# The University of Melbourne
# ENGR30002 Fluid Mechanics

Workshop 05 – *Head loss*

## Part A: Newton-Raphson method

-Most widely used root finding method.
-Converges quickly.
-Only need one initial guess.

To find a root using Newton-Raphson method, do the following:

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}$$

i) Let the initial guess be $x_i$
ii) Find $x_{i+1}$ by using the above relationship
iii) Let $x_i = x_{i+1}$ repeat until you feel your answer is accurate enough.

### Question 01

Find the roots of the following equation using the Newton-Raphson method and starting with $x_1$=4.

$$f(x) = e^x - 10x = 0$$

## Part B

### Question 01

Water at 150°C is flowing steadily in a 60-meter horizontal pipe made of stainless steel at a rate of 6 L/s as shown in Figure 1. Determine a diameter of the pipe (meter). Pressure drop over the pipe length is 96.5 kPa.

*Hint: Since a diameter is not known, you first guess an initial value and then do the iteration until it converges. Apply the Newton-Raphson method and set a tolerance of 1e-3.*

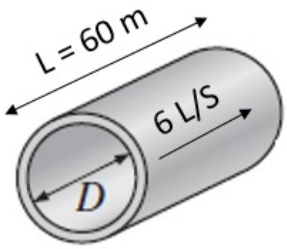


Figure 1: Water flowing in the horizontal pipe

## Question 02

Water at 20°C flows at a rate of 0.28 $m^3$/min by gravity from a reservoir 1 at a high elevation to a smaller reservoir 2 through a 20 meter-long cast iron piping system as shown in Figure 2. It includes four standard flanged elbows, a well-rounded entrance, a sharp-edged exit, and a fully open gate valve. How does the elevation change with a different size of diameters?. Take the free surface of the lower reservoir as the reference level and use the roughness of cast iron pipe $\epsilon$ =0.00026 m.

Resistance coefficient:
A well-rounded entrance $K_L$=0.03
A standard flanged elbow $K_L$ =0.3
A fully open gate valve $K_L$ =0.2
A sharp-edged exit $K_L$ =1.0

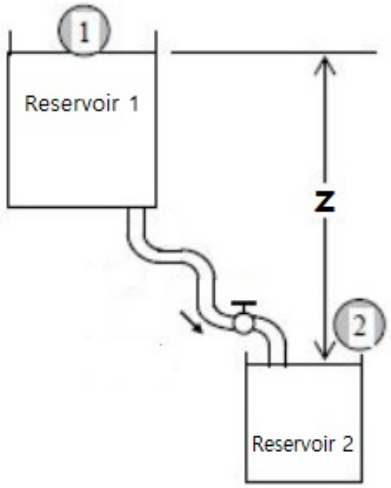


Figure 2: Water flowing from the large reservoir to the small one

**END OF WORKSHOP**