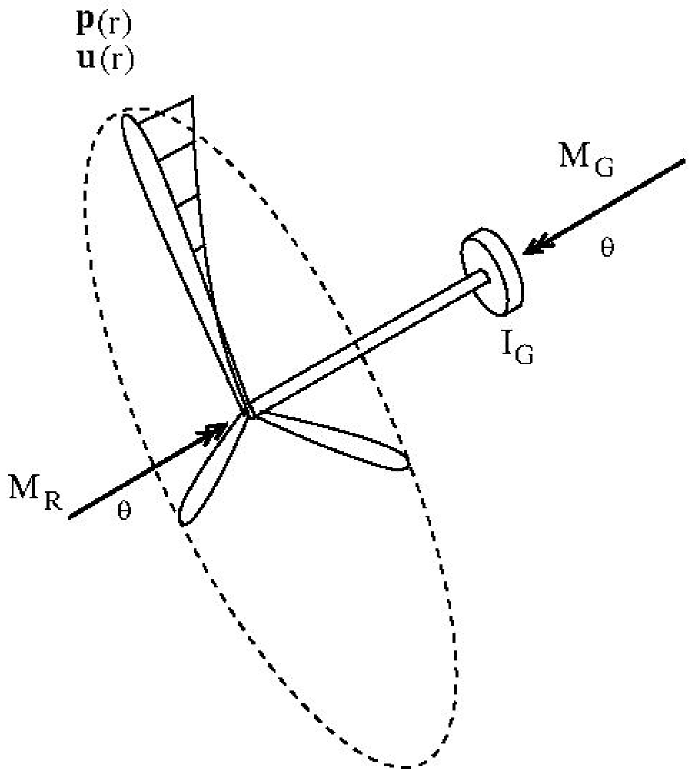
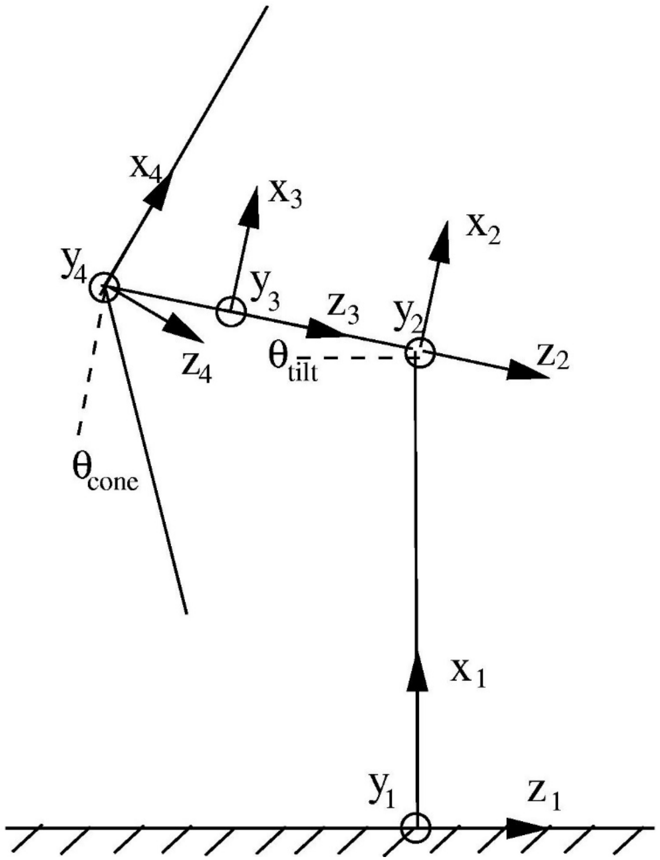
These slides show the resulting Equation of Motions for the 4 DOF system from Module#10. See that you understand why they look as they do and afterwards use your Runge-Kutta-Nyström method to solve in time domain





To add the gravitational load on the blade

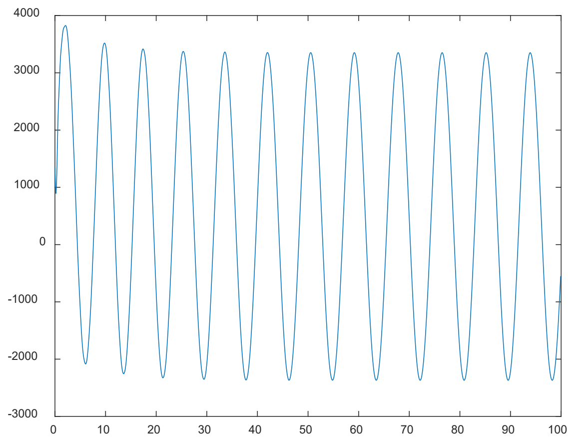
$$\mathbf{p_{grav}}(r) = \begin{bmatrix} p_{grav,x} \\ p_{grav,y} \\ p_{grav,z} \end{bmatrix} = \mathbf{a_{14}} \cdot \begin{bmatrix} -m(r)g \\ 0 \\ 0 \end{bmatrix}$$

These are then added to the aerodynamic loads

$$p_y(r) = p_{y,aero}(r) + p_{grav,y}$$

$$p_z(r) = p_{z,aero}(r) + p_{grav,z}$$

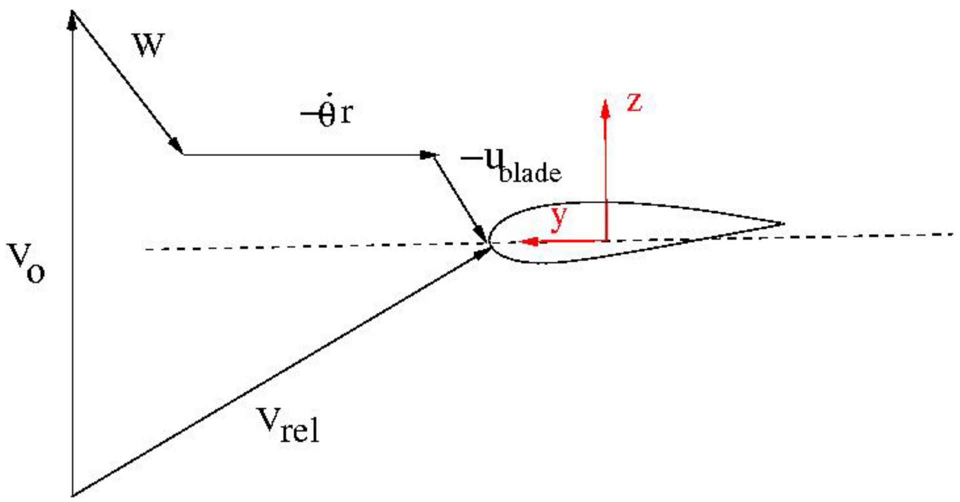
Tangential load as function of time at r= 58.5 m for V=8m/s constant



$$\mathbf{GF} = \begin{bmatrix} \sum_{n=1}^{NB} \int r p_y(r) dr - M_G(\dot{\theta}) \\ \int p_y(r) \cdot u_y^{1f} dr + \int p_z(r) \cdot u_z^{1f} dr \\ \int p_y(r) \cdot u_y^{1e} dr + \int p_z(r) \cdot u_z^{1e} dr \\ \int p_y(r) \cdot u_y^{2f} dr + \int p_z(r) \cdot u_z^{2f} dr \end{bmatrix} = \begin{bmatrix} M_{aero} - M_G(\dot{\theta}) \\ \int p_y(r) \cdot u_y^{1f} dr + \int p_z(r) \cdot u_z^{1f} dr \\ \int p_y(r) \cdot u_y^{1e} dr + \int p_z(r) \cdot u_z^{1e} dr \\ \int p_y(r) \cdot u_y^{2f} dr + \int p_z(r) \cdot u_z^{2f} dr \end{bmatrix}$$

$$\mathbf{M} = \begin{bmatrix} I & \int m \cdot r \cdot u_y^{1f}(r) dr & \int m \cdot r \cdot u_y^{1e}(r) dr & m \cdot r \cdot u_y^{2f}(r) dr \\ \int m \cdot r \cdot u_y^{1f}(r) dr & GM_1 & 0 & 0 \\ \int m \cdot r \cdot u_y^{1e}(r) dr & 0 & GM_2 & 0 \\ \int m \cdot r \cdot u_y^{2f}(r) dr & 0 & 0 & GM_3 \end{bmatrix} \qquad \mathbf{K} = \begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & \omega_1^2 GM_1 & 0 & 0 \\ 0 & 0 & \omega_2^2 GM_2 & 0 \\ 0 & 0 & 0 & \omega_3^2 GM_3 \end{bmatrix}$$

Remember to include the blade velocity in the velocity triangle and the rotational speed $\dot{\theta}$ is directly computed when solving your EOMs, so throw away the old way you computed ω



The blade velocity must be subtracted when computing the relative wind speed approaching the blade element

$$\begin{pmatrix} V_{rel,y} \\ V_{rel,z} \end{pmatrix} = \begin{pmatrix} V_{o,y} \\ V_{o,z} \end{pmatrix} + \begin{pmatrix} W_y \\ W_z \end{pmatrix} + \begin{pmatrix} -\dot{\theta} \cdot x \\ 0 \end{pmatrix} - \begin{pmatrix} u_{blade,y} \\ u_{blade,z} \end{pmatrix}$$

$$\begin{pmatrix} u_{blade,y} \\ u_{blade,z} \end{pmatrix} = \dot{q}_1(t) \begin{pmatrix} u_y^{1f} \\ u_z^{1f} \end{pmatrix} + \dot{q}_2(t) \begin{pmatrix} u_y^{1e} \\ u_z^{1e} \end{pmatrix} + \dot{q}_3(t) \begin{pmatrix} u_y^{2f} \\ u_z^{2f} \end{pmatrix}$$