MECA-H303 TP5

Jefcott rotor

We consider a rotating shaft with a disk of mass m, and an unbalance ϵ attached at 2/3 of the length of the shaft. The shaft is simply supported, as shown in the figure below.

1. Compute the equivalent stiffness of the shaft based on tables given in annex.
2. Derive the equations of motion using the complex notation for the amplitude vector (without damping).
3. Based on the equations of motion, give the expression of the harmonic response when the shaft is rotating. Give the expression of the critical speed. What happens when the disc rotates at this speed ?
4. Give the expression of the harmonic response at high frequency (asymptotic behavior). What is the physical interpretation ? (what is happening physically when the shaft rotates at very high speed ?)
5. How are the equations of motion modified when you consider damping in the system, both in the form of translation c_n and rotation c_r damping ?
6. Give the expression of the harmonic response considering these two types of damping. What is the amplitude when the shaft rotates at the critical speed ? What type of damping does it depend on ?
7. Assume that $c_n = 2c_r$. What is the rotation speed above which the system becomes unstable ?

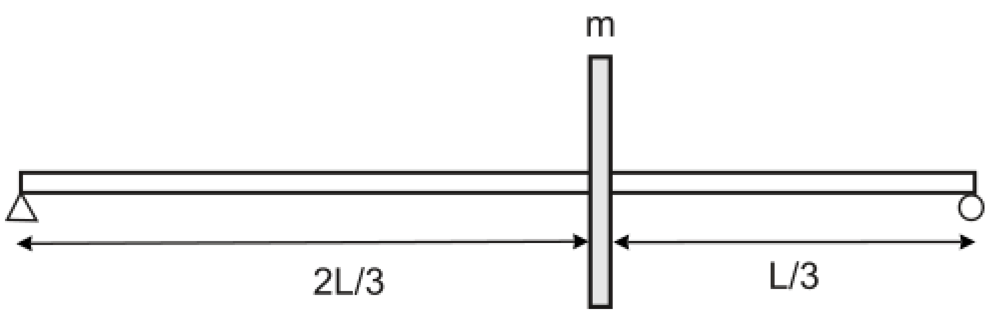


Figure 1: Shaft with disk

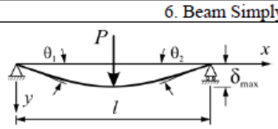
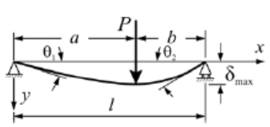
BEAM TYPE	SLOPE AT ENDS	DEFLECTION AT ANY SECTION IN TERMS OF x	MAXIMUM AND CENTER DEFLECTION
6. Beam Simply Supported at Ends – Concentrated load P at the center			
	$\theta_1 = \theta_2 = \dfrac{Pl^2}{16EI}$	$y = \dfrac{Px}{12EI}\left(\dfrac{3l^2}{4} - x^2\right)$ for $0 < x < \dfrac{l}{2}$	$\delta_{\max} = \dfrac{Pl^3}{48EI}$
7. Beam Simply Supported at Ends – Concentrated load P at any point			
	$\theta_1 = \dfrac{Pb(l^2 - b^2)}{6lEI}$ $\theta_2 = \dfrac{Pab(2l - b)}{6lEI}$	$y = \dfrac{Pbx}{6lEI}\left(l^2 - x^2 - b^2\right)$ for $0 < x < a$ $y = \dfrac{Pb}{6lEI}\left[\dfrac{l}{b}(x-a)^3 + \left(l^2 - b^2\right)x - x^3\right]$ for $a < x < l$	$\delta_{\max} = \dfrac{Pb\left(l^2 - b^2\right)^{3/2}}{9\sqrt{3}\,lEI}$ at $x = \sqrt{\left(l^2 - b^2\right)/3}$ $\delta = \dfrac{Pb}{48EI}\left(3l^2 - 4b^2\right)$ at the center, if $a > b$

Figure 2: Beam stiffness table