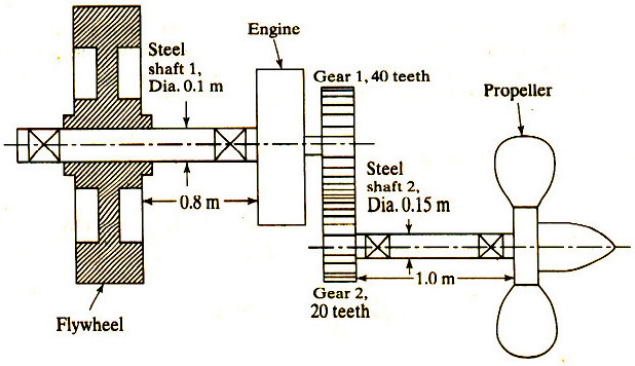
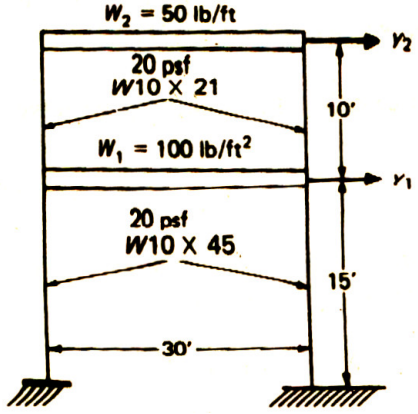
Aerospace Structural Dynamics – AE31002
Tutorial Sheet – 4

1. The schematic diagram of a engine connected to a propeller through gears is shown in the figure. The mass moments of inertia of the flywheel, engine, gear-1, gear-2 and the propeller (in kg-m^2) are 9000, 1000, 250, 150 and 2000, respectively. Find the natural frequencies and mode shapes of the system.



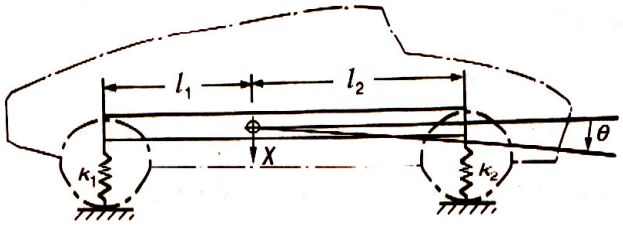
Ans. 9.24 rad/sec, 55.60 rad/sec, 1/1.2072, 1/-0.1916

2. A column structure is shown below with lumped masses at two representative heights. It has been assumed that all masses of the structure are lumped at respective position. The structure is a part of a multiple similar structures spaced @ 15ft. Find out the natural frequencies and mode shapes (draw those) of the structure. E = 30x10^6 lb/in^2 and I of a columen is 248.6 in^4



Ans. 11.8 rad/sec, 32.9 rad/sec, 1/1.263, 1/-1.629

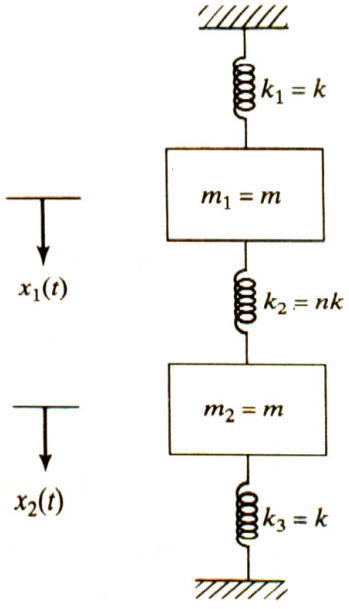
3. The following information is given for a automobile shown in the figure.



m = 1600 kg, k_1 = 30,000 N/m
l_1 = 1.34 m, k_2 = 36,000 N/m
l_2 = 1.7 m, r = 1.22 m = radius of gyration about c.g.. Assume c.g. is located at l_1 distance from left end. Determine the normal modes of vibration and locate the node for each mode.

Ans. 6.1 rad/sec, 8.38 rad/sec, -3.29/1, 0.452/1

4. Find the natural frequencies and mode shapes of the spring mass system shown in the figure below. (for n=1)



Ans. $\sqrt{k/m}$, $\sqrt{3k/m}$

5. Using modal analysis, find the free vibration response of a 2 DOFS with equations of motion

$$\begin{bmatrix} m_1 & 0 \\ 0 & m_2 \end{bmatrix} \begin{Bmatrix} \ddot{x}_1 \\ \ddot{x}_2 \end{Bmatrix} + \begin{bmatrix} k_1+k_2 & -k_2 \\ -k_2 & k_2+k_3 \end{bmatrix} \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \end{Bmatrix}$$