# Homework 3 – Spring 2019

AE 6220: Rotorcraft Dynamics
Prof. Dewey H. Hodges
Due: Feb. 15, 2019

Consider a rotating blade which, in its undeformed state, is cantilevered normal to an inertially fixed axis of rotation. It undergoes pure bending vibration in a plane that contains the axis of rotation. The blade properties are

$$
\begin{aligned}
\ell &= 100 \text{ in} \\
EI &= 62500 \text{ lb in}^2 \qquad \left(0 \le \frac{x_1}{\ell} < .2\right) \\
&= 250000 \text{ lb in}^2 \qquad \left(.2 \le \frac{x_1}{\ell} \le 1\right) \\
m &= .0001 \text{ lb sec}^2/\text{in}^2 \qquad \left(0 \le \frac{x_1}{\ell} < .2\right) \\
&= .0002 \text{ lb sec}^2/\text{in}^2 \qquad \left(.2 \le \frac{x_1}{\ell} \le 1\right) \\
\Omega &\text{ varies as described below}
\end{aligned}
\tag{1}
$$

1. Write a computer program to determine the fundamental frequency and mode shape by means of the transfer matrix method.

2. Plot the fundamental frequency versus $\Omega$ for $0 \le \Omega \le 25$ rad/sec.

3. Normalizing all results for tip deflection of 1 in., plot the fundamental mode shapes and modal moment distributions versus the axial coordinate $x = x_1/\ell$ for $\Omega = 0$ and for $\Omega = 25$ rad/sec.

4. With the same normalization, plot families of curves for the modal bending moment $M$ and the modal shear force $V$ versus $x$ for various values of $\Omega$ from zero upwards in increments of 25 rad/s until you start to have numerical problems. Plot $M(0)$ and $V(0)$ versus $\Omega$. In your report show enough distinct curves to illustrate the trend up to the highest value at which your code still works. Comment on the effect of angular speed on the displacement and moment mode shapes, particularly on $M(0)$ and the shape of the curve $v(x)$ near $x = 0$.

5. Discuss the accuracy of various aspects of the results, the effects of the various tolerances, the applicability of this method, and the pros and cons of the method relative to others discussed in class.