NUST Institute of Civil Engineering (NUST)
School of Civil and Environmental Engineering (SCEE)
National University of Sciences and Technology (NUST), H-12, Islamabad

CE 809: Structural Dynamics 3 (3-0) **Semester: August 2021**

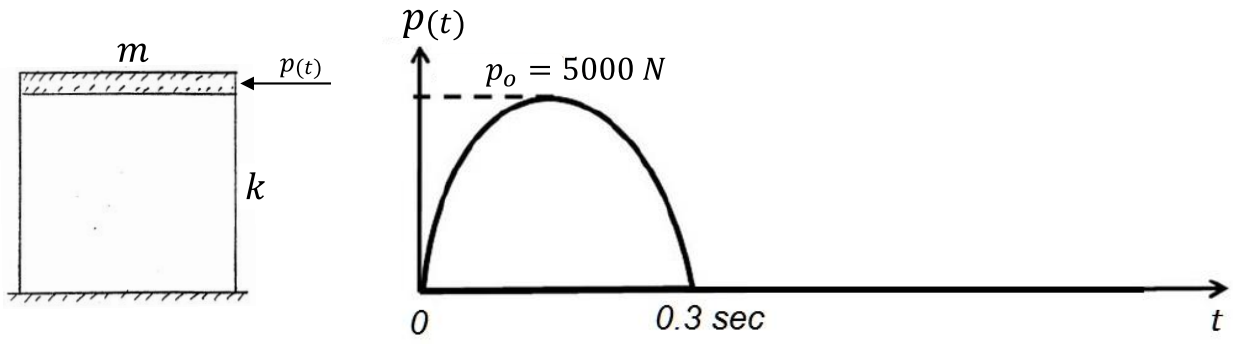
Assignment 4: Response of SDF systems to an arbitrary dynamic force

Question 1:

Consider the following SDF system with $m = 2000\,Kg$, $k = 800{,}000\,N/m$ and $\xi = 0.027$ subjected to a dynamic loading $p(t)$ as shown in Figure 1 (b).

The loading function $p(t)$ is a half sine pulse as shown below.

$$p(t) = \begin{cases} p_o \sin(\pi\, t/t_d) & for\ t < t_d \\ 0 & for\ t \geq t_d \end{cases}$$



(a) The SDF System (b) The dynamic force

Figure 1: An SDF system subjected to a half sine pulse force

Consider the at-rest initial conditions.

$t_d = 0.3\ sec$ and $p_o = 5000\ N$

Task 1: Construct a computer model of this simple structure using ETABS or SAP 2000. Subject the model to a the dynamic force shown in Figure 1. Analyze the model and determine the forced vibration response of system under this force.

Plot the displacement response for $0 \leq t \leq 2\ sec$ and also determine the maximum response.

Task 2: Determine the displacement response of the given system using any one of the following two options.

Option 1 (Analytical Approach):

Consider this loading as an impulse loading.

Divide the response into two phases. Determine the particular solution for phase 1 (i.e. loading phase) and determine the homogeneous solution as free vibration response. Plot the response together in both phases. The maximum displacement response can be in any phase (phase 1 or phase 2).

Option 2 (Numerical Approach):

In this approach, you again have two choices, i.e. (a) use “Duhamel’s integral” (with numerical integration solution) or, (b) use the “Step-by-step Direct Integration” method.

Determine the displacement response using any of the above approach and compare the results with those obtained from computer software.