Kafrelsheikh University
Faculty of Engineering
Dept. of Mechanical Eng.
4th Year, Mech. Power Eng.

Pipelines and Networks (MEP4120)

Date: 11 Jan. 2018
Time allowed: 3 hrs.
Full mark: 60
Final Exam: 2 Pages

Remarks: (Answer ALL the following questions... Assume any missing data... Answers should be supported with sketches... The weight of each problem is indicated.

Question (1) **(9 Marks)**

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 four regions. Explain briefly these regions. (3 Marks)

b) Consider flow of an incompressible fully developed turbulent fluid flow through a long horizontal circular pipe. Due to frictional forces between the fluid and the pipe wall, there exists a shear stress τ_w on the inside pipe wall. Using **dimensional analysis**, develop a non-dimensional relationship between shear stress τ_w and the operational (fluid velocity, density and viscosity) and design (pipe surface roughness and inner diameter) parameters of the pipe flow. (6 Marks)

Question (2) **(12 Marks)**

Reservoirs A, B, and C (Fig. Q2) have constant water levels of 0 m, 48 m, and 50 m respectively above datum and are connected by pipes to a single junction J. **Calculate the following:**

i. The **equivalent hydraulic resistance** of pipes 1, 2, and 3. (2 Marks)
ii. The **pressure head at junction J** (Hint: Use H_J = 45m as an initial guess). (7 Marks)
iii. The **discharge** in each pipe. (3 Marks)

Pipe No.	K (s^2/m^5)	n
1	355	1.927
2	816	1.927
3	816	1.927
4	222	1.974
5	355	1.971

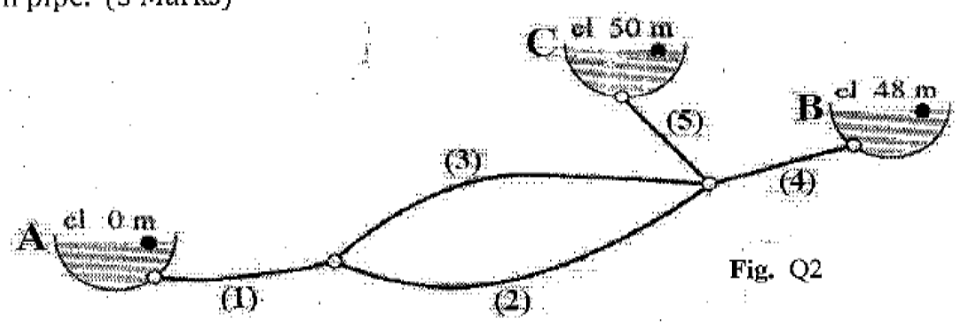

Fig. Q2

Question (3) **(10 Marks)**

A single looped network (Fig. Q3) consists of 4 pipes and 4 nodes. Neglecting minor losses, Do the following tasks:

i. Write the system of **Q-equations** for the network. (2 Marks)
ii. Write the matrices for the Newton's method implementation for this system. (Using subscripts on K, n and Q corresponding to the pipe number, do all necessary work to setup the first iteration of the Newton Method solution for flow rates in this network). (8 Marks)

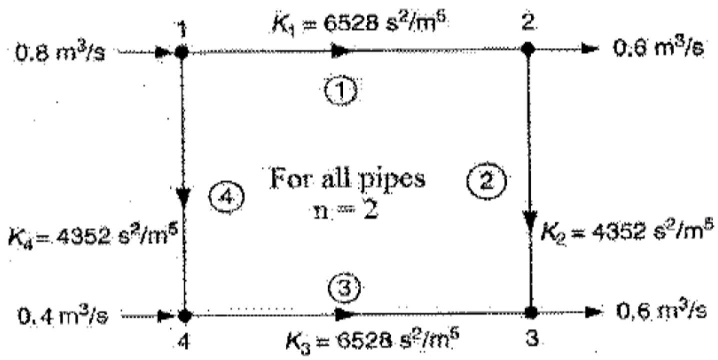

Fig. Q3

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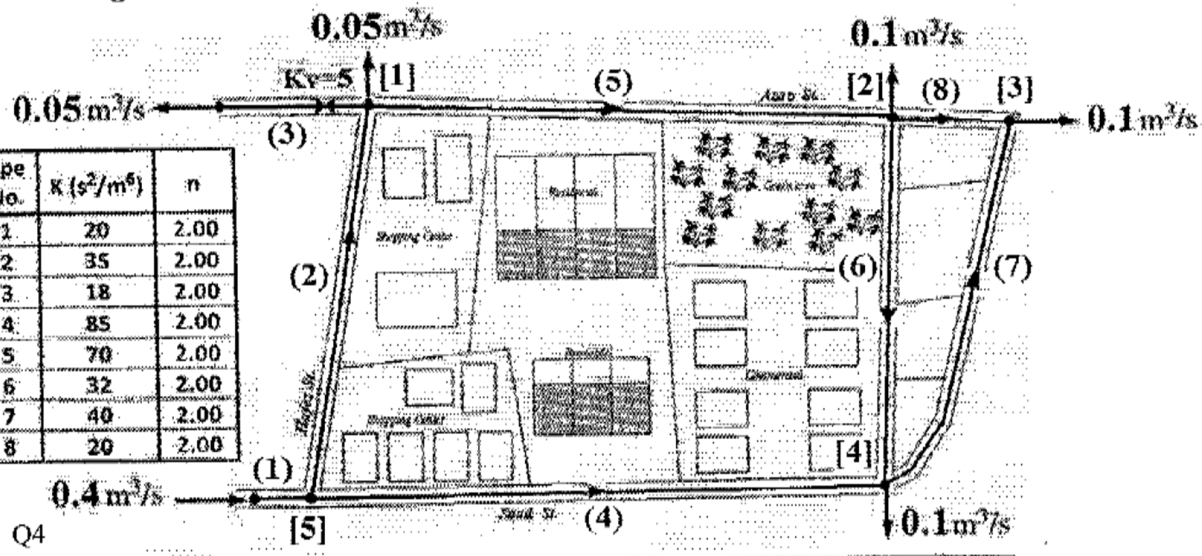
Question (4) **(16 Marks)**

A water distribution network for a town zone is shown in Figure Q4. All network elements are at the same elevation. **Do the following:**

i. Write the system of **ΔQ-equations** for the network. (4 Marks)

ii. Calculate **discharge** in each pipe using **Hardy-Cross methods** for just **two** iterations (**Hint: use the initial guess for discharge tabulated below**). (12 Marks)



Pipe No.	K (s²/m⁶)	n
1	20	2.00
2	35	2.00
3	18	2.00
4	85	2.00
5	70	2.00
6	32	2.00
7	40	2.00
8	20	2.00

Fig. Q4

Initial Guess for discharge in pipes								
Pipe	1	2	3	4	5	6	7	8
Flow rate, Q (m³/s)	0.4	0.3	0.05	0.1	0.2	0.05	0.05	0.05

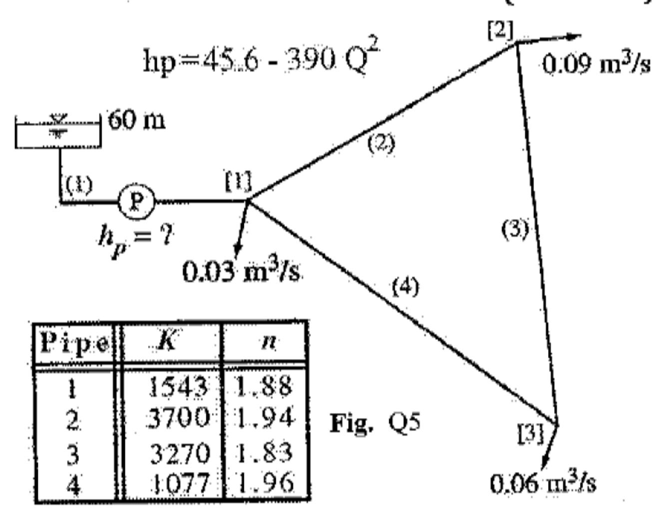
Question (5) **(13 Marks)**

The shown network (Fig. Q5) consists of 4 pipes and 3 nodes. A reservoir and a boosting pump supply the network with water through pipe (1). Neglecting local losses do the following tasks:

i. Write the system of **Q-equations** for the network. (2 Marks)

ii. Calculate the **discharge in pipe (1)** and the **head of the pump** (hp). (2 Marks)

iii. Determine the discharge Q_i (m³/s) in each pipe using **Linear Theory Method** for just **two** iterations (**For initial guess use: Q2=0.12 m³/s, Q3=0.03 m³/s, Q4=0.03 m³/s**). (9 Marks)



Pipe	K	n
1	1543	1.88
2	3700	1.94
3	3270	1.83
4	1077	1.96

Fig. Q5

End of Questions

With my Best Wishes...

Dr. M. Osama El-Samadony