(1) $$\gamma m\left(\ddot{x} - \frac{v_s^2}{r}\right) = -q v_s B_y$$

$$\gamma m \ddot{y} = q v_s B_x$$

$$\gamma m\left(\ddot{x} - \frac{v_s^2}{R(1+\frac{x}{R})}\right) = -q v_s B_0\left(1 + \frac{B_{yx} x}{B_0}\right)$$

$$\gamma m \ddot{y} = q v_s B_0 \frac{B_{xy}}{B_0} y$$

$$q v_s B_0 = \frac{\gamma m v_s^2}{R}$$

$$q B_0 = \frac{P_0}{R} = \frac{\gamma m v_s}{R}$$

$$\ddot{x} - \frac{v_s^2}{R} + \frac{v_s^2}{R^2} x = -\frac{v_s^2}{R} - \frac{v_s^2}{R}\frac{B_{yx}}{B_0} x$$

$$\ddot{y} = \frac{v_s^2}{R}\frac{B_{xy}}{B_0} y$$

$$B_y = B_0\left(\frac{R}{r}\right)^n \qquad \ln B_y = \ln B_0 + \ln\left(\frac{1}{1+x/R}\right)^n$$

$$= \ln B_0 - n \ln\left(1 + \frac{x}{R}\right)$$

$$\frac{dB_y}{B_0} = -n \frac{dx}{(1+x/R)R}\Big|_{x=0}$$

$$\frac{dB_y}{dx} = B_0\left(-\frac{n}{R}\right) = B_{yx} = B_{xy} = -\frac{B_0 n}{R}$$

$$\ddot{x} + \frac{v_s^2}{R^2}(1-n)x = 0$$

$$\ddot{y} + \frac{v_s^2}{R^2} n y = 0$$

$$\frac{v_s}{R} = \omega$$ frequency of revolution

(5) $$M_f = \begin{pmatrix} \cos & \frac{1}{\sqrt{K}}\sin \\ -\sqrt{K}\sin & \cos \end{pmatrix}$$

All args. are $\sqrt{K}L$

$$M_d = \begin{pmatrix} \cosh & \frac{1}{\sqrt{K}}\sinh \\ \sqrt{K}\sinh & \cosh \end{pmatrix}$$

$$M_f M_d = \begin{pmatrix} \cosh\cos + \sinh\sin & \frac{\sinh\cos + \cosh\sin}{\sqrt{K}} \\ \sqrt{K}(\sinh\cos - \cosh\sin) & \cosh\cos - \sinh\sin \end{pmatrix}$$

$$\left|\frac{1}{2}\mathrm{Tr}(M_f M_d)\right| = |\cosh\cos| < 1$$