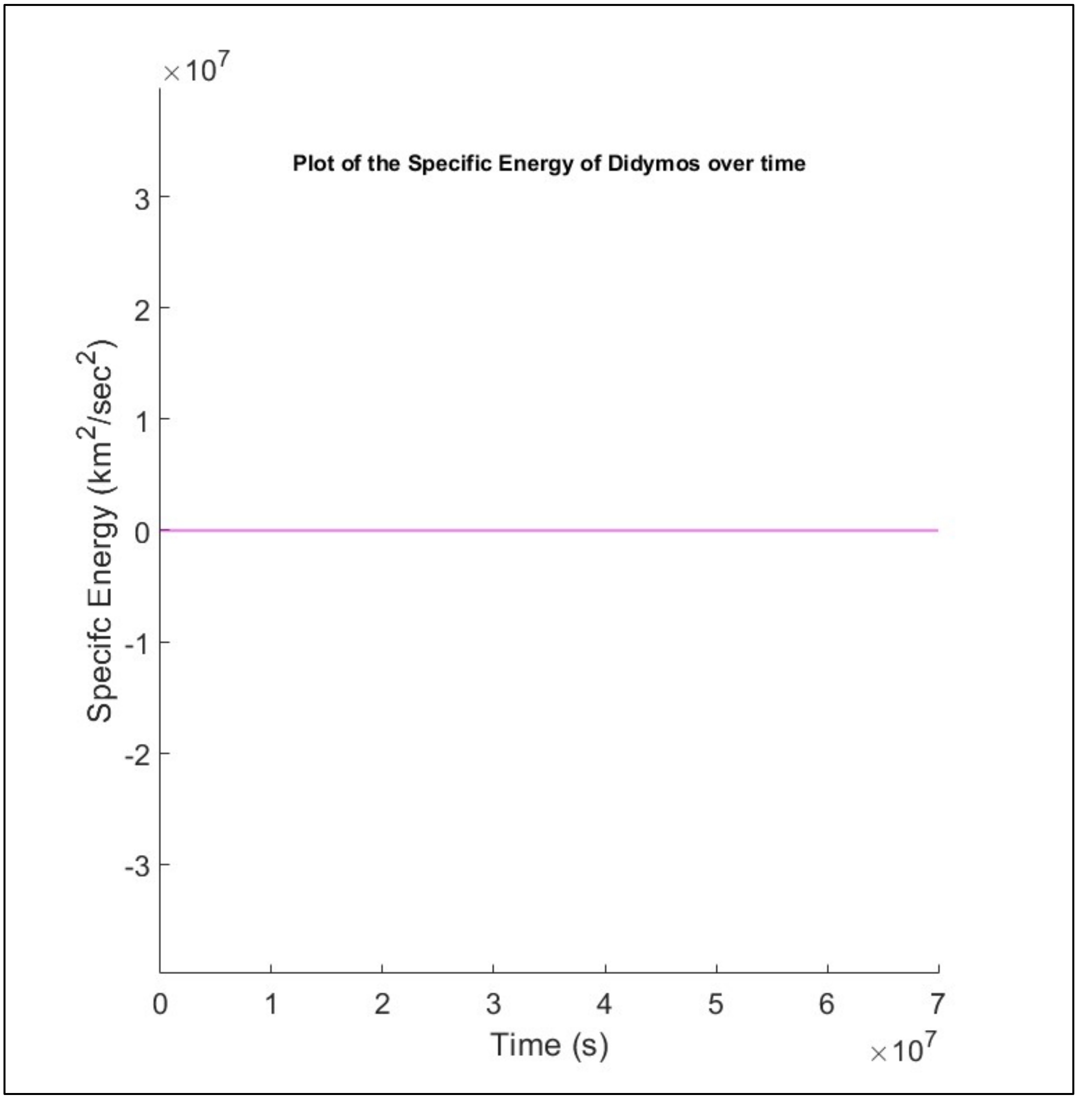
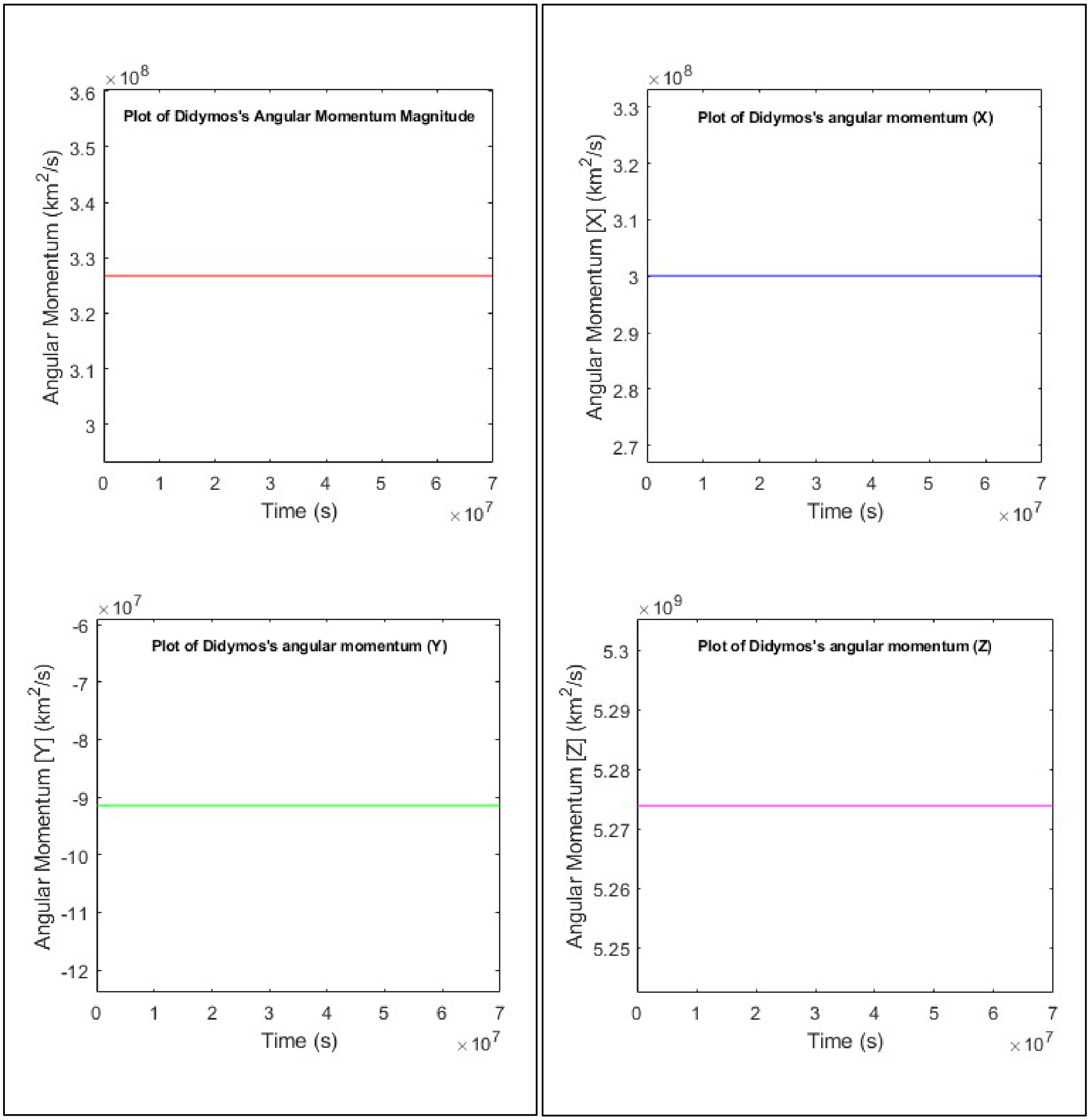
ENAE404 : HW1 Romeo Perlstein, section 0101

Question 1:

a)



b)



c)

From my understanding, the previous two plots indicate that my two-body-problem propagator is working properly because the momentum and energy is "conserved" (i.e., they are pretty much a straight line!). This makes sense due to the constraints we're applying. If energy or angular momentum was not conserved, the planet would eventually begin spiraling in or out or in some way, shape, or form and not form a perfect orbit.

Question 2:

a)

$\boxed{\text{All values of } \upsilon}$

b)

$\boxed{0^{o} \text{ and } 180^{o}}$

c)

$\boxed{0^{o}}$

d)

$\boxed{0^{o}}$

Question 3:

a)

The eccentricity came out to be **1.2436**, meaning that e > 1. With that case, Luke's orbit should be a **hyperbolic** conic section!

b) Using energy: $E = v^2/2 + \mu/r = -\mu/2a$

$a = -\mu/2E = (3.986*10^5)/(2*3.92270560672) = -50806.7696078$ km

The semi-major axis of this orbit is at **−50806.7696078 km** (which checks out since it is a hyperbola, and the semi-major axis is located on the outside of it!)

c) Using specific angular momentum: h = r*v*cos(flight angle)

$h = 12378 * 8.5 * \cos(0.5^{o}) = 105208.993811$ km^2/s

The **specific** angular momentum of Luke's orbit is **105208.993811 km^2/s**

d) $e = \sqrt{1 + \frac{2Eh^2}{\mu^2}} = \sqrt{1 + \frac{2(3.92270560672)(105208.993811)^2}{(3.986*10\text{^}5)^2}} = 1.2436$

As stated in part a), the eccentricity of this orbit is 1.2436

e) $R_P = a(1-e) = -50806.7696078(1-1.2436) = 12377.1497095$ km

The radius of the periapsis is **12377.1497095 km**

Question 4:

a) $p = a(1-e^2) = 20{,}000*(1-(0.4)^2) = 16800$ km

$r = p/(1 - e*\cos(\upsilon)) = 16800/(1 - (0.4)*\cos(30^0)) = 12477.62418928247$ km

The radius at a true anomaly of 30^0 is **12477.6242 km**

b) $r = p/(1 - e*\cos(\upsilon)) = 16800/(1 - (0.4)*\cos(330^0)) = 12477.62418928247$

The radius at a true anomaly of 330^0 is also **12477.6242 km** (makes sense, its basically a mirror image)

c) v = $\sqrt{2*(-\frac{\mu}{2a}+\frac{\mu}{r})} = \sqrt{2*(-\frac{3.986*10\text{^}5}{2(20{,}000)}+\frac{3.986*10\text{^}5}{12477.62418928247})}$ = 6.630261525936095 km/s

The velocity at an anomaly of 30^0 is **6.6303 km/s**

d) v = $\sqrt{2*(-\frac{\mu}{2a}+\frac{\mu}{r})} = \sqrt{2*(-\frac{3.986*10\text{^}5}{2(20{,}000)}+\frac{3.986*10\text{^}5}{12477.62418928247})}$ = 6.630261525936095 km/s

The velocity at an anomaly of 330^0 is **6.6303 km/s** (which still makes sense, mirror image

e) h = $\sqrt{\mu p} = \sqrt{(3.986 * 10^5)(16800)}$ = 81832.02307165576
flight angle = arccos(h/rv) = arccos(81832.0231/(12477.62418928247 * 6.630261525936095))
flight_angle = 8.449113362178327^0

The flight angle at a true anomaly of 30^0 is **8.4491^0**

f)

The flight angle at a true anomaly of 330^0 is *also* **8.4491^0**

g) apoapsis = a(1+e) = 20,000(1 + (0.4) = 28000 km

The apoapsis of this orbit is **28000 km**

h) $\sqrt{2*(-\frac{\mu}{2a}+\frac{\mu}{apoapsis})} = \sqrt{2*(-\frac{3.986*10\text{^}5}{2(20{,}000)}+\frac{3.986*10\text{^}5}{\mathbf{28000}})}$ = 2.922572252559134 km/s

The velocity at the apoapsis is **2.923 km/s**, which checks out! That is when it is the slowest in orbit

Question 5:

a) $\sqrt{(2\mu)/periapsis} = \sqrt{(2(3.986 * 10\text{^}5)/10000}$ = 8.928605714219886 km/s

The velocity at the periapsis is **8.9286 km/s**

b) Since e=1, we have a parabolic trajectory, so no apoapsis

Since e=1, our apoapsis is at **infinity** (since we are in a parabolic trajectory)

c) D

Again, the conic section of this orbit is a **parabola**