In the previous video, we analyzed the response of a system under harmonic loading, ignoring the effect of damping using Ansys. In this video, we will delve deeper into the topic by assessing the effect of load frequency on system response, and we will see what happens when the value of load frequency approaches a value close to the system's natural frequency.

$$u(t) = u_0 \cos \omega t + \left(\frac{\dot{u}_0}{\omega} - \frac{P_0}{k} \frac{\beta}{1-\beta^2} \right) \sin \omega t + \frac{P_0}{k} \cdot \frac{1}{1-\beta^2} \sin \Omega t$$

$u_0 = 0 \qquad \dot{u}_0 = 0$

$$\rightarrow u(t) = -\frac{P_0}{k} \cdot \frac{\beta}{1-\beta^2} \cdot \sin \omega t + \frac{P_0}{k} \cdot \frac{1}{1-\beta^2} \sin \Omega t$$

$$\beta = \frac{\Omega}{\omega} \Rightarrow \boxed{\Omega = \beta \cdot \omega}$$

$$u(t) = \frac{P_0}{k} \cdot \left[\frac{\sin \beta \omega t - \beta \sin \omega t}{1-\beta^2} \right]$$

$$(\text{HOP}) \rightarrow u(t) = \lim_{\beta \to 1} \frac{d(\text{numerator})}{d(\text{denominator})} \Rightarrow u(t) = \lim \frac{P_0}{k} \frac{\omega t \cos \beta \omega t - \sin \omega t}{-2\beta}$$

$$u(t) = \frac{P_0}{k} \cdot \frac{\omega t \cos \omega t - \sin \omega t}{-2} \Rightarrow u(t) = \frac{P_0}{2k} \left(\sin \omega t - \omega t \cos \omega t \right)$$

$E := 200\ GPa$ $\quad I := 36.92 \cdot 10^6 \cdot mm^4$ $\quad M := 100\ kg$ $\quad l := 5\ m$

$k := \frac{192 \cdot E \cdot I}{l^3} = \left(1.134 \cdot 10^4\right)\ \frac{kN}{m}$ $\quad w := \sqrt{\frac{k}{M}} = 336.776\ \frac{rad}{s}$ $\quad T := \frac{2 \cdot \pi}{w} = 0.019\ s$ $\quad f := \frac{1}{T} = 53.6\ Hz$ $\quad \Omega := w$

$\beta := \frac{\Omega}{w} = 1$ $\quad p_0 := M \cdot g$ $\quad u_0 := 0\ mm$ $\quad u'_0 := 0\ \frac{mm}{s}$

$u_{re}(t) := \frac{p_0}{2 \cdot k} \cdot \left(\sin(w \cdot t) - w \cdot t \cdot \cos(w \cdot t)\right)$

$t := 0, 0.001\ s .. 20\ s$