Fall Semester, 2025 **Instructor**: M.J. DeJong
CE 225 – Dynamics of Structures

Homework #5

Due: Monday, October 6, 5pm

**NOTE: If you used any AI tools to complete the HW, please state what tools you used and how you used them. For your submission, please provide the solution requested, in addition to an explanation of how you verified that your code and solution are correct. Please also include the code in an appendix.

**It is fine to work with a friend, but please write (or generate using AI) the code yourself. Do not submit someone else's code that they created.

An SDOF system has the following properties:
k = 5 kips/in
T_n = 1 sec
ζ = 0.05

The following forcing function is applied:
$p(t)$ = 8*sin($\pi\, t$ / 0.4) kips for $0 \le t \le 1.2$ sec
$p(t)$ = 0 for $t > 1.2$ sec

1) Determine the analytical (exact) solution of the equation of motion of the system using any method.

2) Determine the response $u(t)$ of this system using the central difference method, implemented in a computer program in a language of your choice, using Δt = 0.1 sec. Provide your solution as a table of $u(t)$ values.

3) Determine the response $u(t)$ of this system using the constant average acceleration method, implemented in a computer program in a language of your choice, using Δt = 0.1 sec. Provide your solution as a table of $u(t)$ values.

4) (a) Plot the solutions obtained in 1) and 2), along with the static solution $u_{st}(t) = p(t)/k$ and the analytical solution of part (1). Compare all four and comment on the comparison.

(b) Now solve again using both the central difference method and the constant acceleration method using three different levels of damping: ζ = 0.01, ζ = 0.1 and ζ = 0.25. Plot all three solutions together for each method. Comment on how the methods and the damping affect the peak response.

(c) Now solve again using both the central difference method and the constant acceleration method using three different time steps: Δt = 0.05, Δt = 0.2 and Δt = 0.35 seconds. Carry out your solution to 4 seconds. Plot all three solutions together for each method. Comment on what happens to both solutions and why.