Menoufia University
Faculty of Engineering
Shebin El-Kom
Department: Mechanical Engineering
1th Semester
Final Exam: 4 pages +chart

Minufiya University

Post Graduate: Diploma
Subject: Pipe Network *(MPE520)*
Time allowed: 3hr
Full Mark: 100
Academic Year: 2016-2017
Date: 8 /01/2017

Assume any missing data, state your assumption clearly, and Answer all questions

Question (1) (25 Marks)

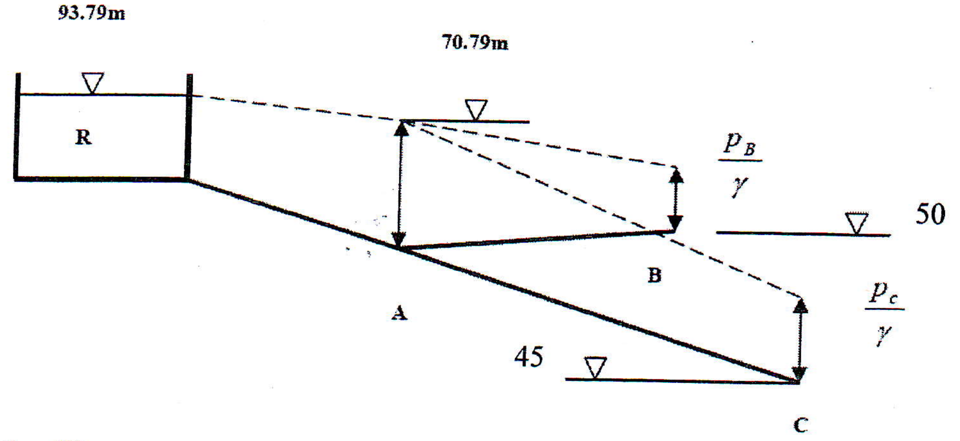
1.a) (i)-Assuming logarithmic low velocity profile $\frac{u}{u^*} = 2.5\ln(\frac{yu^*}{\upsilon}) + 5.5$ for the turbulent flow through smooth pipes. Show that for turbulent flow in a pipe of a radius R the variation of the difference between the maximum velocity V_{max} and the local velocity u at any distance y from the bounding surface follows the same variation with respect to the relative distance y/R in smooth pipe.

(ii) For turbulent flow in a pipe of 25 cm diameter, the centre line velocity is 2.25 m/s and the velocity at a point 8 cm from the centre as measured by a pitot tube is 1.95 m/s. Make calculations for (i) friction velocity and wall shearing stress, (ii) average velocity and discharge through the pipe, (iii) friction factor and (iv) pipe roughness.

1.b) The discharges in the AB and AC pipes are respectively Q_1=50 lit/sec and Q_2=80 lit/sec for the pipe system given. The required pressure at the B and C outlets is 200 kPa and the geometric elevations for these points are Z_B = 50 m and Z_c = 45 m. The physical characteristics of the pipe system are,

Pipe	Length (m)	Diameter (mm)	*f*
RA	2000	300	0.02
AB	1000	350	0.02
AC	1500	400	0.02

Calculate the minimum water surface level of the reservoir R to supply the required pressure at the outlets. Draw the energy line of the system. γ_{water}= 10 kN/m³.



Question (2) (25 Marks)

2. a)The 3-port manifold shown in the next diagram has a port-to-main diameter ratio D_3/D_2=0.4, a friction factor f=0.02 in the main and all laterals, and L_3/D_3=5.0 for each lateral. Considering fluid friction in the main and laterals and junction losses, compute the port discharges Q_a, Q_b and Q_c. The downstream end of the main is closed off by a blank plate.

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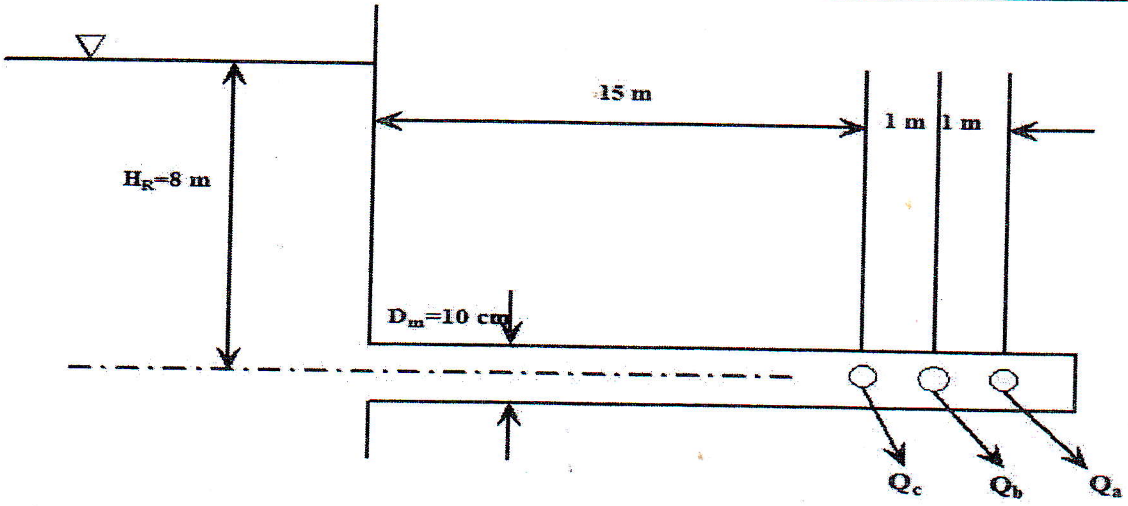
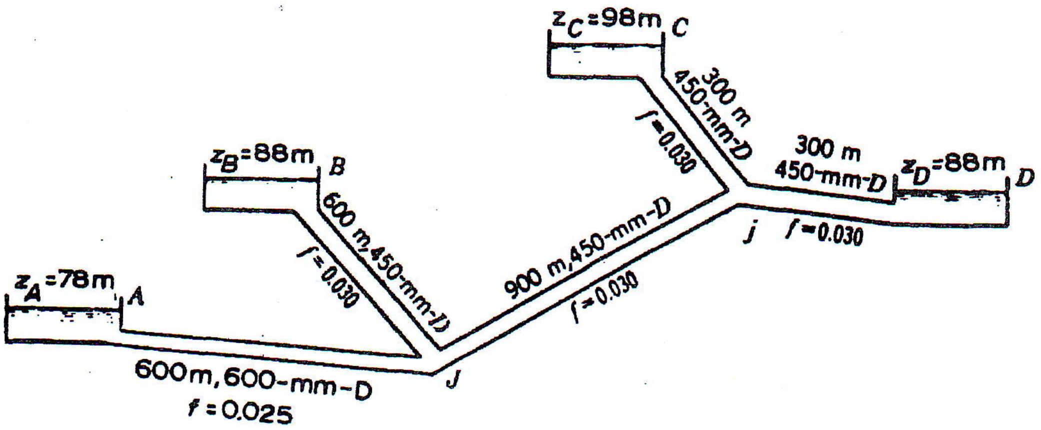


2.b) Compute the steady flow rate in all pipes



Question (3) (25 Marks)

In the sketch as shown in Fig. (3), a network with 10 pipes and 7 nodes which contains three pumps and one turbine. Use the pairs of (Q, hp) data in the table-1 to define the pump curves. The dimension of the pipelines of network (D&L) is given in table-2. The demands discharge and elevations at all nodes for the pipe network are given in table-2. By using the Newton method, solve the ΔQ-system equations, then determine the following: i)-Flowrates for all pipes of the network, ii)-HGL elevations at all nodes of the pipe network, iii)-pressure in bar at all nodes of the pipe network, iv) - Manometric heads for all pumps and turbine. Take for all pipes, f =0.01 and n=2, ν=1.31x10^{-6} m^2/s, ϵ=0.0001 m for all pipe.

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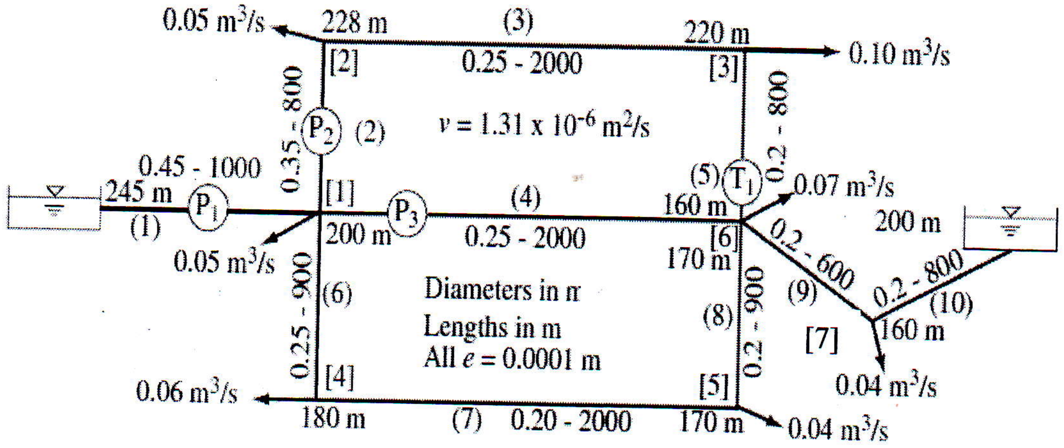

Fig. (3)

Table-1

Pump 1		Pump 2		Pump 3		Turbine	
Q (m^3/s)	H(m)	Q (m^3/s)	H (m)	Q (m^3/s)	H (m)	Q (m^3/s)	H (m)
0.40	20	0.12	16	0.06	8	0.09	-8.0
0.42	18	0.15	15	0.08	7.5	0.10	-7.5
0.44	15	0.18	13.6	0.1	6.8	0.11	-6.8

Table-2

Pipe No.	D(m)	L(m)	Node No.	Elevation (m)	Demands (m^3/s)
1	0.45	10000	1	200	0.05
2	0.35	800	2	228	0.05
3	0.25	2000	3	220	0.10
4	0.25	2000	4	180	0.06
5	0.20	800	5	170	0.04
6	0.25	900	6	160	0.07
7	0.20	2000	7	160	0.04
8	0.20	900			
9	0.20	600			
10	0.20	800			

Question (4) **(25 Marks)**

For the network shown in Fig. (4), the pipe- 5 contains a pressure reducing valve (PRV) 200 m downstream from node 2 that is set to maintain an HGL = 149 m on its discharge side. The dimensions of the pipelines of network (D&L) and (k & n) as given in table-3. The pumps characteristics are listed in table -4. The initial estimations values of Q_{io} for pipes of the network are listed in column vector in table -3. Do the following:

1) - write the system of ΔQ-equations, 2)-Using the Newton iterative formula, solve the system of ΔQ-equations, and then determine the following: i)-Volume flowrate (Q_i) for all pipes, ii)-HGL elevation at every node of the pipe network,

iii)-HGL on the upstream side of the PRV, iv)-What head drop occurs across the PRV?, Whart horse power does this loss represent?.

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Table-3

Pipe No.	D(m)	L(m)	K	n	Q_{oi} (m^3/s)	Q_{oi} (m^3/s)	
1	0.2	500	1160	1.827	Q_1	0.12	
2	0.2	300	613	1.788	Q_2	0.0	
3	0.2	500	1160	1.827	Q_3	0.11	
4	0.2	300	690	1.824	Q_4	0.07	
5	0.2	600	1292	1.801	Q_5	0.04	
6	0.2	500	1115	1.812	Q_6	0.06	
7	0.25	300	322	1.772	Q_7	0.08	
8	0.25	300	239	1.832	Q_8	0.18	

Table -4

Pump 1		Pump 2	
Q (m^3/s)	h_P (m)	Q (m^3/s)	h_P (m)
0.025	12.0	0.06	4.0
0.040	10.5	0.090	3.8
0.055	8.0	0.120	3.5

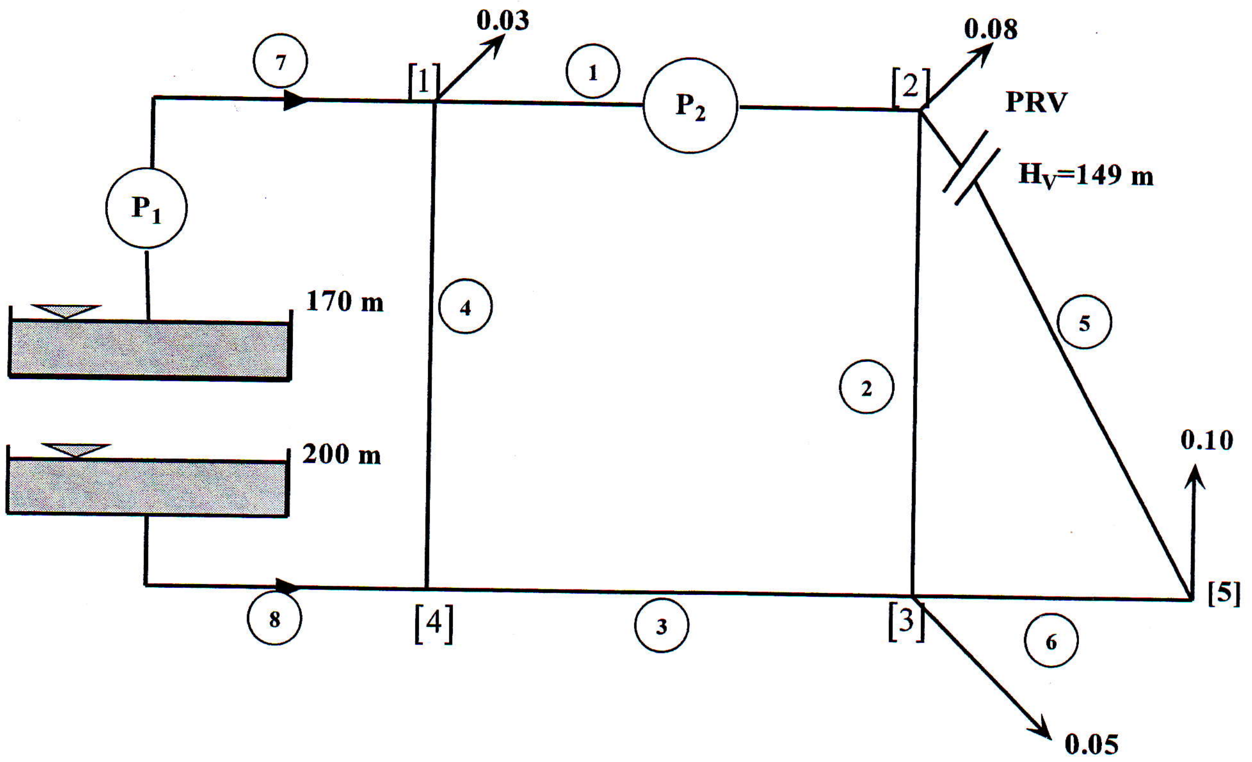

Fig. (4)

GOOD LUCK

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