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Exercise #2: Response to harmonic and periodic motion

Problem 1

The steady-state acceleration amplitude of a structure caused by an eccentric-mass vibration generator was measured for several excitation frequencies. The data are as follows:

Frequency [Hz]	Acceleration $[10^{-3}g]$	Frequency [Hz]	Acceleration $[10^{-3}g]$
1.337	0.68	1.500	7.10
1.378	0.90	1.513	5.40
1.400	1.15	1.520	4.70
1.417	1.50	1.530	3.80
1.438	2.20	1.540	3.40
1.453	3.05	1.550	3.10
1.462	4.00	1.567	2.60
1.477	7.00	1.605	1.95
1.487	8.60	1.628	1.70
1.493	8.15	1.658	1.50
1.497	7.60	-	-

Determine the natural frequency and damping ratio of the structure.

Problem 2

An SDF system is excited by a sinusoidal force. At resonance, the amplitude of displacement was measured to be $50.8mm$. at an exciting frequency of one-tenth $(1/10)$ the natural frequency of the system, the displacement amplitude was measured to be $5.08mm$. Estimate the damping ratio of the system.

Problem 3

In a forced vibration test under harmonic excitation, it was noted that the amplitude of motion at resonance was exactly four times the amplitude at an excitation frequency 20% higher than the resonant frequency. Determine the damping ratio of the system.

Problem 4

An SDF undamped system with a period T_n is subjected to a force $p(t)$ consisting of a sequence of two impulses, each of magnitude I, as shown in the figure below.

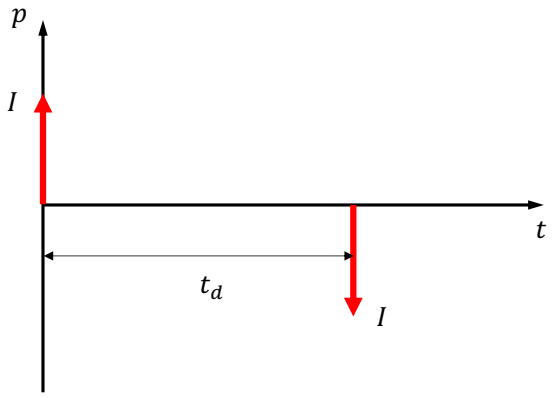

Figure 4.1. external force

1. Plot the displacement response of the system for $\frac{t_d}{T_n} = \frac{1}{8}, \frac{1}{4}$ and 1. For each case show the response to individual impulses and the combined response.
2. Plot $u_o \div (I/m\omega_n)$ as a function of t_d/T_n. Indicate separately the maximum occurring at $t \leq t_d$ and $t \geq t_d$. Such a plot is called the response spectrum for this excitation.