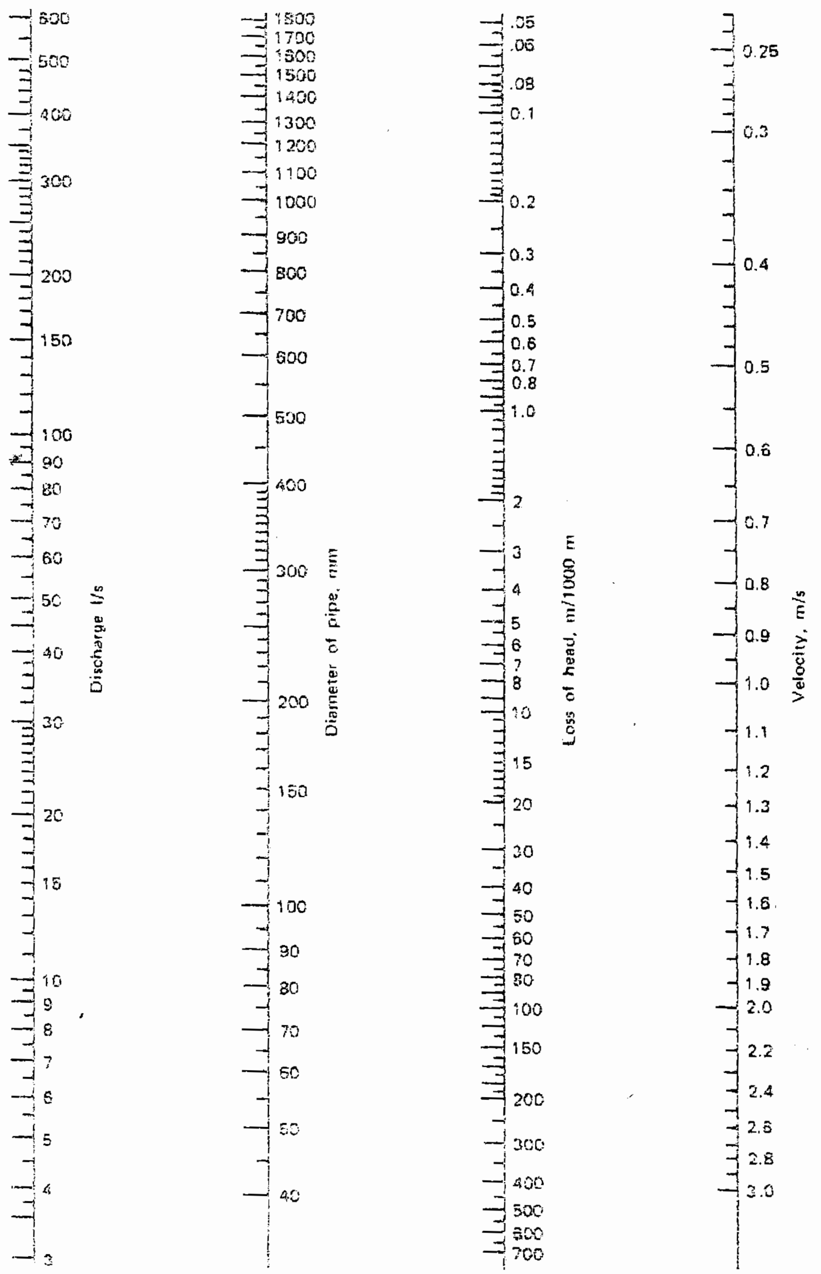

Discharge l/s
600 500 400 300 200 150 100 90 80 70 60 50 40 30 20 15 10 9 8 7 6 5 4 3
Diameter of pipe, mm
1800 1700 1600 1500 1400 1300 1200 1100 1000 900 800 700 600 500 400 300 200 150 100 90 80 70 60 50 40
Loss of head, m/1000 m
.05 .06 .08 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 1.0 2 3 4 5 6 7 8 10 15 20 30 40 50 60 70 80 100 150 200 300 400 500 600 700
Velocity, m/s
0.25 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2.0 2.2 2.4 2.6 2.8 3.0

FIGURE 9

FORMULARS

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

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

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. $F_S = V_S/\sqrt{g Y_S}$

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. $W = \sum_{i=1} \dfrac{p^{2rms(1)} S_i}{\rho C}$, where ρC = 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. $L_p(\text{total}) = 10 \log (p_{\text{total}}/p_0)^2$

20. $I = W/A$

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

22. $h = \dfrac{2\sigma \cos\theta}{R\rho g}$

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

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

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