LOTI.05.019 Data Analysis and Computational Methods with MATLAB
Fifth Practical Session

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1. Question 1

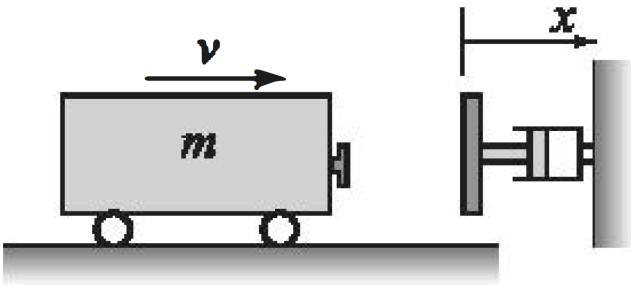
Make two separate plots of the function $f(x) = -3x^4 + 10x^2 - 3$, one plot for $-4 \leq x \leq 3$ and one for $-4 \leq x \leq 4$.

2. Question 2

A railroad bumper is designed to slow down a rapidly moving railroad car. After a 20,000 kg railroad car traveling at 20 m/s engages the bumper, its displacement x (in meters) and velocity v (in m/s) as a function of time t (in seconds) is given by:

$$x(t) = 4.219\left(e^{-1.58t} - e^{-632t}\right) \qquad \text{and} \qquad v(t) = 26.67e^{-6.32t} - 6.67e^{-1.58t} \tag{1}$$

Plot the displacement and the velocity as a function of time for $0 \leq t \leq 4$ s. Make two plots on one page.



3. Question 3

A simply supported beam is subjected to distributed loads w_1 and w_2 as shown. The bending moment as a function of x is given by the following equations:

$$M(x) = R_A x - \frac{w_1 x^2}{2} \quad \text{for} \quad 0 \leq x \leq a \tag{2}$$

$$M(x) = R_A x - \frac{w_1 a}{2}(2x - a) \quad \text{for} \quad a \leq x \leq (a + b) \tag{3}$$

$$M(x) = R_B(L - x) - \frac{w_2(L - x)^2}{2} \quad \text{for} \quad (a + b) \leq x \leq L \tag{4}$$

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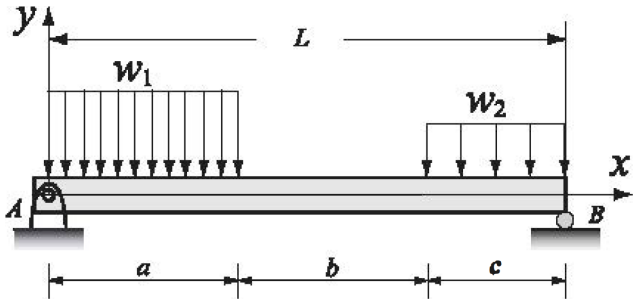
where $R_A = [w_1 a(2L-a) + w_2 c^2]/(2L)$ and $R_B = [w_2 c(2L-a) + w_1 a^2]/(2L)$ are the reactions at the supports. Make a plot of the bending moment M as a function of x (one plot that shows the moment for $0 \leq x \leq L$). Take $L = 16$ ft, $a = b = 6$ ft, $w_1 = 400$ lb/ft, and $w_2 = 200$ lb/ft.



4. Question 4

Biological oxygen demand (BOD) is a measure of the relative oxygen depletion effect of a waste contaminant and is widely used to assess the amount of pollution in a water source. The BOD in the effluent (L_c in mg/L) of a rock filter without recirculation is given by:

$$L_c = \frac{L_0}{1 + \frac{2.5D^{2/3}}{\sqrt{Q}}} \tag{5}$$

where L_0 is influent BOD (mg/L), D is the depth of the filter (m), and Q is the hydraulic flow rate (L/(m^2-day)). Assuming Q=300 L/(m^2-day) plot the effluent BOD as a function of the depth of the filter ($100 \leq D \leq 2000$ m) for L_0 =5, 10, and 20 mg/L. Make the three plots in one figure and estimate the depth of filter required for each of these cases to obtain drinkable water. Label the axes and display a legend.