Kafrelsheikh University
Faculty of Engineering
Dept. of Mechanical Eng. (4th Year)
Final Exam: 2 Pages

Pipelines and Networks

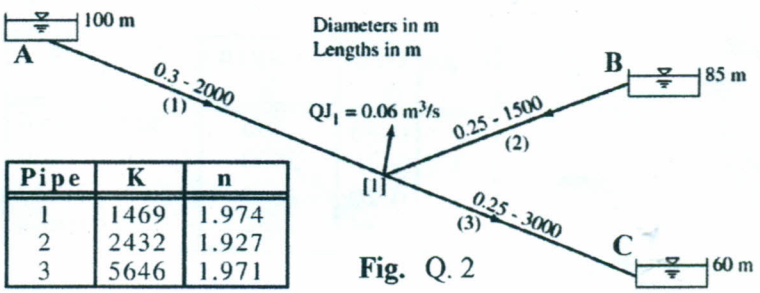
Date: 16 Jan. 2016
Time allowed: 3 hrs.
Full mark: 60

ANSWER ALL THE FOLLOWING QUESTIONS

1- **a)** For a pipe of radius R, the entire region $0 \le r \le R$ of turbulent flow is considered to be made up of three regions. Explain briefly these regions. **(3 Marks)**

b) Heavy crude oil (S.G = 0.925 and $\nu = 1.0 \times 10\text{-}4\ m^2/s$) is pumped through a pipeline laid on flat ground. The line is made from steel pipe with 600 mm inner diameter and has a wall thickness of 12 mm. According to allowable tensile stress in the pipe wall and corrosion considerations, the maximum allowable inside pressure is 11 MPa. It is important to keep the oil under pressure to ensure that gases remain in solution. The minimum recommended pressure is 500 kPa. The pipeline carries a flow of 6400 m^3 per day. Knowing that the friction coefficient of the pipe is 0.0277, determine the maximum spacing between pumping stations. **(4 Marks)**

2- Three reservoirs are connected by three pipes with an external demand at the common junction of the pipes, as shown in figure Q. 2. Water surface elevations in reservoirs A, B, and C are 100 m, 85 m, and 60 m, respectively. Determine the discharge in each pipe. **(8 Marks)**

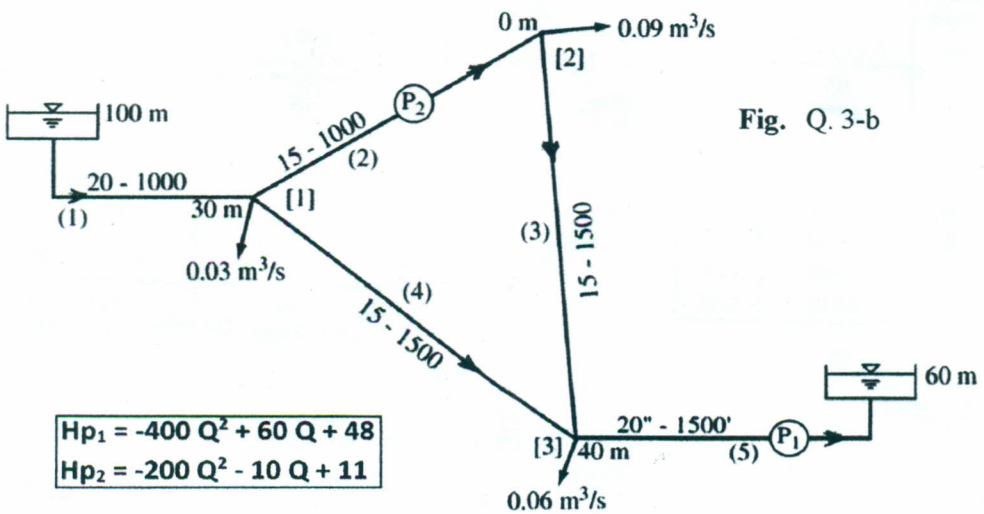


Pipe	K	n
1	1469	1.974
2	2432	1.927
3	5646	1.971

Fig. Q. 2

3- **a)** Show that f = 64/Re for laminar flow in a circular pipe **(4 Marks)**

b) For the following network (Fig. Q.2-b), write the system of **Q-equations**, the system of **H-equations**, and the system of **ΔQ-equations**. In writing these equations, use K and n with subscripts that correspond to the pipe number. **(10 Marks)**



$Hp_1 = -400\ Q^2 + 60\ Q + 48$
$Hp_2 = -200\ Q^2 - 10\ Q + 11$

Fig. Q. 3-b

4- **a)** What are the different methods of analyzing a given distribution system? Explain Hardy-Cross method of pipe network analysis. **(3 Marks)**

b) The shown network (Fig. Q. 4-b) consists of 4 pipes and 3 nodes. A source pump and one reservoir supply the network. The pump characteristics and pipes data are tabulated below. Neglecting local losses, do the following tasks:

i. Determine the discharge Q_i (m^3/s) in each pipe using **Linear theory method** for just **two** iterations.

ii. Determine the piezometric head at nodes [2], [3].

iii. Sketch qualitatively the EGL and HGL for the path **R→[1]→[3]**.

(14 Marks)

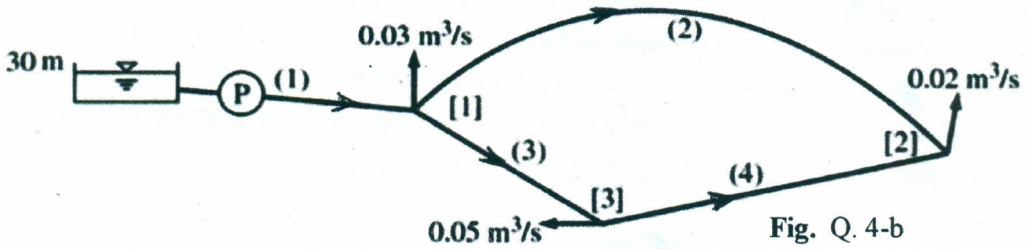


Fig. Q. 4-b

Pipe	Dia. m	Length m	K	n
1	0.30	1000	543	1.886
2	0.20	2500	13700	1.946
3	0.20	1000	3270	1.839
4	0.30	1500	1077	1.965

Pt.	Q m^3/s	h_p m
1	0.05	35
2	0.10	31
3	0.15	24

5- Analyze the looped pipe network shown in Figure Q. 5 for pipe discharges using **Hardy-Cross methods** for just two iterations and find the flow demand at node F. The water surface elevation in the storage tank is 47.0 m and the total (energy) head at point A is 29.986 m.

(14 Marks)

Pipe No.	K (s^2/m^5)	n
0	68	2.00
1	4350	2.00
2	6525	2.00
3	4350	2.00
4	4350	2.00
5	4350	2.00
6	4350	2.00
7	4350	2.00

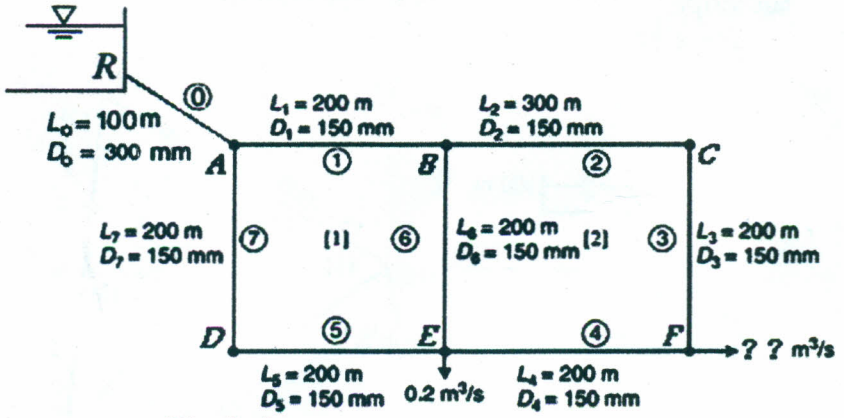


Fig. Q. 5

=== (With my best wishes) ===

Dr. M. Osama El-Samadony