EM375 – MECHANICAL ENGINEERING EXPERIMENTATION

SECOND ORDER SYSTEM TRANSDUCER EQUATION SHEET FOR SINUSOIDAL EXCITATION

Details of these equations and graphs are given in class. This handout is a summary.

Measuring FORCE from the ABSOLUTE displacement of the mass:

$$\left|\frac{Y}{F}\right| = \frac{1}{m\left\{\left(w_n^2 - w^2\right)^2 + 4z^2 w^2 w_n^2\right\}^{1/2}} = \frac{w_n^2}{k\left\{\left(w_n^2 - w^2\right)^2 + 4z^2 w^2 w_n^2\right\}^{1/2}}$$

Measuring DISPLACEMENT from the RELATIVE displacement of the mass and base:

$$\left|\frac{X}{S}\right| = \frac{w^2}{\left\{\left(w_n^2 - w^2\right)^2 + 4z^2 w^2 w_n^2\right\}^{1/2}}$$

Measuring ACCELERATION from the RELATIVE displacement of the mass and base:

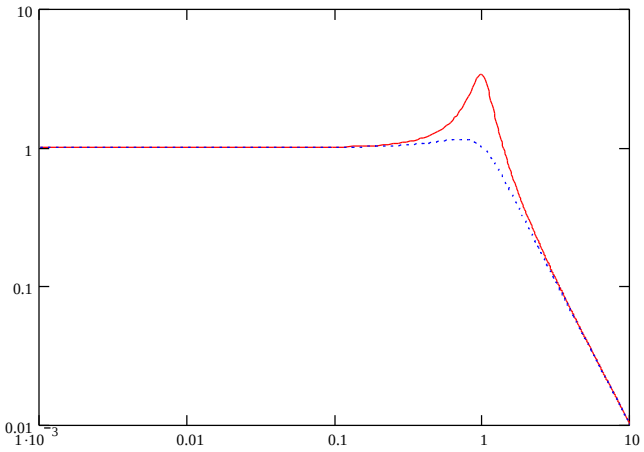
$$\left|\frac{X}{A}\right| = \frac{1}{\left\{\left(w_n^2 - w^2\right)^2 + 4z^2 w^2 w_n^2\right\}^{1/2}}$$

Phase is the same for all cases:

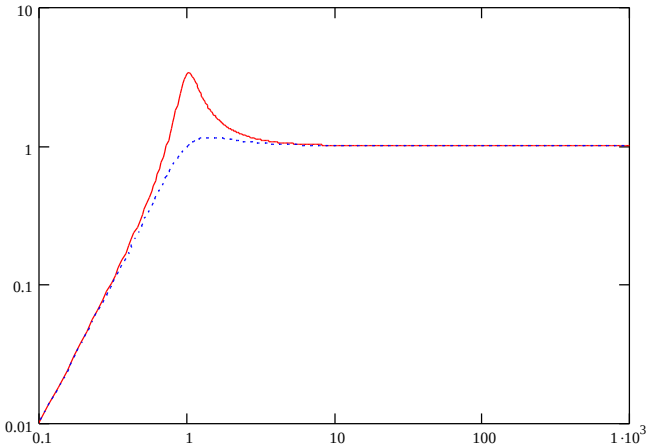
$$\text{phase } f = -\tan^{-1}\left(\frac{2zww_n}{\left(w_n^2 - w^2\right)}\right)$$

Symbols:

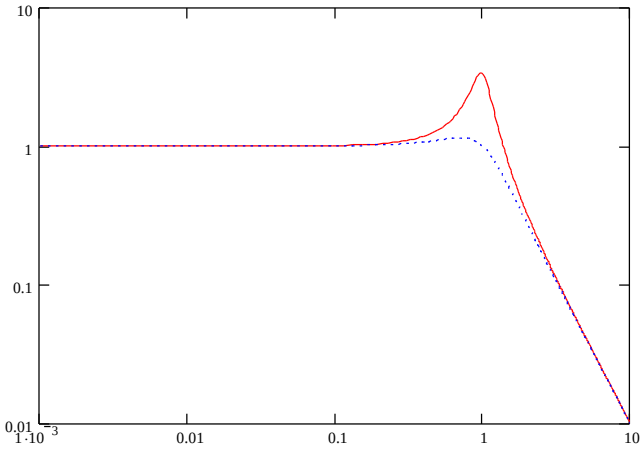
- F Amplitude of force (lbs)
- S Amplitude of the base displacement (ft)
- A Amplitude of the base acceleration (ft)
- Y Amplitude of ABSOLUTE displacement of the mass (ft)
- X Ampliutude of RELATIVE displacement between mass and base (ft)
- w Excitation (measurment) frequency (rad/s)
- w_n Natural frequency (rad/s)
- m mass (slugs)
- k Stiffness of the spring (lb/ft)
- z Viscous damping ratio
- f Phase between input and output



Force Transducer: *Y/F* versus frequency



Seismograph: *X/S* versus frequency



Accelerometer: *X/A* versus frequency