Armstrong State University
Engineering Studies
MATLAB Marina – Integration Exercises

1. Write a MATLAB program that will:
   - Create a vector t consisting of 100 values over the interval of -5 to 5 seconds.
   - Evaluate the function $f(t) = -2t^2 + 3t + 7$ for the vector t.
   - Using the MATLAB `trapz` function, compute the definite integral of $f(t)$ for the range -5 to 5 seconds.
   - Using the MATLAB `cumtrapz` function, compute the cumulative numerical integral of $f(t)$.
   - Compare the last value in the vector returned by the `cumtrapz` function for the cumulative numerical integral to the value obtained using the `trapz` function for the definite integral. The values should be the same (or very close).
   - Plot the function $f(t)$ and the cumulative numerical integral of $f(t)$ for the range -5 to 5 seconds in the same plot in a single figure window. Title and label the plot appropriately. A legend is appropriate here.
2. Write a MATLAB program that will:
   - Create a vector t consisting of 100 values over the interval of 0 to 8 seconds.
   - Evaluate the function $g(t) = 5te^{-0.5t}$ for the vector t.
   - Using the MATLAB `cumtrapz` function, compute the cumulative numerical integral of $g(t)$.
   - Plot the function $g(t)$ and the cumulative numerical integral of $g(t)$ for the range 0 to 8 seconds in the same plot in a single figure window. Title and label the plot appropriately. A legend is appropriate here.
3. Write a MATLAB program that will repeat the operations of exercise 2 except using only 20 values over the interval of 0 to 8 seconds for the t vector. How does the cumulative numerical integral of $g(t)$ with 100 values from 0 to 8 seconds compare with the cumulative numerical integral of $g(t)$ with 20 values from 0 to 8 seconds.
4. Write a MATLAB program that will:
   - Load the noisy voltage data from the file `nmdata.xlsx`. The data is in two columns: time and voltage. Each column of data has a text header.
   - Plot the voltage data using black + for the points and no line. Title and label the plot appropriately.
   - Fit a polynomial function to the voltage data. Determine the sum of squared error for the fit function and plot the fit polynomial function for the voltage data using a red solid line on the same axes as the plot of the original data with the black +. You will need to evaluate the fit polynomial function for the original time points so you can plot the best fit polynomial function. Title and label the plot appropriately.

Hints:
Look at the data and visually estimate what order polynomial function could match the shape of the data. Use this order as your starting point.
If the sum of squared error is too large or the plot of the fit polynomial does not match the data well, fit a higher order polynomial function and repeat until the error is acceptable.
Too low a polynomial order yields a poor fit and too high a polynomial order can yield a poorly conditioned polynomial.

- Compute the approximate derivative of the voltage data and the approximate derivative of the best fit polynomial function for the voltage data. In a new figure window, plot the approximate derivatives of the data and the best fit polynomial function. Title and label the plot appropriately.
- Compute the cumulative numerical integral of the voltage data and the cumulative numerical integral of the best fit polynomial function for the voltage data. In a new figure window, plot the cumulative integrals of the data and the best fit polynomial function. Title and label the plot appropriately.
- Compare the approximate derivatives and numerical integrals of the data and the best fit polynomial function. Which are most likely the better representations of the derivative and integral of the function underlying the voltage data, those from the original data or from the best fir polynomial function.

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