John Clouse IMD HW 4 Problem 3

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Initialize

```
clearvars -except hw_pub function_list

CelestialConstants;

JD_launch = 2447807.5;
JD_Venus = 2447932.5;
JD_Earth1 = 2448235.5;
```

Planet positions and velocities, V_inf in and out

```
[r_earth_L,~] = MeeusEphemeris(Earth, JD_launch,Sun);
[r_venus, v_venus] = MeeusEphemeris(Venus,JD_Venus,Sun);
[r_earth_1,~] = MeeusEphemeris(Earth, JD_Earth1,Sun);

[~,v_in] = lambert(r_earth_L, r_venus,(JD_Venus-JD_launch)*day2sec,1,Sun);
[v_out,~] = lambert(r_venus, r_earth_1,(JD_Earth1-JD_Venus)*day2sec,-1,Sun);

v_inf_in = v_in - v_venus;
v_inf_out = v_out - v_venus;
```

Flyby params

```
psi = acos(dot(v_inf_in,v_inf_out)/norm(v_inf_in)/norm(v_inf_out));
rp = Earth.mu/(norm(v_inf_in)^2)*(1/cos((pi-psi)/2)-1);
hp = rp - Venus.R; %km
```

Energy

```
energy_pre_flyby = norm(v_in)^2/2 - Sun.mu/norm(r_venus);
energy_post_flyby = norm(v_out)^2/2 - Sun.mu/norm(r_venus);
percent_change = (energy_post_flyby - energy_pre_flyby)...
    /abs(energy_pre_flyby)*100;
```

Results

The v-infinities do not match exactly because the events aren't precisely targeted. True event JDs can be found to make them line up even better. The altitude of closes approach to Venus is shown below. The energy changed by 15%, making a trajectory with a higher aphelion.

```
fprintf('Closest approch altitude: %.3f km\n',hp);
fprintf('Heliocentric energy before: %.3f km^2/s^2\n',energy_pre_flyby);
fprintf('Heliocentric energy after: %.3f km^2/s^2\n',energy_post_flyby);
```

```
Closest approch altitude: 17105.222 km
Heliocentric energy before: -528.482 km^2/s^2
Heliocentric energy after: -448.317 km^2/s^2
```

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