REE 307 - Aerodynamics
Sheet 1
Pipe Networks

1. Choose the right answer from the following:

i. Branched pipe problems are solved
   - (a) Analytically by using as many equations as unknowns.
   - (b) By assuming the head loss is the same through each pipe.
   - (c) By equivalent lengths.
   - (d) By assuming a distribution which satisfies continuity and computing a correction.
   - (e) By assuming the elevation of hydraulic grade line at the junction point and trying to satisfy continuity.

ii. In networks of pipes
   - (a) The head loss around each elementary circuit must be zero.
   - (b) The (horsepower) loss in all circuits is the same.
   - (c) The elevation of hydraulic grade line is assumed for each junction.
   - (d) Elementary circuits are replaced by equivalent pipes.
   - (e) Friction factors are assumed for each pipe.

2. In Fig.1, find the discharges for water at 20 ℃ with the following pipe data and reservoir elevations:

$f_1 = 0.015$, $D_1 = 1.00$ m, $L_1 = 3000$ m, $Z_1 = 30$ m. $f_2 = 0.024$,

$D_2 = 0.45$ m, $L_2 = 600$ m, $Z_2 = 18$ m.

$f_3 = 0.020$, $D_3 = 0.60$ m, $L_3 = 1000$ m, $Z_3 = 9$ m.

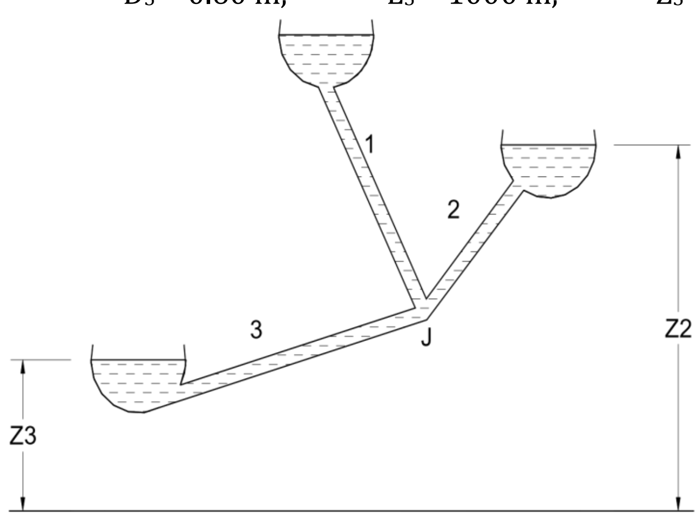

Fig.1

3. In Fig.2, find the flow rate through the system.

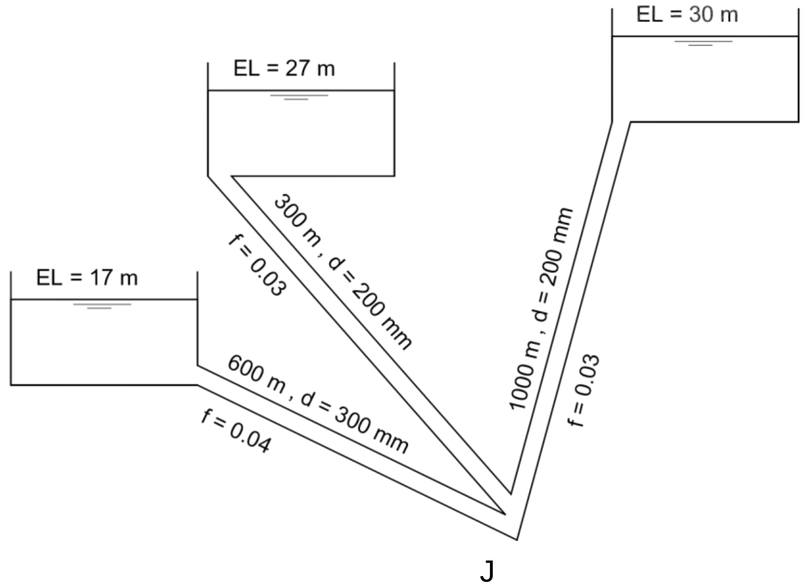

Fig.2

4. Water enters the four-sided ring main shown in Fig.3 at A at a rate of 0.4 m^3/s and is delivered at B, C, D at the rate of 0.15, 0.10, and 0.15 m^3/s respectively. All pipes are 0.6 m in diameter with a friction coefficient ' f ' of 0.0078 and 78their lengths are: AB = CD = 150 m, BC = 300 m, and DA = 240 m.
   Determine the flow through each pipe and the pressures at B, C, and D if that at A is 105 kN/m^2.

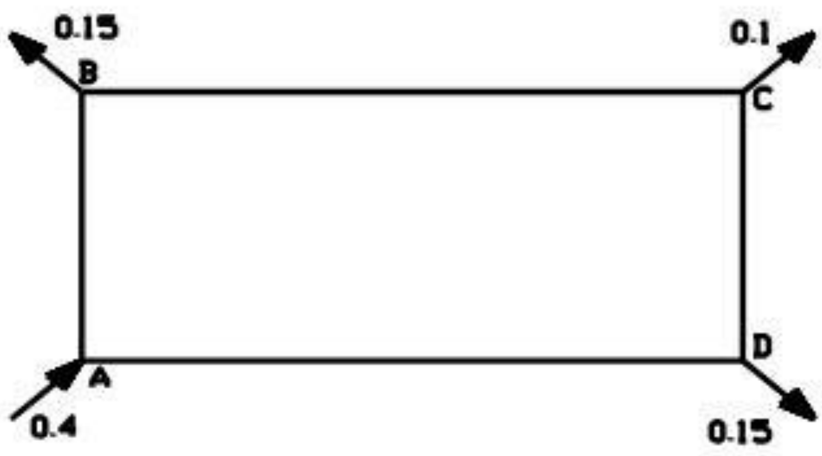

Fig.3

5. Calculate the flow rate through each pipe of the network shown in Fig.4. Take n = 2.0.

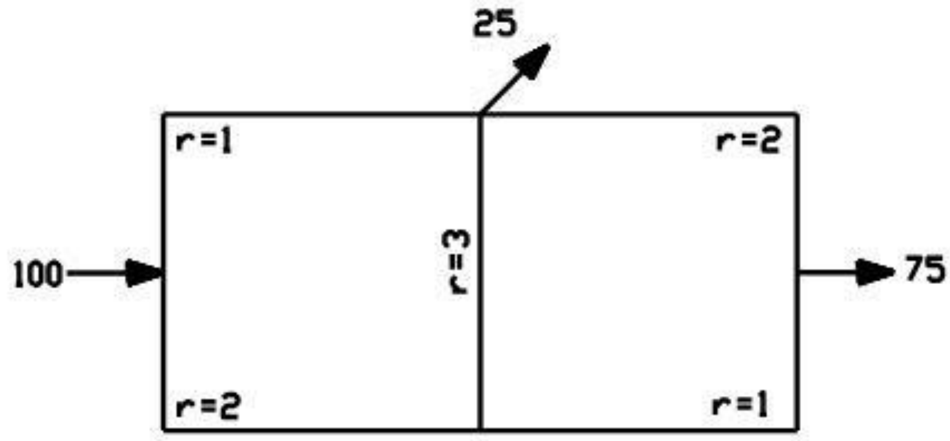

Fig.4

6. The distribution of the flow through the network shown in Fig.5 is desired for the inflows and outflows. The initial assumption of some flow rates in some pipes is given and take n = 2.0. Calculate the flow rate through each pipe of the network.

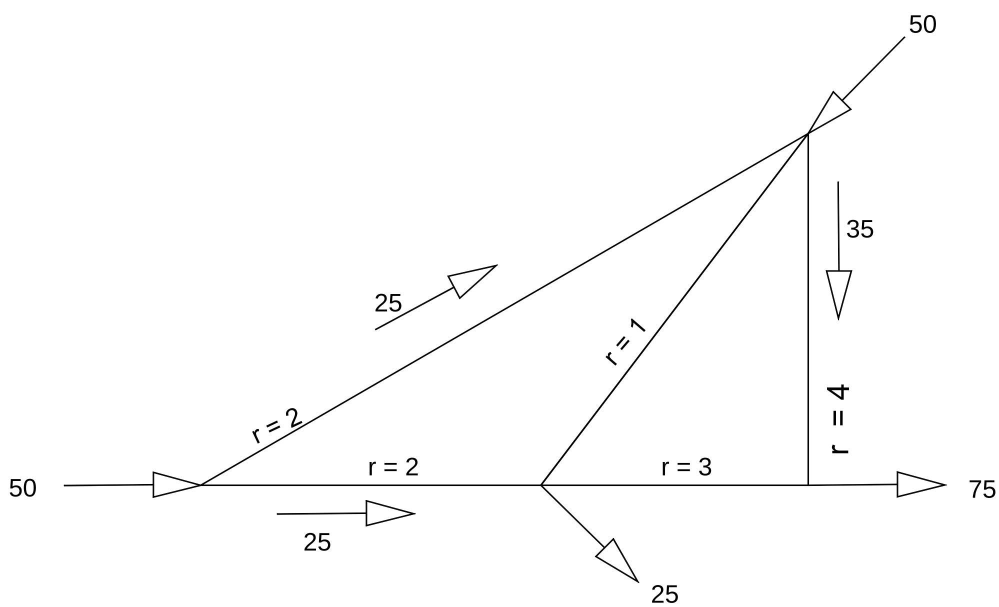

Fig.5

7. For the water network showed in Fig.6, the flow rate required at point B is 7 m^3/s, while the flow rate required at point C is 8 m^3/s. The pump P is 10 m above datum (Zp) and supplies a constant pressure of 10 bar, while the water surface level in tank T is 60 m above the same datum. Determine the flow rate leaving the pump and the tank given the following valve data:

   i. Loss coefficient of the valve = 50

   ii. Diameter of valve = 1.6 m

   Determine the pressure at the supply points B & C.

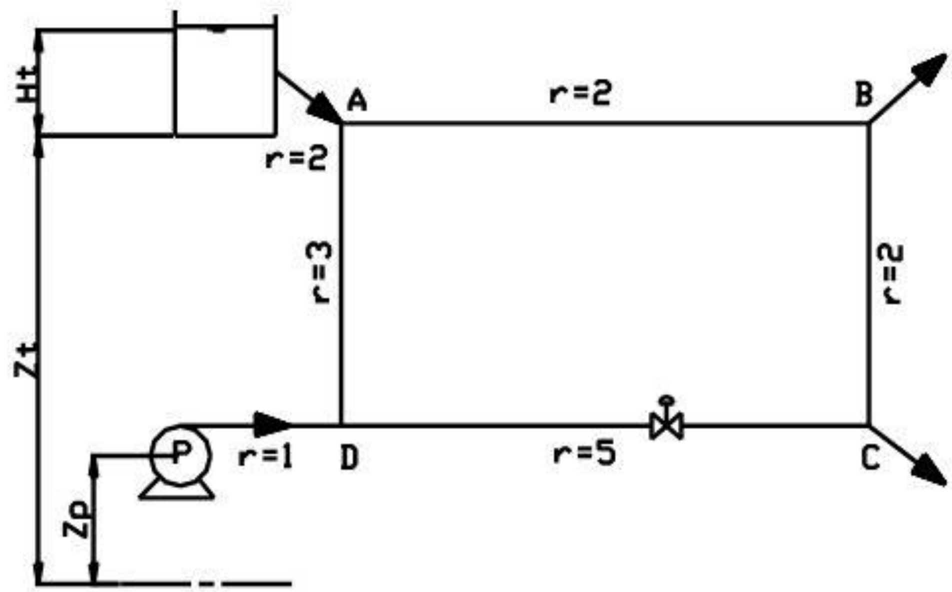

Fig.6

8. Two reservoirs 'A' and 'B', having a difference in level of 20 m. 'A' being the higher, are connected by a 200 mm diameter pipe 1000 m long. Two other reservoirs 'C' and 'D', having a difference of level 40 m, 'C' being the higher and 10 m below reservoir 'A', are connected by a 300 mm pipe 3000 m long. In order to increase the quantity of water entering reservoir 'D', the two pipes are connected by a pipe MN 1500 m long 200 mm diameter which branches from the 200 mm pipe at point M, 300 m from reservoir 'A', and connects with the 300 mm pipe at N, 700 m from reservoir 'D'. The friction coefficient is 0.05 for all pipes. Determine the quantity of water entering the reservoirs 'B' and 'D' before and after the two systems were connected. Neglect all secondary losses and attempt only two trials.

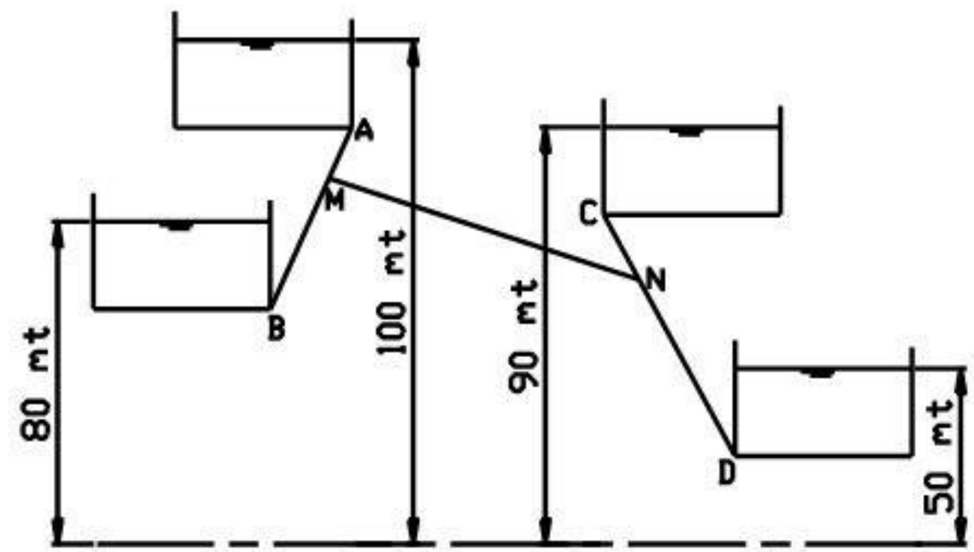

Fig.7

9. Given the network shown in Fig.8, representing a pump that delivers water from tank 'A' to the customers at 'C' and 'D' and to fill the tank 'F'. The flow into tank "F" is controlled by valve "V" at the beginning of branch EF, as shown in Fig.8, where 'r' of the valve equals 2. The total heads in tanks A and F are 40m, and 50 m., respectively, measured from the same datum. The diameters and lengths of the branches are as shown in table. The coefficient of friction 'f' for all branches is 0.003, and the resistance of branch 'AB' is neglected. The pump flow rate in branch 'AB' can be represented by the quadratic equation $H = rQ^2$ where, r=1 and H is the difference in head before and after the pump.

a- Assume the initial flow rate in the branches is given as shown in figure. Find the flow rate in each branch after <u>one</u> <u>trial only.</u> then find the pressure head at point 'D' if the pressure head before the pump is 10m.

b- (Unsteady) For the calculated flow rates, if tank F started to be full, valve 'V is closed suddenly, estimate the minimum pressure in the branch 'EF' and predict if column separation would occur, if vapor pressure equals -10 m. Valve closes linearly in 10 sec. and the elevation of 'E' is zero

Branch	Pipe diameter (mm.)	Length of pipe (m.)
BC	400	100
CD	300	50
DE	400	100
BE	300	50
EF	300	50

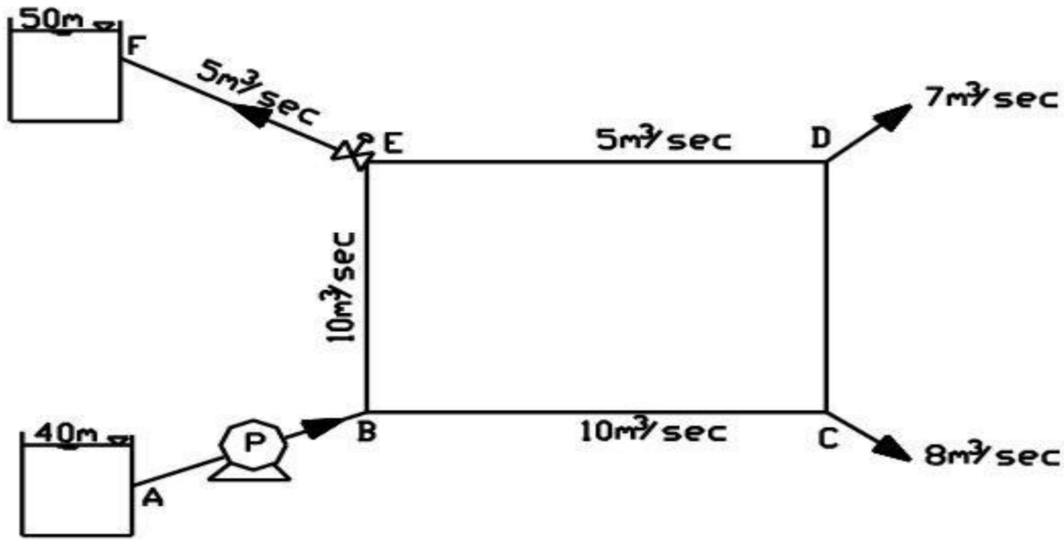
50m
F
5m³/sec
E
5m³/sec
D
7m³/sec
10m³/sec
40m
P
B
10m³/sec
C
8m³/sec
A

Fig.8

10. a- In the branched pipe system shown in Fig.9, find the flow rate in each branch. Attempt only two trials. (neglect all secondary losses). Draw the total energy line for the system. b- After determining the correct value of the flow rate in each pipe, will this value remain constant with time. c- After sufficiently long time what do you expect the level of water in the three tanks will be relative to each other if the height of all tanks was sufficiently large. d- In case the valve on the branch c-J was partially closed, find the valve constant 'r ' so that no flow entering or leaving tank B, assuming the loss in the valve, $h_l = r\,Q^2$.

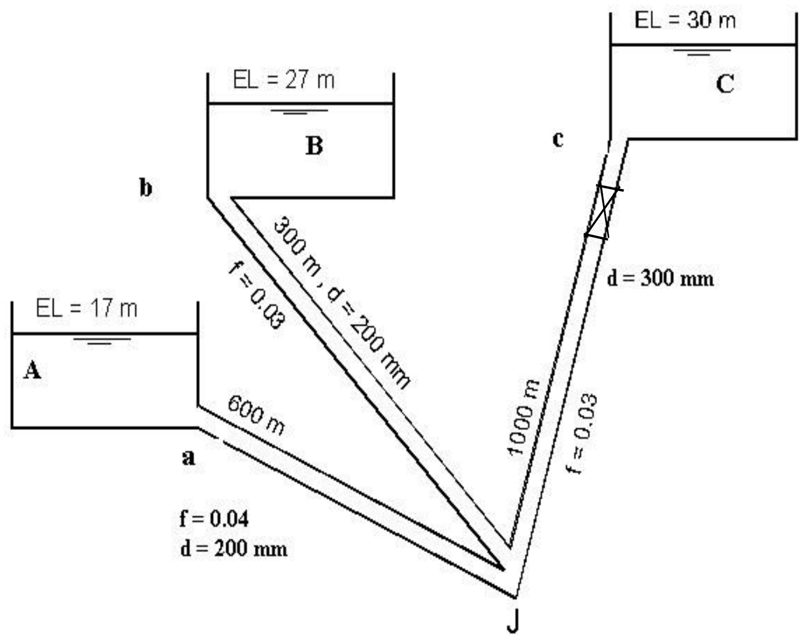

Fig.9

11. a- If the pump of Fig.10 is delivering 8 m^3/sec towards 'J' find the flow into tanks 'A' and 'B' and the energy at 'J'. b- Find the flow through the system when the pump is removed using Hardy Cross method, assuming as initial flows the values derived in 'a' and in the opposite direction. Attempt only one trial.

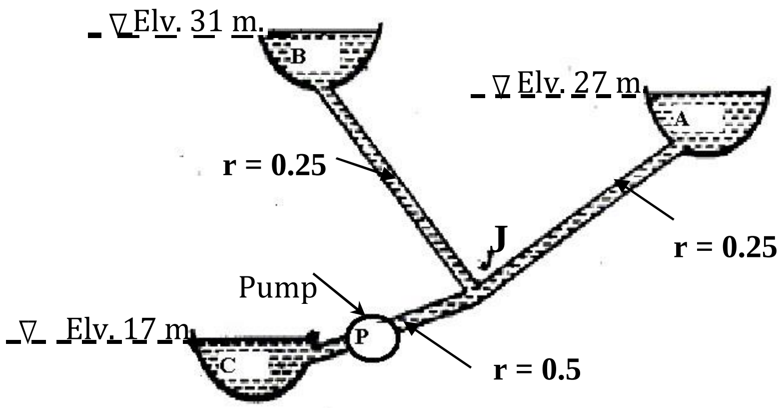

Fig.10

12.

a- In Fig.11 pipeline 'AJB ' connects two tanks 'A' and 'B'. If the elevation of water in tanks 'A' and 'B' are 30mt. and 22.5 mt., respectively and the elevation of the junction point 'J' is 35 mt., prove that the flow from 'A' to 'B' will be interrupted and stopped. Take h vap = -8 mt. and g = 10 m/sec^2 .

b- To maintain a continuous flow from 'A' to' B' a valve installed in branch 'JB' was partially closed. Find the minimum equivalent length for the losses in the valve to insure a continuous uninterrupted flow from 'A' to 'B', neglecting all secondary losses and kinetic energy.

c- If tank 'C' was connected to the pipe at 'J', and assuming the energy at the junction 'J' to be one of the values (25 Or 32 Or 15mt), find attempting two trials only the flow rate in each branch, neglecting all secondary losses except the losses in the partially closed valve in branch 'JB'.

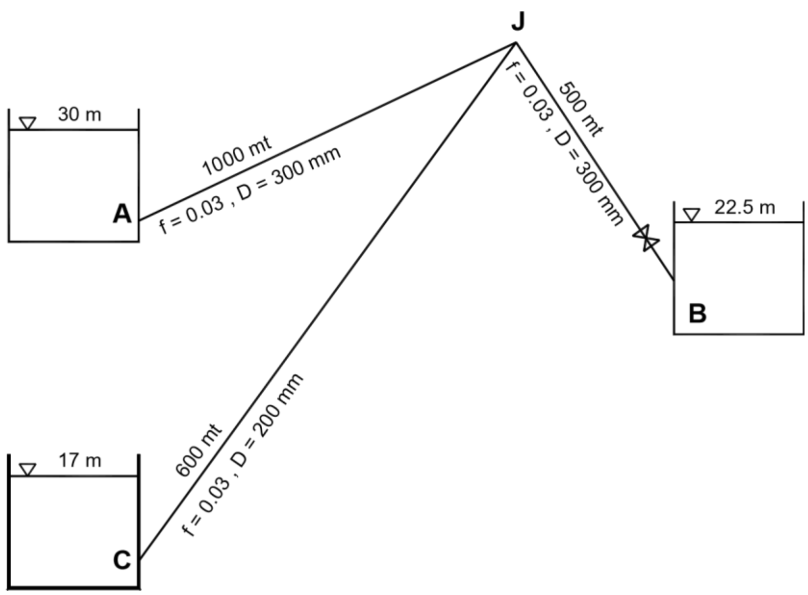

Fig.11