

## TASK 1

The following 4<sup>th</sup> order polynomial has 4 distinct real roots:

$$x^4 + 6x^3 + 7x^2 - 6x - 8 = 0$$

- A. Plot the function and identify by eye where all four roots are located. Use a line width of 2.
- B. Create a function for the false-position method then use it to find the 4 different roots. Use a precision of 0.001.
- C. Plot the roots on the figure from part A as blue squares with a marker size of 10.

## TASK 2

You are given an equation:

$$f(x) = \sin(x) + \cos(1 + x^2) - 1$$

where  $x$  is in radians. Create a **function** for the secant method and use it to find the converged root with initial guesses of:

- A.  $x_{i-1} = 3.0$  and  $x_i = 1.0$ ,
- B.  $x_{i-1} = 1.5$  and  $x_i = 2.5$ ,
- C.  $x_{i-1} = 1.5$  and  $x_i = 2.2$ .

Plot  $f(x)$  and the roots found from A, B and C. Use a precision of 0.1 and ensure that you have a legend.

## TASK 3

The total head loss  $h$  (m) in a piping system can be represented by:

$$h = \frac{\left(f \frac{L}{D} + K_v + K_e\right) v^2}{2g}$$

where  $f$  is the friction factor, defined as:

$$f = \frac{16\mu}{\rho D v}$$

and  $L$  is the pipe length,  $D$  is the pipe diameter,  $K_v$  is the valve friction constant,  $K_e$  is the elbow friction constant,  $v$  is the linear velocity in pipe,  $g$  is the gravitational acceleration ( $9.8 \text{ m/s}^2$ ),  $\mu$  is the fluid viscosity and  $\rho$  is the fluid density.

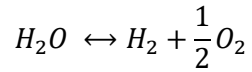
Experiments indicate that  $K_v$  and  $K_e$  are 4.5 and 0.6, respectively. The fluid viscosity is  $1.7 \times 10^{-3} \text{ Pa.s}$  and the density is  $1800 \text{ kg/m}^3$ . The pipe diameter and length are 0.025 m and 25 m, respectively.

- A. Plot the total pressure loss against linear velocity values between 0 and 30 m/s
- B. Use the secant method to determine the linear velocity that results in a total head loss of 50 m
- C. Mark the linear velocity that provides a total head loss of 50 m on the figure from part A using a red asterisk. Use `sprintf()` in the legend to indicate that the asterisk represents head loss = 50.
- D. Use `fprintf()` to print the required linear velocity that provides a total head loss of 50 m. An example output is provided below.

A linear velocity of xx.xx m/s provides a total head loss of 50 m

#### TASK 4

In a chemical engineering process, water vapor ( $H_2O$ ) is heated to sufficiently high temperatures that a significant portion of the water dissociates, or splits apart, to form oxygen ( $O_2$ ) and hydrogen ( $H_2$ ):



If it is assumed that this is the only reaction involved, the mole fraction,  $x$ , of  $H_2O$  that dissociates can be represented by:

$$K = \frac{x}{1-x} \sqrt{\frac{2p_t}{2+x}}$$

Where  $K$  is the reaction's equilibrium constant and  $p_t$  is the total pressure of the mixture.

- Write two **function** files which perform the bisection and modified secant methods separately.
- Assume  $p_t$  to be 3.5 find the value of  $x$  when  $K=0.04$ . Plot the function that you are solving. Then prompt the user to enter a lower and upper limit. If the initial guesses do not bracket a root, your m-file should display an error message. Perform the bisection method using the function file written in part A with a precision of  $1e-4$  to find the root of the profile and print the root value.
- Repeat part B but using the modified secant method function file written in part A. Prompt the user for an initial guess and use a perturbation of 0.05. The precision remains as  $1e-4$ .