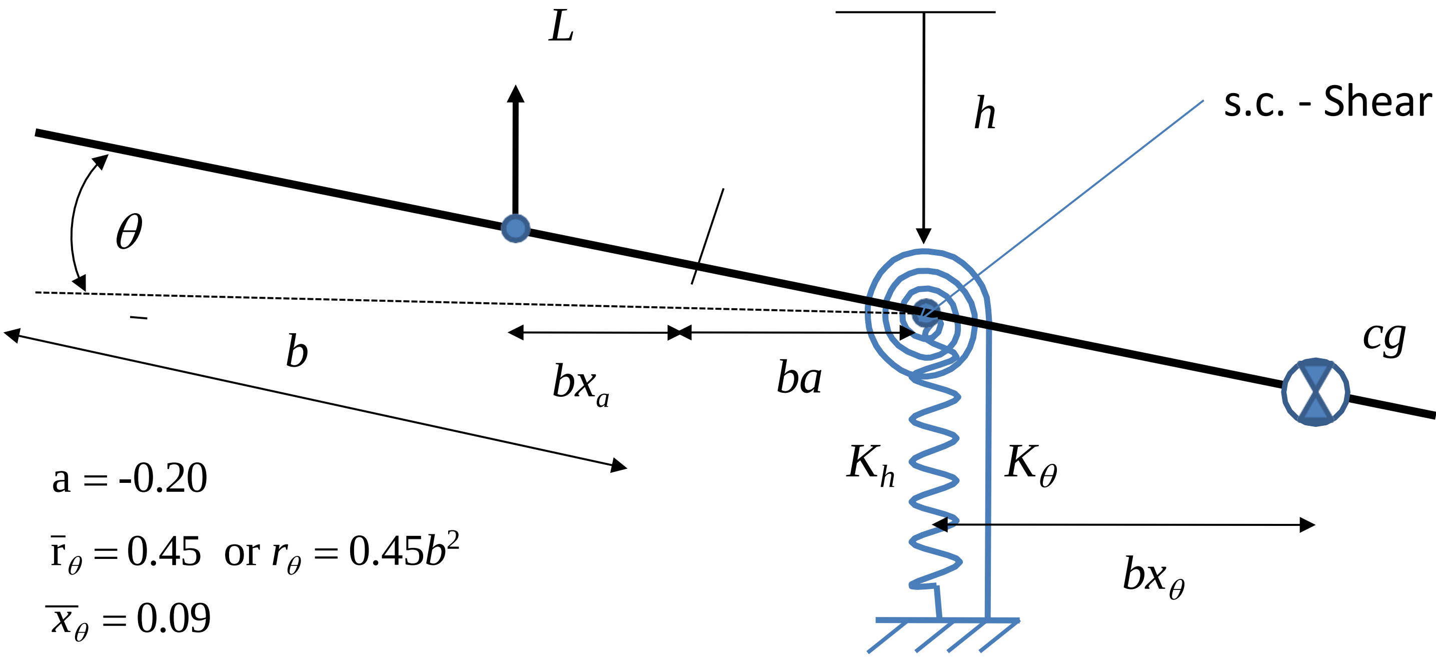
An airfoil section of an unswept wing is show below. Note that dimensions are measured with respect to the semi-chord of the airfoil.



$$a = -0.20$$

$$\bar{r}_\theta = 0.45 \text{ or } r_\theta = 0.45 b^2$$

$$\overline{x_\theta} = 0.09$$

$$C_{L\alpha} = 6.5/\text{rad}$$

$$\omega_h = 12.\ \text{rad/sec}$$

$$\omega_\theta = 30.\ \text{rad/sec}$$

$$b = 40.\ \text{in}$$

$$\mu = 15$$

a) Solve for the natural frequencies and normal modes of this model. Transform the eigenvectors into orthonormal modes of the system. Sketch these modes and locate the node points of each.

b) Include the quasi-steady aerodynamic loads in the analysis. Use the orthonormal modes to transform the equations of motion of the aeroelasitc system into motion in two generalized coordinates, given as

$$\begin{Bmatrix} h/b \\ \theta \end{Bmatrix} = \begin{Bmatrix} \varphi_1^1 \\ \varphi_2^1 \end{Bmatrix} x_1 + \begin{Bmatrix} \varphi_1^2 \\ \varphi_2^2 \end{Bmatrix} x_2$$

c) Plot the natural frequencies of the system (using equations in (b)) as a function of airspeed V. Solve for the flutter speed.

d) Use the original equations of motion to solve for the flutter speed. Explain any differences.