```
% Astrodynamics master code

% functions
orbitalPeriod = @(a,mu) 2*a^(3/2)*pi*mu^(-1/2); %finds orbital period from mu and
the semimajor axis a

orbitalVelocity = @(r,a,mu) sqrt((2*mu/r)-(mu/a)); % finds orbital period from the
position r the semi major axis a and mu

orbitalEnergy = @(a,mu) mu/(a*2); % finds orbital energy from mu and the semimajor
axis a]

mag = @(vector) sqrt(vector(1)^2 + vector(2)^2 + vector(3)^2)
```

```
mag = function_handle with value:
    @(vector)sqrt(vector(1)^2+vector(2)^2+vector(3)^2)
```

```
% constants for earth
duE = 6378.136; % conversion from du earth to km
tuE = 806.8118744; % converson from tu earth to seconds
muE = 3.986004418*10^5; % mu for earth

% constants for the sun
duS = 1.4959965*10^8; % conversion from du sun to km
au = duS; % a sun du is sometimes called a au
tuS = 5.0226757*10^6; % converson from tu sun to seconds
muS = 1.3271544*10^11; % mu for sun

r = [2 0.5 1];
v = [0.5 0.5 -0.5];

h = cross(r,v); % finds angular momentum from the position vector r and the
velocity vector v

n = cross([0 0 1],h);

e = (mag(v)^2-1/mag(r))*r - (dot(r,v))*v
```

```
e = 1×3
    0.2521   -0.2182    0.6886
```

```
mag(e)
```

```
ans = 0.7651
```

```
i = acosd(h(3)/mag(h))
```

```
i = 65.9052
```

```
if n(2) > 0
    bigOmega = acosd(n(1)/mag(n))
else
    bigOmega = 360 - acosd(n(1)/mag(n))
end
```

```
bigOmega = 206.5651
```

```
if e(3) > 0
    omega = acosd(dot(n,e)/(mag(n)*mag(e)))
else
    omega = 360 - acosd(dot(n,e)/(mag(n)*mag(e)))
end
```

```
omega = 99.6253
```

```
if dot(r,v) > 0
    nu = acosd(dot(e,r)/(mag(e)*mag(r)))
else
    nu = 360 - acosd(dot(e,r)/(mag(e)*mag(r)))
end
```

```
nu = 51.8139
```

```
if r(3) > 0
    u = acosd(dot(n,r)/(mag(n)*mag(r)))
else
    u = 360 - acosd(dot(n,r)/(mag(n)*mag(r)))
end
```

```
u = 151.4392
```

```

```

```
a = 6.3920;
e = 0.488;
i = 63.5;
bigOmega = 96.4;
omega = 246;
nu = 18;

p = a*(1-e^2)
```

```
p = 4.8698
```

```
rMagnitude = p/(1+e*cosd(nu))
```

```
rMagnitude = 3.3261
```

```
r(1) = rMagnitude*cosd(nu);
r(2) = rMagnitude*sind(nu);
r(3) = 0
```

```
r = 1×3
    3.1633    1.0278         0
```

```
v(1) = sqrt(1/p)*(-1*sind(nu));
v(2) = sqrt(1/p)*(e*cosd(nu));
v(3) = 0
```

```
v = 1×3
   -0.1400    0.2103         0
```

```
rTilda = [cosd(bigOmega)*cosd(omega)-sind(bigOmega)*sind(omega)*cosd(i)
-cosd(bigOmega)*sind(omega)-sind(bigOmega)*cosd(omega)*cosd(i)
sind(bigOmega)*sind(i);
          sind(bigOmega)*cosd(omega)+cosd(bigOmega)*sind(omega)*cosd(i)
-sind(bigOmega)*sind(omega)+cosd(bigOmega)*cosd(omega)*cosd(i)
-cosd(bigOmega)*sind(i);
          sind(omega)*sind(i) cosd(omega)*sind(i) cosd(i)]
```

```
rTilda = 3×3
    0.4504    0.0785    0.8894
   -0.3588    0.9281    0.0998
   -0.8176   -0.3640    0.4462
```

```
vijk = rTilda*v'
```

```
vijk = 3×1
   -0.0466
    0.2454
    0.0379
```

```
rijk = rTilda*r'
```

```
rijk = 3×1
    1.5055
   -0.1810
   -2.9603
```

```
L = 30;

theta = 304 + 7.292*10^(-5)*(34200) - 97.5
```

```
theta = 208.9939
```

```
rSEZ = [0 0 7015.95];
roh = 637.814;
Az = 30;
El = 90;
ElDot = 0.0123813;
```

```
rohDot = [0 0 0];
rohDot(1) = roh*sind(El)*ElDot*cosd(Az);
rohDot(2) = -roh*sind(El)*ElDot*sind(Az);
rohDot(3) = roh*cosd(El)*ElDot
```

```
rohDot = 1×3
    6.8390   -3.9485         0
```

```
dTilda = [sind(L)*cosd(theta) sind(L)*sin(theta) -cosd(L);
          -sind(theta) cosd(theta) 0;
          cosd(L)*cosd(theta) cosd(L)*sind(theta) sind(L)]
```

```
dTilda = 3×3
   -0.4373    0.4985   -0.8660
    0.4847   -0.8747         0
   -0.7575   -0.4198    0.5000
```

```
rijk = dTilda^(-1)*rSEZ'
```

```
rijk = 3×1
10^3 ×
   -6.4775
   -3.5896
    1.2049
```

```
rohDotijk = dTilda*rohDot'
```

```
rohDotijk = 3×1
   -4.9592
    6.7686
   -3.5230
```

```
vijk = rohDotijk + cross([0 0 7.292*10^(-5)]',rijk)
```

```
vijk = 3×1
   -4.6974
    6.2962
   -3.5230
```