PHY 321, APRIL 7, 2023

Earth-Sun case

$$GM_{\odot} = 4\pi^2 (AU)^3 / (yr)^2$$

$$a_x = \frac{dv_x}{dt} = -\frac{4\pi^2 x}{\sqrt{x^2+y^2}}$$

$$a_y = \frac{dv_y}{dt} = -\frac{4\pi^2 y}{\sqrt{x^2+y^2}}$$

$$\frac{dx}{dt} = v_x \quad \wedge \quad \frac{dy}{dt} = v_y$$

Part 2

include Jupiter

$$M_J = 1.9 \cdot 10^{27}\,\mathrm{kg}$$

Need Force between Earth - Jupiter

$$F_{EJ_x} = -\frac{G M_J M_E}{r_{EJ}^3} x_{EJ}$$

$$x_{EJ} = x_E - x_J$$

$$r_{EJ} = \sqrt{(x_E - x_J)^2 + (y_E - y_J)^2}$$

$$F_{EJy} = -\frac{G M_J M_E}{r_{EJ}^3} y_{EJ}$$

$$y_{EJ} = y_E - y_J$$

F_{Ex} = Force on Earth from Sun & Jupiter

$$\frac{F_{Ex}}{M_E} = a_{Ex} = -\frac{G M_\odot x_E}{r^3}$$

$$-\frac{G M_J \cdot M_\odot}{r_{EJ}^3 M_\odot}(x_E - x_J)$$

$$= -\frac{4\pi^2 x_E}{r^3} - \frac{4\pi^2 \left(\frac{M_J}{M_\odot}\right)(x_E - x_J)}{r_{EJ}^3}$$