272(8): Graphics of $\ddot{r}$ Versus θ and ϕ

The relevant equations in this case are:

$$\ddot{r} = r\left(\dot{\theta}^2 + \dot{\phi}^2 \sin^2\theta\right) - \frac{MG}{r^2} \quad -(1)$$

$$\dot{\phi} = \frac{L_Z}{mr^2 \sin^2\theta} \quad -(2), \quad \dot{\theta} = \frac{1}{mr^2}\left(L^2 - \frac{L_Z^2}{\sin^2\theta}\right)^{1/2} \quad -(3)$$

$$r = \frac{\alpha}{1+\epsilon\cos\beta} \quad -(4)$$

$$\cos\beta = \left(1 - \frac{L^2\cos^2\theta}{L^2 - L_Z^2}\right)^{1/2} \quad -(5)$$

$$\cos\beta = \frac{\cos\phi}{\left(\cos^2\phi + \left(\frac{L_Z}{L}\right)^2 \sin^2\phi\right)^{1/2}} \quad -(6)$$

$$\sin^2\theta = \left(\frac{L_Z}{L}\right)^2 + \left(1 - \left(\frac{L_Z}{L}\right)^2\right)\left(\frac{\cos^2\phi}{\cos^2\phi + \left(\frac{L_Z}{L}\right)^2 \sin^2\phi}\right) \quad -(7)$$

Type One

Use Eq. (7) in Eq. (2) and Eq. (5) in Eq. (4).

2)

Type Two

Use Eq. (7) in Eq. (3) and Eq. (5) in Eq. (4)

Type Three

Use Eq. (7) in Eq. (2) and Eq. (6) in Eq. (4)

Type Four

Use Eq. (7) in Eq. (3) and Eq. (6) in Eq. (4)

The Two Dimensional Equivalent is:

$$\ddot{r} = r\dot{\phi}^2 - \frac{MG}{r^2} \quad -(8)$$

$$\dot{\phi} = \frac{L_z}{mr^2} \quad -(9)$$

$$r = \frac{\alpha}{1 + \epsilon\cos\phi} \quad -(10)$$

so $$\ddot{r} = f(\phi)$$