Vibrations - 1

Question 1: (10 points)

- Can you use superposition principle to solve a non-linear differential equation?

YES NO (circle your answer)

- Write an example of a non-linear differential equation?

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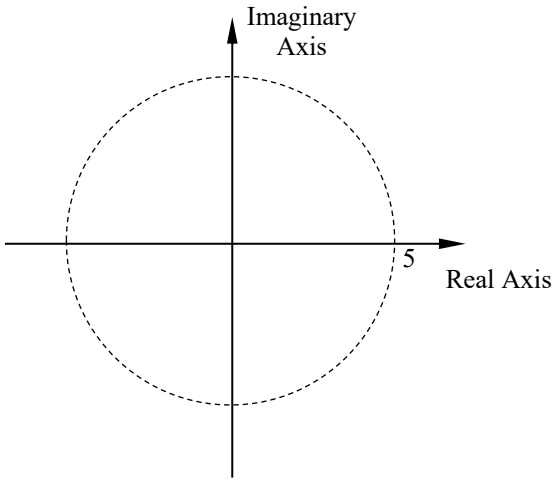
Question 2: (15 points)

- Find magnitude and phase of the following complex number $z = -4e^{i\pi/4}$

- Sketch the complex number z in the complex plane



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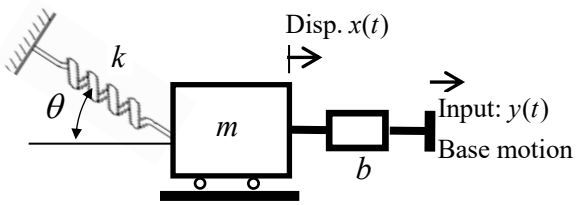
Question 3: (15 points)

Find spring deformation, e, in terms of x and θ assuming small displacements, i.e. change in angle, $\Delta\theta$, is much smaller than θ.



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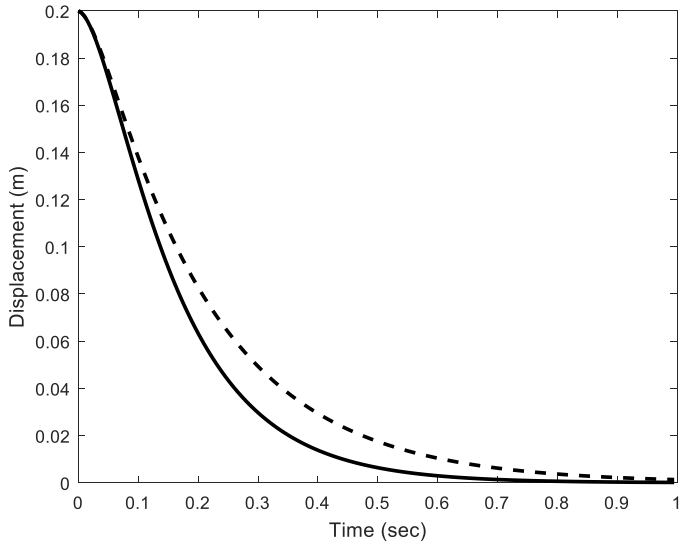
Question 4: (10 points)

The free response of a 2nd order mechanical system for two damping ratios (110% and 140%) is shown in the figure. Indicate in the figure the response corresponding to 140% damping ratio.



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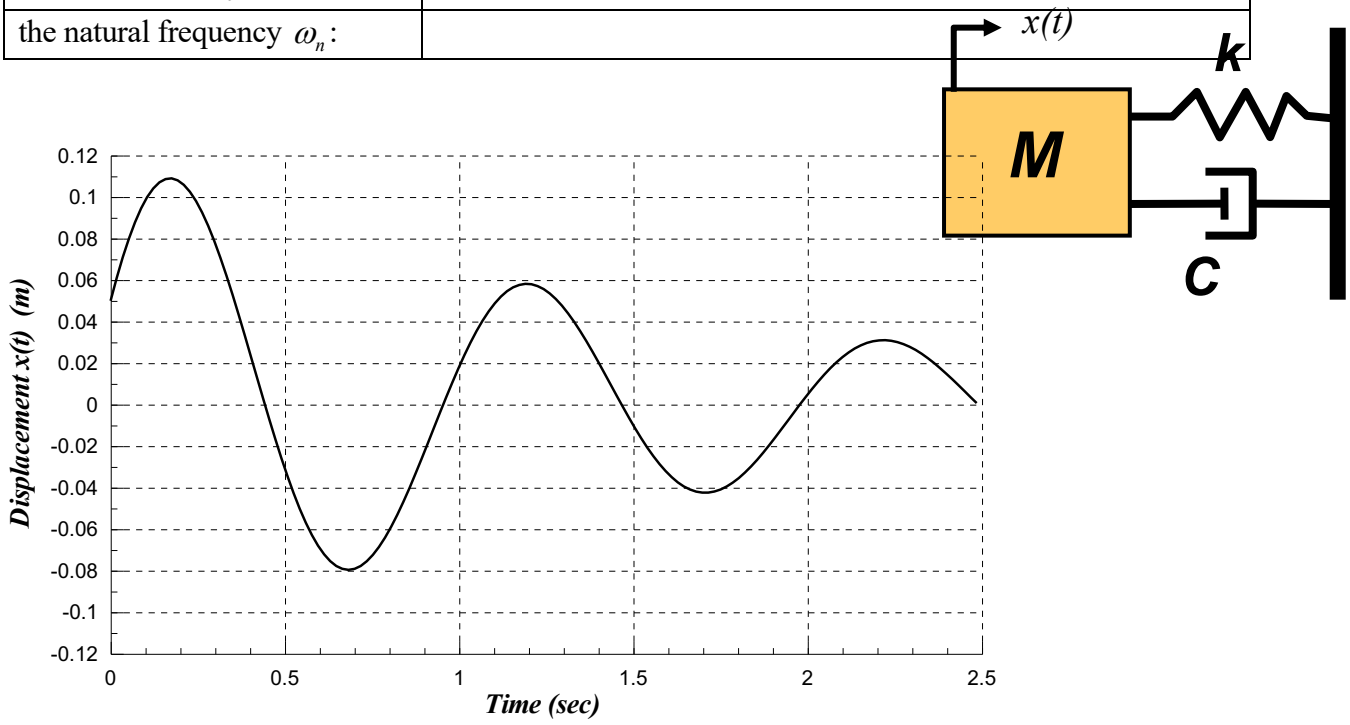
Question 5: (15 points)

The mechanical system is allowed to vibrate freely from the static equilibrium position. The time history of the displacement is shown below. If the mass of the system is *100 N.s²/m*, estimate:

Initial displacement x_o :	
Initial velocity $\dot{x}_o$:	
the natural frequency ω_n :	



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Question 6: (10 points)

What is the particular solution of $m_{eq}\ddot{\hat{x}}_p + b_{eq}\dot{\hat{x}}_p + k_{eq}\hat{x}_p = Pe^{i\omega t}$?

What is the particular solution of $m_{eq}\ddot{x}_p + b_{eq}\dot{x}_p + k_{eq}x_p = P\cos(\omega t)$?

NOTE: Please write the expression for the particular solution. NO need to solve for any unknown parameters in the solution.

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Question 7: (15 points)

Estimate the amplitude of the steady-state response *x(t)*

$$\dot{x}(t) + x(t) = \sin(10t)$$

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Question 8: (10 points)

Estimate the frequency in Hz of the first 3 harmonics for the following periodic signal.