EEE 391
Basics of Signals and Systems
Spring 2020–2021
MATLAB Assignment 1
due: 3 March 2021, Wednesday by 23:55 on Moodle

In this computer assignment, you will write a MATLAB program to express the sum of sinusoidal waveforms with the same frequency as a *single* sinusoidal waveform. You need to use phasor addition to calculate the parameters (amplitude and phase) of the resulting sinusoidal waveform.

Let $x(t)$ be the sum of three sinusoidal signals with the same angular frequency ω_o:

$$x(t) = \sum_{k=1}^{3} x_k(t) = \sum_{k=1}^{3} A_k \cos(\omega_o t + \phi_k)$$

This signal can be expressed as a single sinusoid

$$x(t) = A \cos(\omega_o t + \phi)$$

whose amplitude A and phase ϕ can be determined by using the phasor addition rule:

$$\sum_{k=1}^{N} A_k e^{j\phi_k} = A e^{j\phi}$$

(a) Write down your 8-digit student ID ($d_1 d_2 d_3 d_4 d_5 d_6 d_7 d_8$). Determine and write down the frequency, amplitude, and phase values of the three signals according to the digits of your student ID.

- Frequency: $\omega_o = (d_5 d_6)$ rad/s.
  If $\omega_o = 0$, then use $\omega_o = 100$ rad/s instead.
- Amplitude values: $A_1 = d_6,\ A_2 = d_7,\ A_3 = d_8$.
  If any of them is 0, use 10 instead.
- Phase values in degrees: $\phi_1 = (d_4 d_5 d_6)^\circ,\ \phi_2 = (d_5 d_6 d_7)^\circ,\ \phi_3 = (d_6 d_7 d_8)^\circ$.
  Convert the phase values so that they take values in the principal interval. Express them both in degrees and radians.

For example, for the student ID 21098760, the parameters should be $\omega_o = 87$ rad/s, $A_1 = 7,\ A_2 = 6,\ A_3 = 10,\ \phi_1 = 987^\circ,\ \phi_2 = 876^\circ,\ \phi_3 = 760^\circ$. Note that you also need to convert the phase values into the principal interval and express them in degrees and radians.

(b) Write a MATLAB program that calculates the parameters (A and ϕ) of the resulting sinusoidal signal and demonstrates the phasor addition method.

(i) The program should ask for the values of $\omega_o, A_1, A_2, A_3, \phi_1, \phi_2$, and ϕ_3 one-at-a-time as input in the command window. The phase values must be provided in degrees.

(ii) The program should calculate the values of A and ϕ by summing the phasors of the three sinusoids and finding the magnitude and phase of the summation. The program should display the values of A and ϕ in the command window. The value of ϕ must be in degrees. There should be at least four digits to the right of the decimal point.

(iii) The program should also display the resulting sinusoidal signal in the command window in the form of "`x(t) = 2.61 cos(87t+0.80)`." Here, the amplitude and phase should contain exactly two digits to the right of the decimal point. The phase value must be in radians. There should be "+" or "–" sign to the left of the phase according to its sign.

(iv) The program should demonstrate phasor addition geometrically. It should plot the phasors of the three sinusoidal signals as well as the resulting phasor on the complex z plane whose horizontal and vertical axes are the real and imaginary axes, respectively. The resulting phasor should be plotted with thicker (or heavier) linestyle. Sketch all of the four phasors on the same z plane. The horizontal and vertical axes should have the range of $[-30, 30]$.

(v) In another figure window, the program should plot the three phasors end-to-end to demonstrate phasor addition. That is, the first phasor must start from the origin. The second phasor must start from the end of the first phasor. The third phasor must start from the end of the second one. In this way, the end point of the third phasor is the resulting phasor (considering that it starts at the origin). The program should also plot the phasor of the summation starting at the origin with thicker (or heavier) linestyle.

Submit the results of your own work in the form of a well-documented report on Moodle. Borrowing full or partial code from your peers or elsewhere is strictly forbidden and will be punished. Please include all evidence (plots, screen dumps, MATLAB codes, MATLAB command window print-outs, etc.) as needed in your report. Append your MATLAB code at the end of your assignment, do not upload it separately. The axes of all plots should be scaled and labeled. Typing your report instead of handwriting some parts will be better. Please do not upload any photos/images of your report. Your complete report should be uploaded to Moodle as a single good-quality pdf file by the given deadline. Please DO NOT submit any files by e-mail.