In [1]:

```python
import numpy as np
```

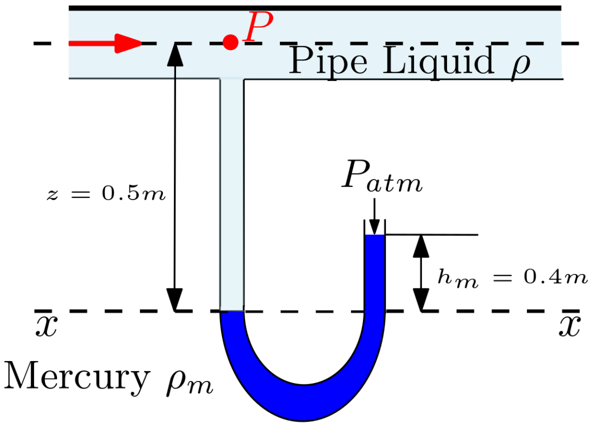
Seminar 3

Pressure measurements

1. **Manometer**

Problem 1 - Simple Manometer

The lower part of the U-tube manometer in Figure contains mercury (ρ_m = 13600 kg/m^3). The pipe contains water ($\rho = 1000$ kg/m^3). Determine the gauge pressure, P, at the centre of the pipe if the manometer readings are as shown in the diagram.



Solution of Problem 1

The relevant equations can be found in slides L3 - slide 10

$$P = \rho_m g h_m + P_{atm} - \rho g z$$

In [3]:

```python
#Given,
dy_w = 1000 # kg/m^3, density of water
dy_m = 13600 # Kg/m^3, density of of mercury
g1 = 9.81 # m/s^2, earth's gravity
P1_atm = 101000 # N/m^2, Standard atmospheric pressure
h1_m = 0.4 # m, height of Hg above x-x axis right
z1 = 0.5 # m, height of water above x-x axis left

#Calculations
P1 = dy_m * g1*h1_m + P1_atm - dy_w*g1*z1
P1
# output
print("The pressure of the tank is {0:1.3E}".format(P1),"N/m\u00b2")
```

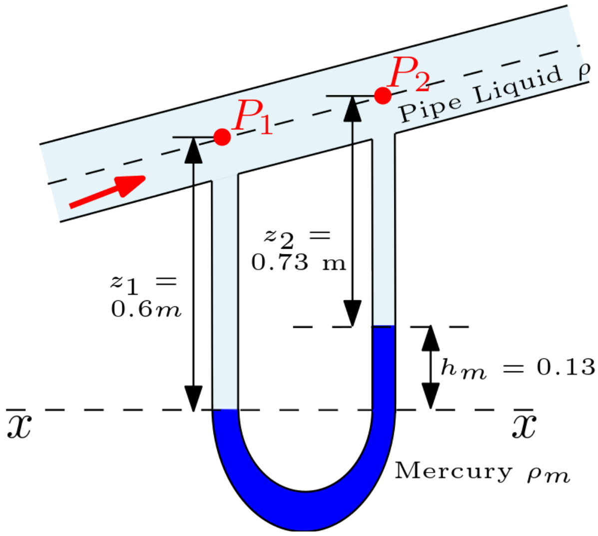
```
The pressure of the tank is 1.495E+05 N/m²
```

Problem 2 - Differential U-tube

A differential U-tube manometer is used to measure the change in pressure between two points in a pipeline which carries oil. The lower part of the U-tube contains mercury. There is an increase in elevation between the two points of 0.26m. If $z_1 = 0.60$ m, $z_2 = 0.73$ m and $h_m = 0.13$ m, calculate the difference in pressure when

Density of oil, $\rho_o = 800$ kg/m^3

Density of mercury, $\rho_m = 13600$ kg/m^3



Solution of Problem 2

The relevant equations are (check L3 slides 13)

$$P_{LL} = \rho \cdot g \cdot z_1 \cdot + P_1$$
$$P_{RL} = \rho_m \cdot g \cdot h_m + \rho \cdot g \cdot z_2 + P_2$$
$$(P_1 - P_2) = \rho_m g h_m + \rho g (z_2 - z_1)$$
$$(P_1 - P_2) = g h_m (\rho_m - \rho)$$

Information provided in the problem are:

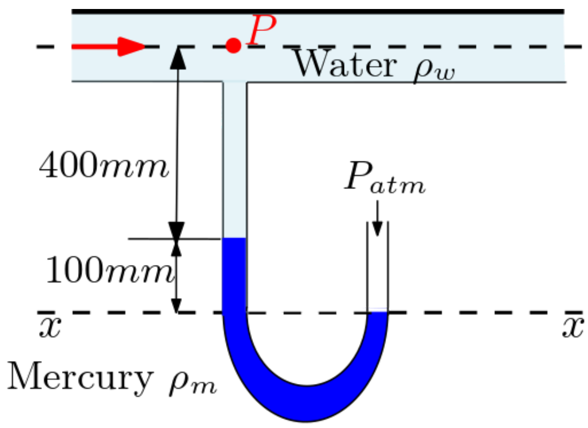
In [5]:

```
# Given are

dy2_o = 800 # kg/m^3, oil density
dy2_m = 13600 # kg/m^3, mercury density
g2 = 9.81 # m/s^2
h2_m = 0.13 # m, mercury height above x-x in right
z2_1 = 0.6 # m, oil height above x-x in left
z2_2 = 0.73 # m, water height above mercury on right

# interim calculation
P3_L =dy2_o*g2*z2_1 # P_LL wihtout P_1
P3_R =dy2_m*g2*h2_m + dy2_o*g2*z2_2 # P_LR wihtout P_2


# calculation
P3_d = P3_R - P3_L # N/m^2


# output
print("The pressure difference is {0:1.2f}".format(P3_d),"N/m\u00b2", "\n")
```

```
The pressure difference is 18364.32 N/m²
```

Assignment Problem 1- Simple U-Tube Manometer

The U-tube manometer shown in Fig. is used to measure the pressure in a pipeline as it passes over the crest of a hill. The pipeline carries fresh water (r = 1000kg/m^3). The bottom of the U-tube contains mercury (rM = 13600kg/m^3). Taking atmospheric pressure as the equivalent of 10.3m of water, with the readings shown in the diagram calculate the absolute pressure at the centre of the pipeline.



Assignment Problem 2 - Differential U-Tube Manometer

The differential U-tube manometer in Fig. is used to measure the difference in pressure between two points in an expanding pipeline. The pipe liquid is water and the gauge liquid is mercury (1.0 and 13.6 relative density, respectively). For the dimensions shown in the diagram, calculate the value of $(P_1 - P_2)$.