AAE 532 – Orbit Mechanics
Problem Set 10
Due: 2459194.1875 (UT)

Problem 3: Recall Problem 2. We are still trying to get to Mars to save Mark Watney—yep, we are still using the 2015 movie to explore that challenges of getting to Mars! Following up on Problem 2, consider the fact that the trip requires a significant time interval and survival on the Mars surface while awaiting rescue, Watney is running out of food. This time try to speed up the trip to Mars. Still assume all the same conditions as in Problem 2, i.e., use the SAME space triangle. But reduce the trip time--

(a) Consider a transfer with a transfer angle of 120 degrees and a time of flight of 92 days. Given this space triangle, is the transfer elliptic or hyperbolic? A transfer of what type then emerges?

Repeat the steps in Prob 2 for this new time:

(b) Produce the transfer and include the following:
$type, a, p, e, \mathcal{E}, v_{dep}, v_{arr}, \theta^*_{dep}, \theta^*_{arr}, \gamma_{dep}, \gamma_{arr}$. As usual, supply all the appropriate justifications for these results. Include the r_p and r_a distances as determined. Does the difference in the true anomalies equal the transfer angle?

(c) Determine the maneuvers at departure $\left|\Delta\bar{v}_{dep}\right|, \alpha_{dep}$ and arrival $\left|\Delta\bar{v}_{arr}\right|, \alpha_{arr}$.
Transform the maneuvers to VNB coordinates.

(d) Plot the transfer using either GMAT or Matlab. (Recall that GMAT gives you a chance to check your results.) Include the orbit of Earth; then apply the maneuver. After the suitable transfer angle, apply the second maneuver. Include the Mars orbit as well.

(f) Now consider the Earth local field. [In the movie, a vehicle was launched from Earth to rendezvous with the Hermes rescue vehicle at Earth closest approach to receive additional supplies for the return trip to Mars.] The transfer computed in (b)-(c) requires a $\bar{v}_{\infty/\oplus}$ relative to Earth in the Earth local view. What is the magnitude of this $\bar{v}_{\infty/\oplus}$? Assume that the pass distance at the Earth is required to be at 1000 km altitude. What is the velocity magnitude at closest approach along the hyperbolic path?
Of course, a diagram of the local view is necessary. Should the rescue vehicle pass ahead or behind Earth to pick up the supplies?
Is it reasonable to attempt to rendezvous with the rescue vehicle moving at such a speed?

(g) In the Mars local field, what is the speed at periapsis if the Mars pass distance is 500 km altitude? Discuss: Is it likely that Watney could have reached this speed in his launch from the Mars surface?

Is it reasonable to try to reach Mars in 92 days?