Hydraulics

Course Content

« 5 lec. »

1- Pipe flow
- three Tanks problem
- Net works
- water hammar
- Pumps

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2 - open channel

* Designal open channel
* Energy in open channel
* Rapidly Varied flow
* Gradually Varied flow

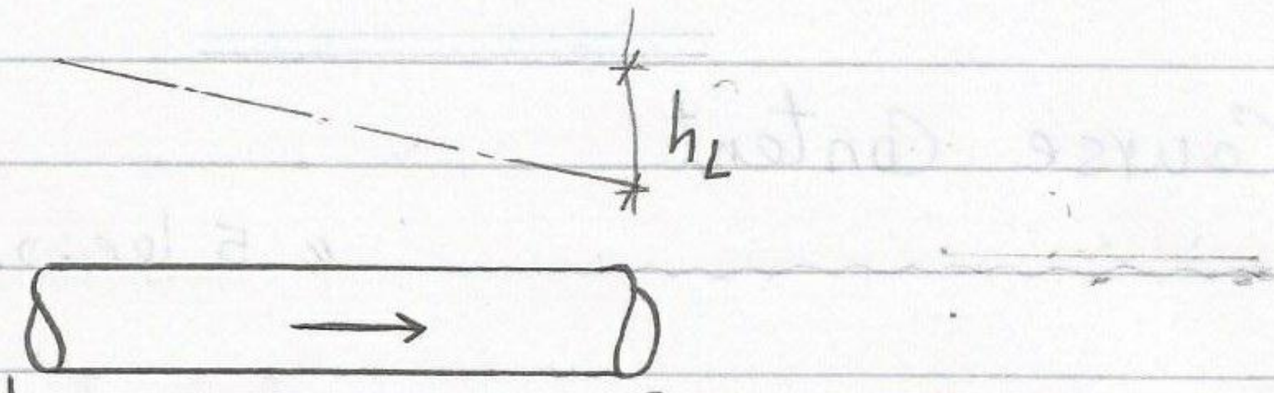
→ Dr/ Iman

Total Degrees 100
- final 60
- lab 20
- Student 20

Dr/ Mohamed Elfawy

Remember

$T.E_1 > T.E_2$



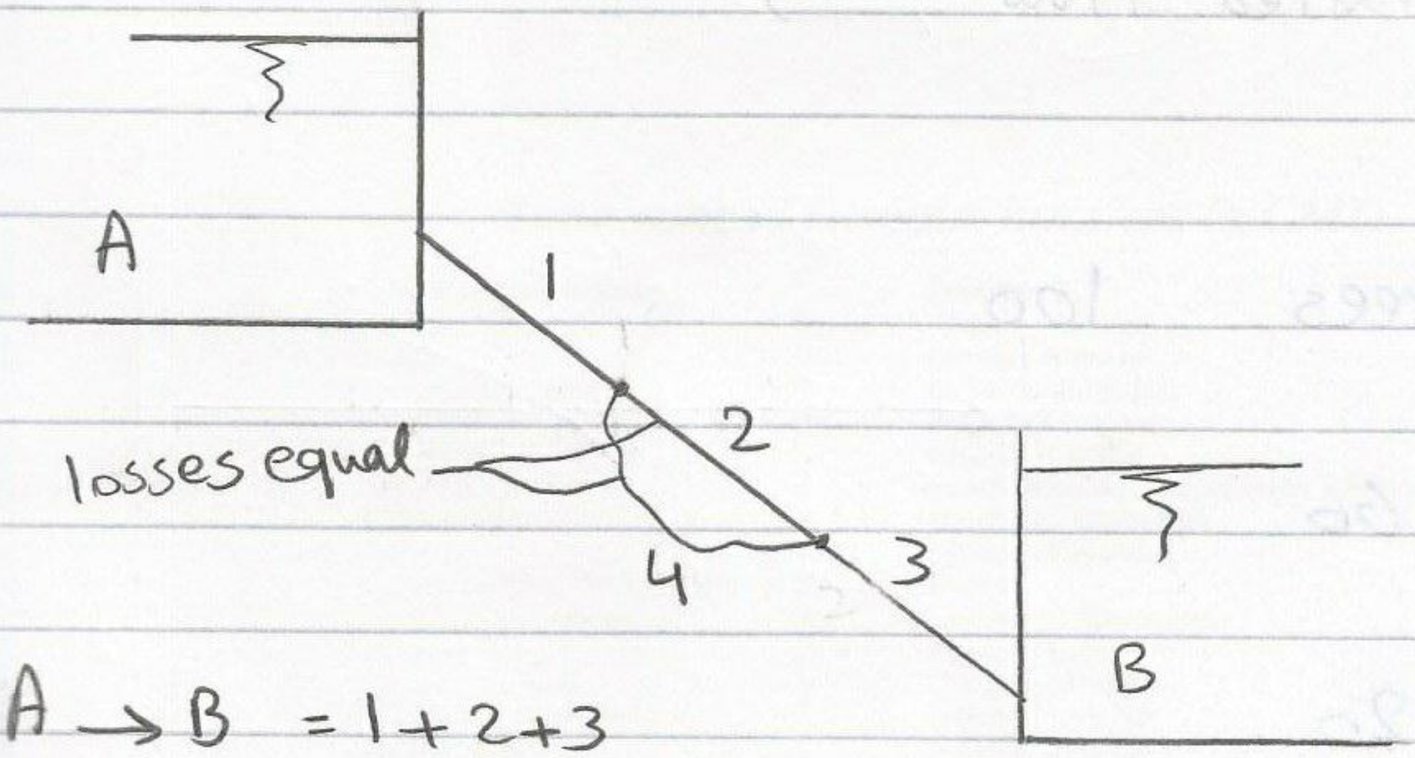
$h_{1\to2} = T.E_1 - T.E_2$

→ Minor $K\frac{V^2}{2g}$

→ Main $h_L = h_f = \frac{FLV^2}{2gd} = \frac{8FLQ^2}{\pi^2 g d^5}$

↳ Darcy_weisBach

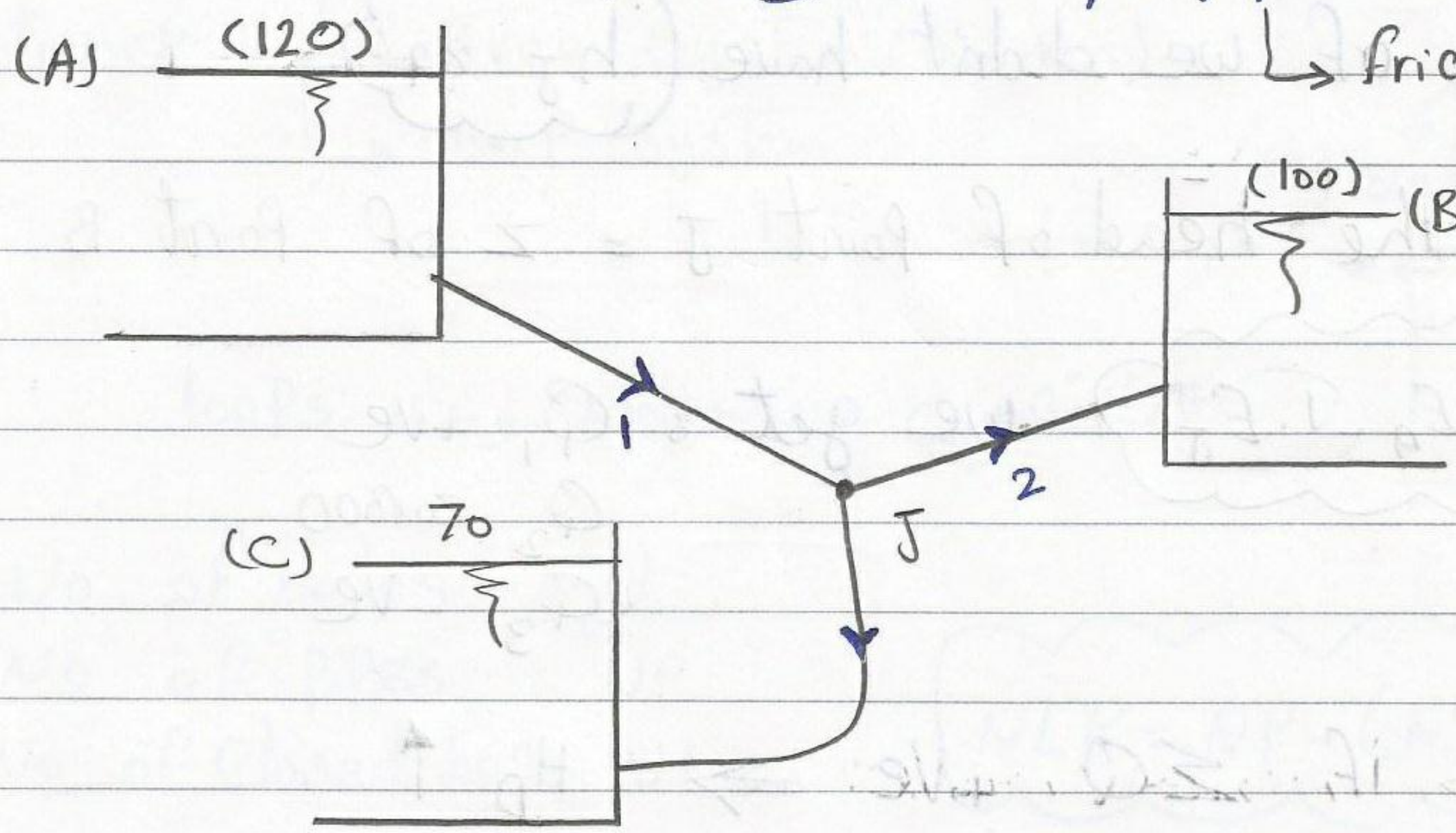
Note: if $L/D > 1000 \Rightarrow$ ignore Minor losses



losses A → B = 1 + 2 + 3

Three Tanks Problem

For any Pipe L, d, f are given
↳ friction factor



★★ in the case of we have $h_J = 105$

$\Rightarrow h_L = T.E_A - T.E_J = 120 - 105 = 115 \quad m = \frac{8FLQ_1^2}{\pi^2 g d^5}$

we get $Q_1 \Rightarrow$ Same as Q_2, Q_3

Check at Junction point Σ discharge = 0 (+ve ↘ • → -ve)

★★ in the case of we didn't have $h_J = ??$

$\Rightarrow$ Suppose direction of unKnown Tanks
افرض اتجاه لسرعات المجهول

$\Rightarrow$ get eq. of each tank from $* h_L = T.E_1 - T.E_2$

For the 3 tank $\Rightarrow$ we have 3 eq.s

$\Rightarrow * \Sigma Q_J = 0 \Rightarrow$ we have the 4th eq.

4 eq.s in 4 unKnown (Q_1, Q_2, Q_3, h_J) $\Rightarrow$ Solve then get them

ملحوظة: الطريقة السابقة يصعب فيها حل الأربع معادلات مع بعض وحد تحتاج إلى برنامج كالوسا

★★ in case of we didn't have ($h_J = ??$)

⇒ Suppose the head of point J = Z of point B

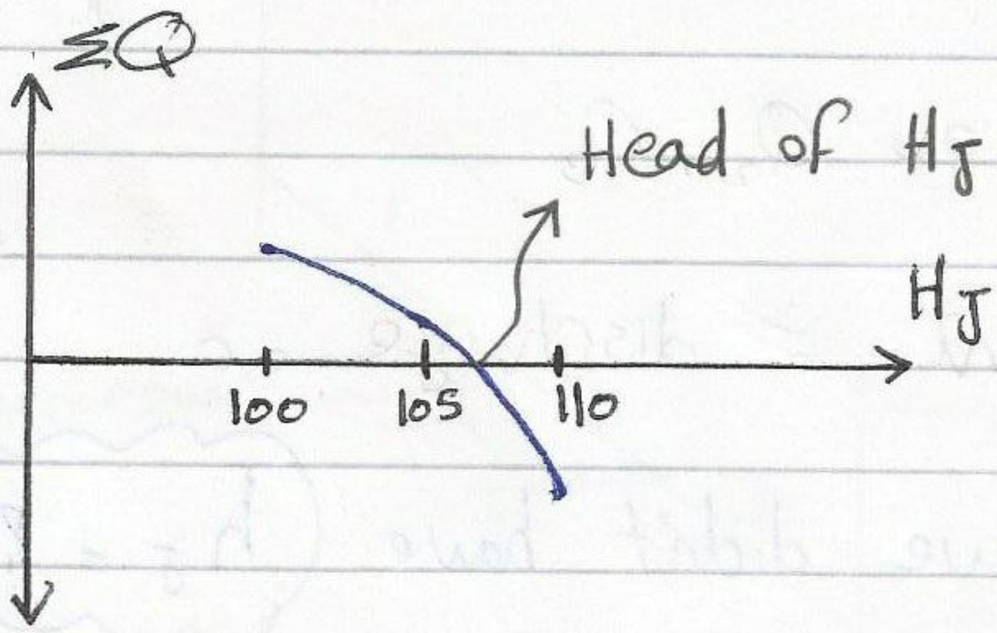
From ($h_L = T.E_A - T.E_J$) we get : Q_1 +ve
Q_2 zero
Q_3 -ve

→ should be

($\sum Q = 0$) ⇒ if $\sum Q$ +ve ⇒ H_J ↑

if $\sum Q$ -ve ⇒ H_J ↓

نرسم علاقة بين $\sum Q$ عند كل قيمة لـ H_J



Estimating New Head at Junction

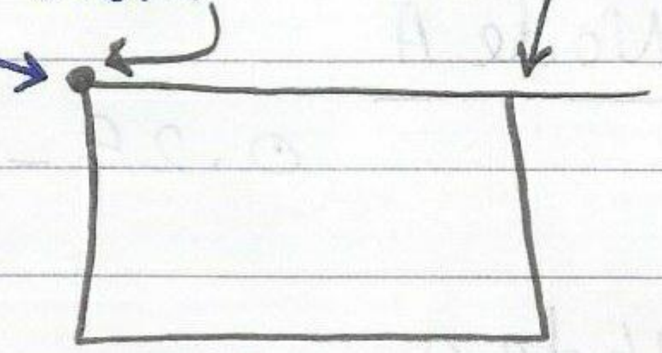
$$\Delta h = \frac{-2\sum Q}{\sum (Q/h_1)}$$

$$h_{new} = h_{old} - \Delta h$$

Pipe Network

Network → Single Pipe line
Tree System (Branch)
Loop System

Node → Sink (تدخل المياه من عندها) , Junction



العلاقة بين عدد Nodes وعدد loops

No of nodes NN
No of pipes NP
No of Closed loops NLP

$$NLP = NP - (NN - 1)$$

Friction Head Loss Equation

$$H_f = KQ^n$$

$$h_1 = \frac{FLV^2}{2gD} = \frac{8FLQ^2}{\pi^2 g D^5} \longrightarrow \text{Darcy\_weisbach}$$

$$h_1 = \frac{K_u L Q^{1.852}}{C_{HW}^{1.852} D^{4.87}} \quad ; K_u = \begin{matrix} 4.73 \text{ English} \\ 10.7 \text{ S.I} \end{matrix} \longrightarrow \text{Hazen\_Williams}$$

C_{HW} حدود في 140

$$Q = \left(\frac{h_L}{K}\right)^{1/n} \longrightarrow \text{For Pipe}$$

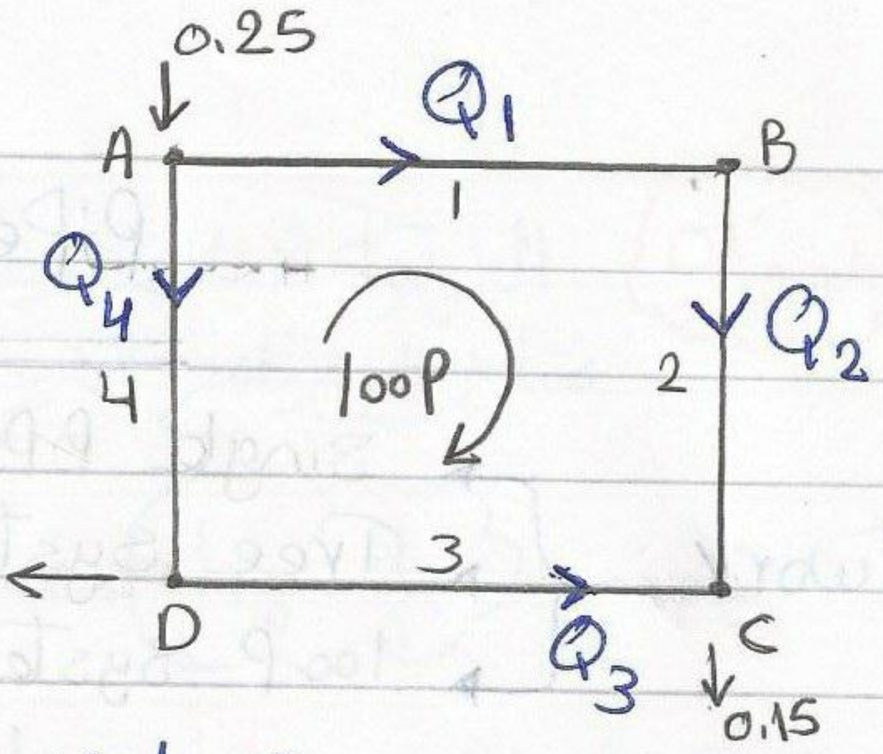
Nodes give (NN-1) eqs

* قواعد

* ال loop في اتجاه عقارب الساعه +ve ⇐ loop

* اتجاه الـ Q مع الـ loop ⇐ -ve ولو عكس الـ loop

$\Rightarrow \Sigma h_L$ of loop $= 0$



Node A

$0.25 - Q_1 - Q_4 = 0$

Node B

$Q_1 - Q_2 = 0$

Node C

$Q_2 + Q_3 - 0.15 = 0$

loop

$h_{L_1} + h_{L_2} - h_{L_3} - h_{L_4} = 0$

(Q_1, Q_2, Q_3, Q_4) مجاهيل 4 معادلات في 4 معلوم

ملحوظة: الطريقة السابقة يصعب فيها حل الأربع معادلات مع بعضها وقت نحتاج إلى برنامج لحلها

طريقة الحل

* نفرض الـ Q بقيم

* هنعوض في معادلة تصحح قيمة الـ Q

$$\Delta Q = \frac{-\Sigma h_L}{n \Sigma |K Q^{n-1}|}$$

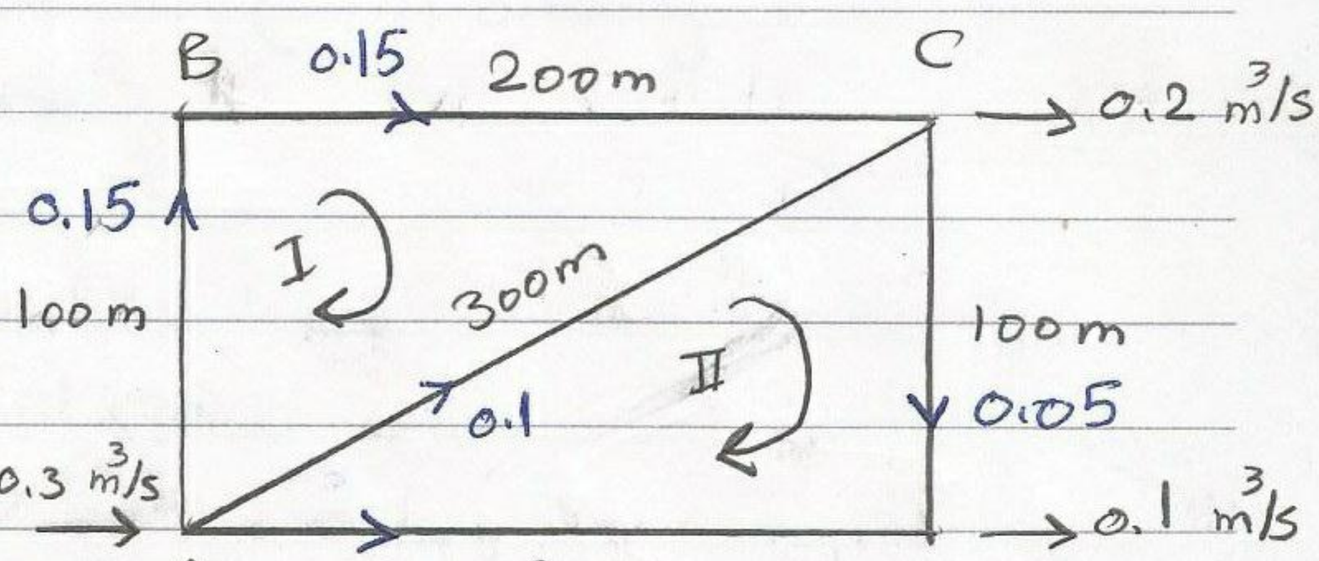
n: الأس الموجود في معادلة Darcy , Hazen

$$Q_n = Q_o + \Delta Q$$ ← معامل تصحيح

Hardy_Cross Method

D for all pipes = 0.5 m

F = 0.01



⇒ get Q in all pipes

Suppose Q in all pipes

check by the last point الفرق

Node كل عند Continuity أطبق

Loop	e	F	L	d	K	sign	Q	KQ^2	2K|Q|	Δ
	AB	0.01	100	0.5		1	0.15	0.0596		
I	BC	0.01	200	0.5		1	0.15	0.1191		
	CA	0.01	300	0.5		-1	0.1	-0.079		
						Sigma		0.0993	3.97	-0.025

Same as loop II $\Longrightarrow \Delta Q_{II} = -0.031$

⇒ we can use $\sum Q_{Node} = 0$

The diagonal pipe ⇒ can be calculated from loop I or loop II

$Q_{n_I} = Q_{o_I} + \Delta Q_I - \Delta Q_{II}$ → Calculated from loop I

المسأله مش هتزيد عن محاولتين