Menoufiya University Faculty of Engineering Shebin El-Kom 1^{th} Semester Academic Year: 2014-2015	Minufiya University	Post Graduate: Diploma Department: *Mechanical Power* Subject: Pipe Network system *(MPE520)* Time Allowed: 3 hrs Date:17 /1/2015

Note: Assume any data required , state your assumption clearly. Answer all the following Questions

Question (1) (30 Marks)

1.a) Starting from first principles, show that the loss of head due to friction for water flows through a horizontal diffuser is given by,

$$h_f = \frac{f}{8\sin\theta}\left(1-\frac{1}{AR^2}\right)\frac{V_1^2}{2g}$$

Where, f=friction coefficient, AR=total area ratio, □=half-diffuser divergence angle, V_1=inlet velocity.

1.b) (i)-Assuming logarithmic low velocity profile $\frac{u}{u^*} = 2.5\ln(\frac{y}{\varepsilon}) + 8.5$ for the turbulent flow through rough pipes, Find the following:

a-The ratio of maximum velocity to average velocity $u_{max} = \bar{u}(1+1.33\sqrt{f})$

b-The friction coefficient $\frac{1}{\sqrt{f}} = 0.88\ln(\frac{r_o}{\varepsilon}) + 1.67$

where u_{max} is the maximum velocity , $\bar{u}$ is average velocity an f is the friction factor.

(ii) In a fully rough turbulent flow in a 15 cm diameter pipe the centre line velocity is 2.5 m/s and the local velocity at mid-radius is 2.28 m/s. find the discharge and the hight of the roughness projections.

Question (2) (30 Marks)

2.a) Consider the three-reservoir system of **Fig. (1)** with the following data:
$L_1 = 95$ m, $L_2 = 125$ m, $L_3 = 160$ m, $z_1 = 25$ m ,$z_2 = 115$ m and $z_3 = 85$ m. All pipes are 28-cm-diameter unfinished concrete (ε = 1 mm). **Compute** the steady flow rate in all pipes for water at 20°C ($\mu = 0.001$ Pa.s, ρ=998 kg/m^3).

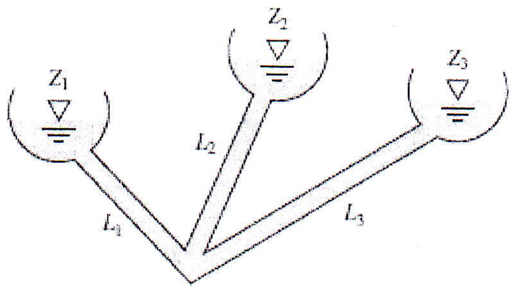


Fig.(1)

2.b)A system of pipes conveying water is connected in parallel and in series, as shown in **Fig. (2)**. the pipe friction factor is 0.024 for all pipes, and their lengths and diameters are given in the table:

pipe	Length(m)	Diameter(m)
AA_1B	30	0.1
AA_2B	30	0.125
BC	60	0.15
CD	15	0.1
CF	30	0.1

If the whole of water-entering the branch CF is **draw off** at a uniform rate along the length of the pipe. **Calculate** the total difference of head between inlet and outlet when the inflow to the system is 0.28 m^3/s. Consider only frictional losses and assume atmospheric pressure at the end of branch. Also, **calculate** the head at C and the flow rates in the two branches.

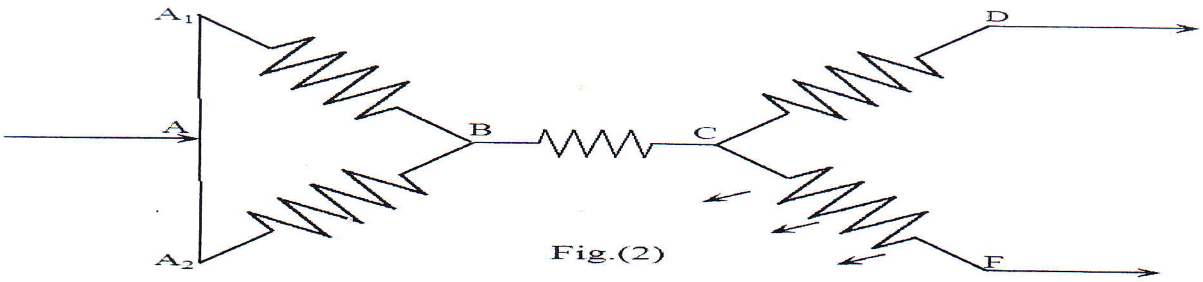
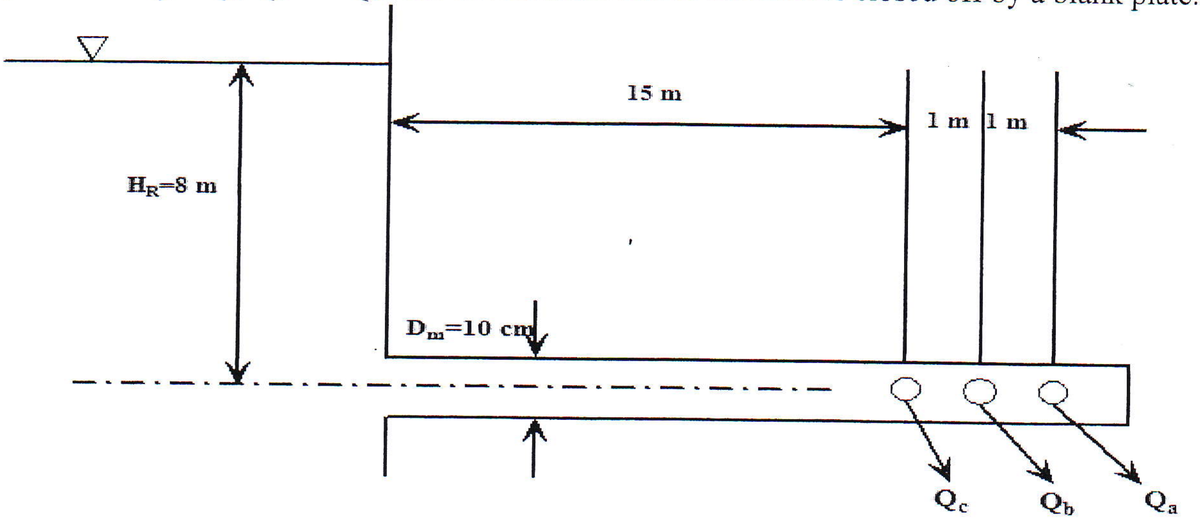


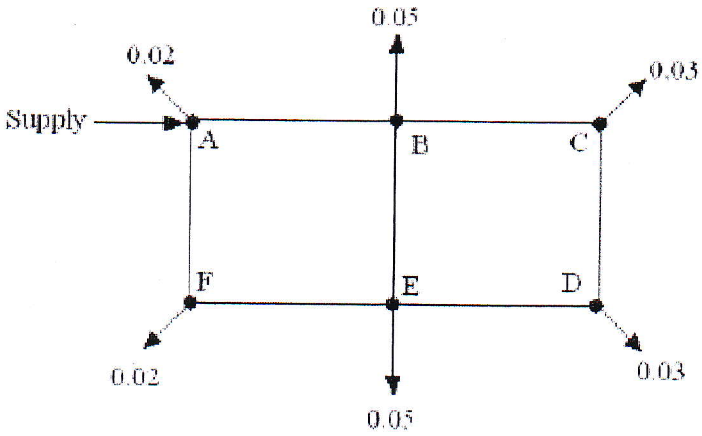
Fig.(2)

2.c) 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=4.0 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.



Question (3) **(15 Marks)**

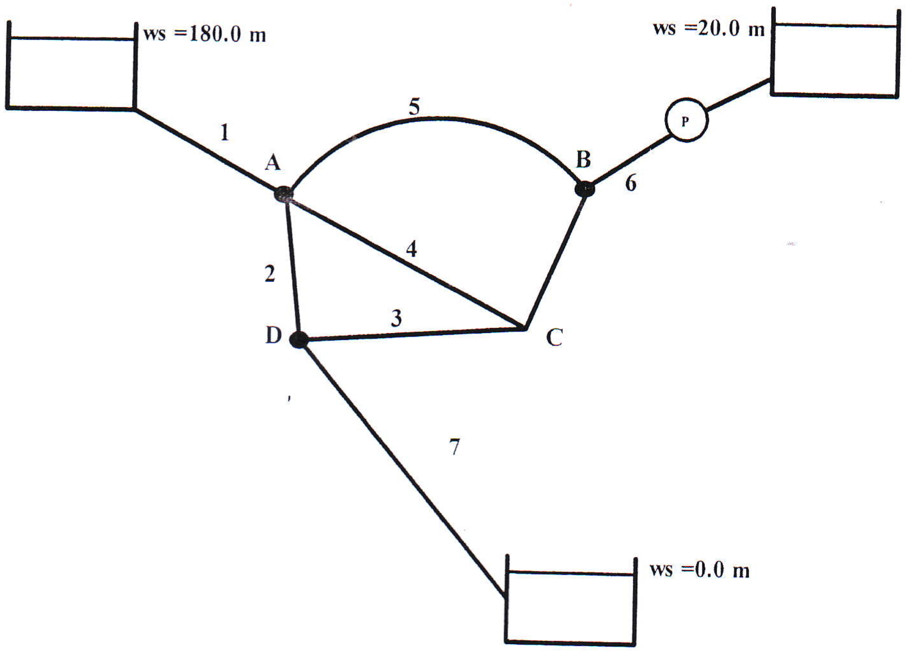
The diagram shows a water supply network with the demands indicated at eaach node. The value of K for each pipe is 1000 s^2/m^5 except for BE which is 7500 s^2/m^5. The supply heat at a is 50 m. calculate the head at each node using Hardy-Cross method.



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

In the sketch the network consists of 6 pipes and 3 nodes. A source pump and one reservoir supply the network, and the lower reservoir receives water. Do the following tasks: (a) write the system of Q-equations; (b) write the system of ΔQ-equations; (a) write the system of H-equations; (d) using the Newton method, describe the solution of the system of Q-equations; (e) if two pressure reducing valves are installed in the middle of pipes 2 and 3 creating HGL of 100 m downstream of both valves (the flow in these pipes is towards d) and the pump supplies 0.01 m^3/s , calculate the flow rate in each pipe and the pressure drop across theses valves as well as the head supplied by the pump. (f= 0.02)

Pipe	Length (m)	Diameter (m)
1	400	0.08
2	400	0.08
3	800	0.1
4	400	0.08
5	400	0.1
6	400	0.08
7	400	0.08



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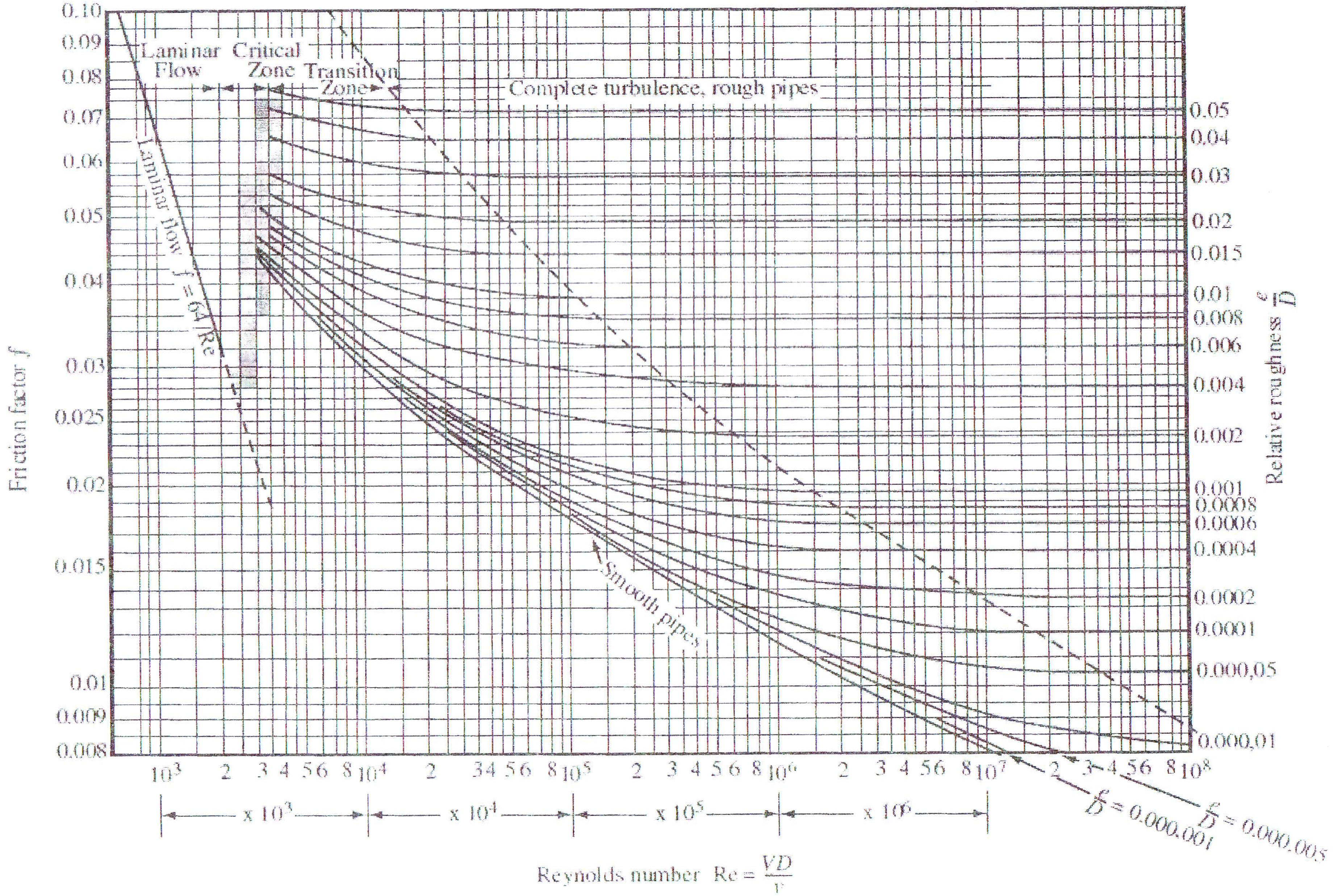
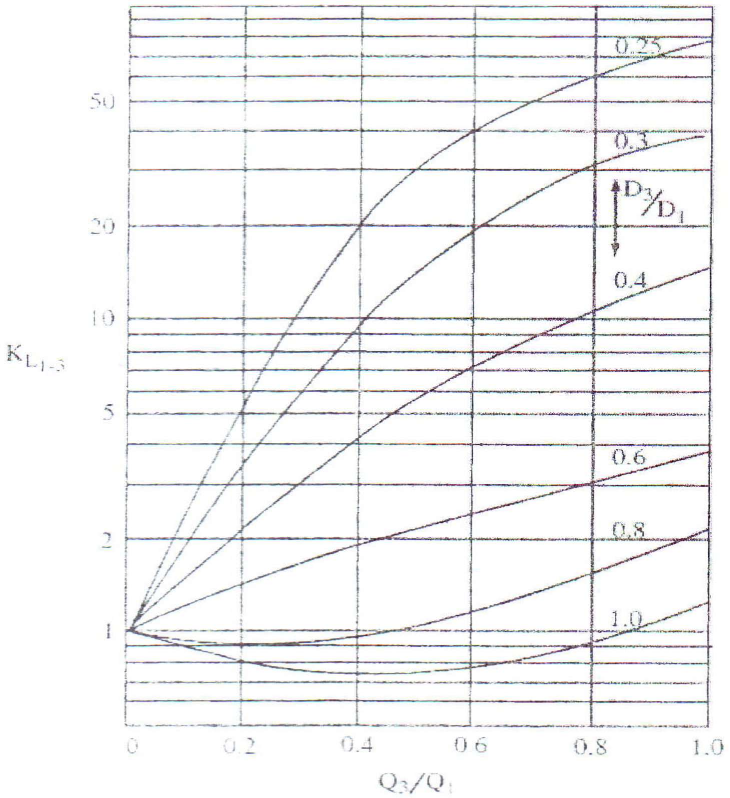
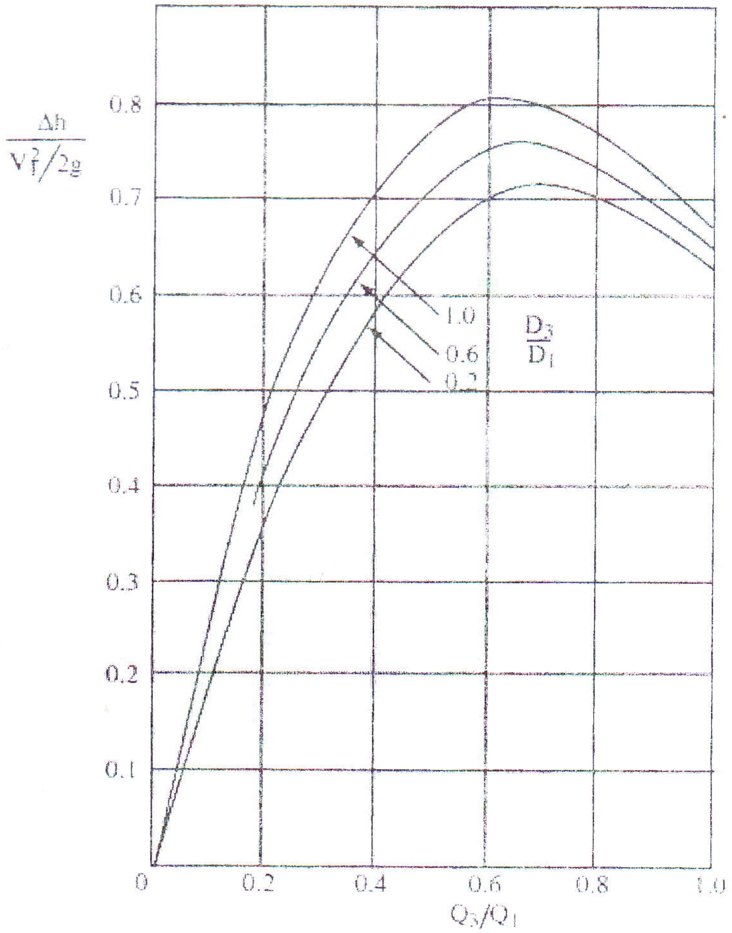
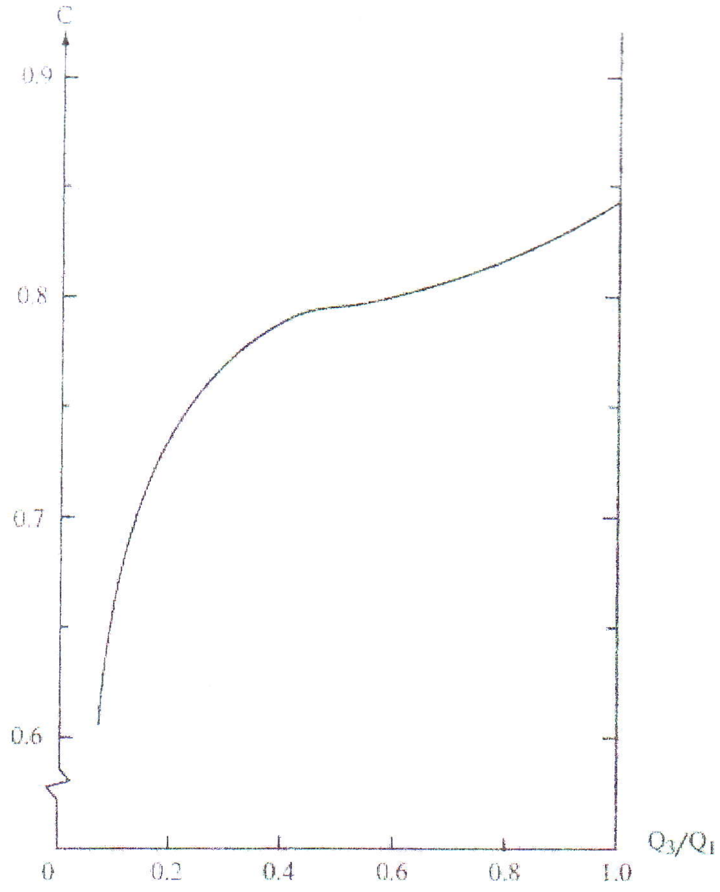

Friction factor f
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.025
0.02
0.015
0.01
0.009
0.008
Laminar Flow
Critical Zone
Transition Zone
Complete turbulence, rough pipes
Laminar flow f = 64/Re
Smooth pipes
Relative roughness ε/D
0.05
0.04
0.03
0.02
0.015
0.01
0.008
0.006
0.004
0.002
0.001
0.0008
0.0006
0.0004
0.0002
0.0001
0.000,05
0.000,01
ε/D = 0.000,001
ε/D = 0.000,005
10³ 2 3 4 5 6 8 10⁴ 2 3 4 5 6 8 10⁵ 2 3 4 5 6 8 10⁶ 2 3 4 5 6 8 10⁷ 2 3 4 5 6 8 10⁸
x 10³
x 10⁴
x 10⁵
x 10⁶
Reynolds number Re = VD/ν





experimental data for the pressure rise coefficient.



An example of the behavior of the orifice coefficient C.

Orifice coefficent C based on f_3 =0.02 and L_3/D_3 =5