Some Helpful and Not-So-Helpful Equations

E1. $$E = mc^2$$

E2. $$\frac{{}^i d}{dt}(.) = \frac{{}^b d}{dt}(.) + \vec{\omega}^{bi} \times (.)$$

E3. $$\frac{{}^i d^2}{dt^2}(.) = \frac{{}^b d^2}{dt^2}(.) + \frac{{}^b d}{dt}\left(\vec{\omega}^{bi}\right) \times (.) + 2\vec{\omega}^{bi} \times \frac{{}^b d}{dt}(.) + \vec{\omega}^{bi} \times \left[\vec{\omega}^{bi} \times (.)\right]$$

E4. $$\vec{F}_e = m \frac{{}^i d^2}{dt^2} \vec{r}_c$$

E5. $$H^b = I^b \omega^{bi} + m\tilde{r}^b v^b$$

E6. $$\vec{\omega}^{bi} = \omega_1 \vec{b}_1 + \omega_2 \vec{b}_2 + \omega_3 \vec{b}_3$$

E7. $$I^a = R^{ba} I^b R^{ab}$$

E8. $$I^b = -\int_m \tilde{r}^b \tilde{r}^b \partial m$$

E9. $$I = \int \begin{bmatrix} y^2 + z^2 & -xy & -xz \\ -xy & x^2 + z^2 & -yz \\ -xz & -yz & x^2 + y^2 \end{bmatrix} \partial m$$

E10. $$R^{bi} = R_3(-\psi) R_2(-\theta) R_1(-\phi)$$

E11. $$C_{m_\alpha} = C_{L_{\alpha W}} \left(\frac{x_{cg}}{\bar{c}} - \frac{x_{ac}}{\bar{c}} \right) + C_{m_{\alpha F}} - \eta V_H C_{L_{\alpha T}} \left(1 - \frac{d\varepsilon}{d\alpha} \right)$$

E12. $$\frac{x_{NP}}{\bar{c}} = \frac{x_{ac}}{\bar{c}} - \frac{C_{m_{\alpha F}}}{C_{L_{\alpha W}}} + \eta V_H \frac{C_{L_{\alpha T}}}{C_{L_{\alpha W}}} \left(1 - \frac{d\varepsilon}{d\alpha} \right)$$

E13. $$C_{L_\alpha} = \frac{C_{l_\alpha}}{1 + C_{l_\alpha} / (\pi AR)}$$

E14. $$f = \left(1 - \frac{C_{L_{\delta e}} C_{h_{\alpha_t}}}{C_{L_{\alpha_t}} C_{h_{\delta e}}} \right)$$

E15.
$$L = I_x \dot{p} - I_{zx} \dot{r} + qr(I_z - I_y) - I_{zx} pq$$
$$M = I_y \dot{q} + rp(I_x - I_z) + I_{zx}(p^2 - r^2)$$
$$N = I_z \dot{r} - I_{zx} \dot{p} + pq(I_y - I_x) + I_{zx} qr$$

E16.
$$X - mg \sin\theta = m(\dot{u} + qw - rv)$$
$$Y + mg \cos\theta \sin\phi = m(\dot{v} + ru - pw)$$
$$Z + mg \cos\theta \cos\phi = m(\dot{w} + pv - qu)$$

E17. $$E = \frac{v^2}{2} - \frac{\mu}{r}$$

E18. $$\frac{r}{R} \approx \left(\frac{m}{M} \right)^{2/5}$$