```
[1]  import numpy as np
```

Seminar 5

Flow Measurements

1. **Hydrodynamics II**

Problem 1 - Venturi Meter

Water flows along a horizontal pipeline of 100 mm diameter at an unknown rate. A Venturi meter installed in the pipeline indicates a piezometric head (pressure head) of 950 mm at the entrance and 200mm at the throat. The throat diameter is 60 mm. If the $C_D = 0.97$, what is the discharge through the pipeline?

Solution of Problem 1

The relevant equations can be found in slides L5 - slides 6-7

The main equation is:

$$Q_A = C_D A_1 \sqrt{\frac{2gH}{[(A_1/A_2)^2 - 1]}}$$

with $H = P_1 - P_2$ and $A = \pi D^2/4$

```
[3]  #Solution problem 1
     # Given are:
     D1 = 100 # mm, diameter of pipe
     D2 = 60 # mm, thraot diameter
     P1 = 950 # mm, pressure head at inlet
     P2 = 200 # mm, pressure head at throat
     CD1 = 0.97# [], coeff. of discharge.
     g1 = 9.81 # m/s^2, gravity

     # Interim calculation
     A1 = np.pi*D1**2/4*(1/1E6) # m^2, area at inlet, unit converted
     A2 = np.pi*D2**2/4*(1/1E6) # m^2, area at throat, unit converted
     H = (P1-P2)*1/1000 # m, difference in pressure head between inlet
     and throat.
```

```python
# calculation (see equation above for Q_A)
QA = CD1*A1*np.sqrt(2*g1*H/((A1/A2)**2 -1 ))

#output
print("The resulting discharge is: {0:1.4f}".format(QA),
"m\u00b3/s")
```

```
The resulting discharge is: 0.0113 m³/s
```

Problem 2 - Orifice

Water is contained in a large tank whose surface is open to the atmosphere. The water discharges freely to the atmosphere through an orifice 50 mm in diameter. The C_c of the orifice is 0.62.

(a) What is the discharge if the head is maintained at a constant 2.50 m?

(b) If the head is reduced by 50% to 1.25 m, what is the percentage decrease in the discharge?

Solution of Problem 2

For more details check slide L05: 14-15

The relevant equation is:

$$Q_t = C_D A \sqrt{2gH}$$

The given information are:

[18]
```python
# Given are:

Cd2 = 0.62 # [], coeff. of discharge
D2 = 50 # mm, orifice diameter
H2_1 = 2.50 # m, head
H2_2 = 1.25 # m, reduced head
g2 = 9.81 # m/s^2, gravity

# interim calculation
A2_o = np.pi*(D2/2)**2/10e5 # m**2, area of orifice. D2 unit
converted

#Calculation
Q_H1 = Cd2*A2_o* np.sqrt(2*g2*H2_1)
```

```
Q_H2 = Cd2*A2_o* np.sqrt(2*g2*H2_2)
Re = ((Q_H1-Q_H2)/Q_H1)*100 # %, reduction in discahrge due to
reduction of head

#output
print("The resulting discharge when Head is 2.50 m is:
{0:1.4f}".format(Q_H1), "m\u00b3/s")
print("The resulting discharge when Head is 1.250 m is:
{0:1.4f}".format(Q_H2), "m\u00b3/s")
print("The % reduction in discharge due to change in head is:
{0:1.2f}".format(Re), "%")
```

```
The resulting discharge when Head is 2.50 m is: 0.0085 m³/s
The resulting discharge when Head is 1.250 m is: 0.0060 m³/s
The % reduction in discharge due to change in head is:29.29 %
```

Assignment problems

Assignment Problem 1 - Venturi meter

The flow of water in a 150 mm diameter pipeline has to be measured using a horizontal Venturi meter. The normal operational velocity in the pipeline is about 2.3 m/s. What diameter must the throat of the Venturi be in order to obtain a differential head, H, of about 1.2 m of water?

Assignment Problem 2 - Orifice

Water discharges into the atmosphere through an orifice with a diameter of 25 mm. The head above the centre of the orifice is 1.42 m. The jet travels 1.25 m horizontally while falling through a vertical distance of 0.30 m. The diameter of the jet at the vena contracta has been measured as 20 mm. Determine the value of the coefficients.

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[ ]
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