/

1) We are targeting 1100 rpm. Thus $\omega_a = \frac{1100 \cdot 2\pi}{60}$
$\omega_a = 115.2$ rad/s

Choosing $\mu = .25$, $m_a = 2268$ kg, $k_a = \omega_a^2 m_a = 3.01 \times 10^7$ N/m
This will work unless there are two natural frequencies near ω_{dr}.
Without more information, this is the best that can be done.

2) $\xi_i = \frac{\alpha}{2\omega_i} + \frac{\beta \omega_i}{2}$

For ω_1 + ω_3, choose ξ_i at maximum

+5 $\xi_1 = .3 = .966\ \alpha + .2588\ \beta$
$\xi_3 = .3 = .2588\ \alpha + .966\ \beta$

$\alpha = .245$
$\beta = .245$

Thus $\xi_2 = \frac{.245}{2 \cdot 1.4142} + \frac{.245 \cdot 1.4142}{2} = .26$
With $\alpha = \beta = .245$, ξ_1, ξ_2 + ξ_3, are inside the bounds

Choosing $\alpha = \beta = .2$

+5 $\xi_1 = .245$
$\xi_2 = .2121$
$\xi_3 = .245$

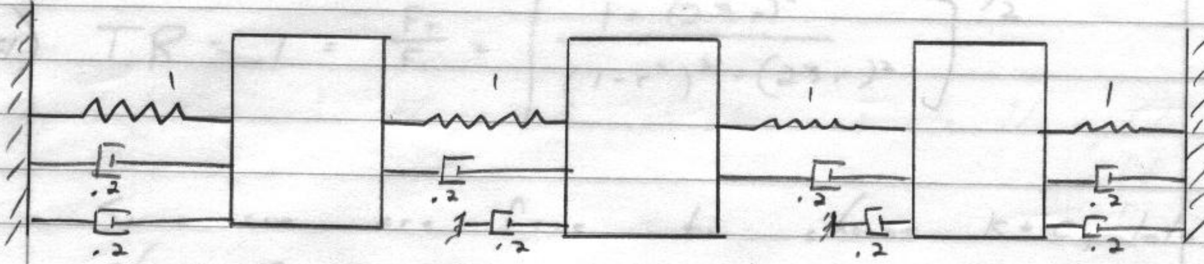
The damping ratios are now well within the bounds

From the diagram

+5 $K = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}$, $M = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

+5 $C = \begin{bmatrix} .6 & -.2 & 0 \\ -.2 & .6 & -.2 \\ 0 & -.2 & .6 \end{bmatrix}$

+5



3) $t_s = \frac{3}{\zeta\omega}, \quad t_p = \frac{\pi}{\omega_d}$ +6

$\zeta\omega = .3$, $\omega_d = \pi$

$\omega\sqrt{1-\zeta^2} = \pi$

$$\frac{\sqrt{1-\zeta^2}}{\zeta} = \frac{\pi}{.3}$$

$$1-\zeta^2 = \left(\frac{\pi}{.3}\right)^2 \zeta^2$$

$$\zeta^2 = \frac{1}{1+\left(\frac{\pi}{.3}\right)^2} = 9.04 \times 10^{-3}$$

$\zeta = .0951$ +3

$\omega = \frac{.3}{.0951} = 3.156 \text{ rad/s}$ +3

$2\ddot{x} + 2\dot{x} + 2x = u = -g_1 x - g_2 \dot{x}$

$\ddot{x} + \left(1 + \frac{g_2}{2}\right)\dot{x} + \left(1 + \frac{g_1}{2}\right)x = 0$ +4

$1 + \frac{g_1}{2} = \omega^2$

$g_1 = 2(\omega^2 - 1) = 17.9 \quad N/m$ +2

$1 + \frac{g_2}{2} = 2\zeta\omega$

$g_2 = 2(2\zeta\omega - 1) = 2(2 \cdot .3 - 1) = -.8$ +2

$u = -17.9x + .8\dot{x}$

4) $T.R. = .1 = \frac{F_T}{F_o} = \left[\frac{1+(2\zeta r)^2}{(1-r^2)^2+(2\zeta r)^2} \right]^{1/2}$ +10

Since we are free to choose k + c, lets choose $\zeta = 0$

$$.1 = \frac{1}{r^2-1}$$

$$r^2 - 1 = 10$$

$$r^2 - 9 = 0$$

$$r = 3$$

$$\omega_{dr} = \frac{180 \cdot 2\pi}{60} = 18.85 \text{ rad/s}$$

$$\omega = \frac{1}{3} \cdot 18.85 = 6.28 \text{ rad/s}$$

* $k = m\omega^2 = 987$ N/m +5

* $c = 0$ kg/s +5

5) Let x_1 be the motion of mass 1 to the right
" x_2 " 2 " left

$$T = \frac{1}{2}\left(m_1 \dot{x}_1^2 + m_2 \dot{x}_2^2\right)$$ +5

$x_1 \approx b\theta$ where θ is the clockwise rotation of the lever

$x_2 \approx a\theta$

$$T = \frac{1}{2}\left(m_1 b^2 \dot{\theta}^2 + m_2 a^2 \dot{\theta}^2\right)$$

$$T = \frac{1}{2}\left(m_1 b^2 + m_2 a^2\right)\dot{\theta}^2$$

$$U = \frac{1}{2} k_2 x_2^2 + \frac{1}{2} k_1 x_1^2 + a(1-\cos\theta) m_2 g$$ +5

$$U = \frac{1}{2}\left(k_2 a^2 + k_1 b^2\right)\theta^2 + a(1-\cos\theta) m_2 g$$

$$\frac{d}{dt}\left(\frac{\partial T}{\partial \dot{\theta}}\right) = \left(m_1 b^2 + m_2 a^2\right)\ddot{\theta}$$

$$\frac{\partial U}{\partial \theta} = \left(k_2 a^2 + k_1 b^2\right)\theta + a\sin\theta\, m_2 g$$

Thus, the eqn of motion is

$$\left(m_1 b^2 + m_2 a^2\right)\ddot{\theta} + \left(k_2 a^2 + k_1 b^2\right)\theta + m_2 g a \sin\theta = 0$$

Or, for small θ

$$\left(m_1 b^2 + m_2 a^2\right)\ddot{\theta} + \left(k_2 a^2 + k_1 b^2 + m_2 g a\right)\theta = 0$$

+5 +5