

```

1 function p1
2 r1 = 1;
3 r2 = 5.2;
4
5 %% Part B
6 mu = 1.327e11; % Standard Gravitational Parameter of the Sun [km^3/s^2]
7 th = 150;
8
9 c = sqrt(r1^2 + r2^2 - 2*r1*r2*cosd(th));
10 s = (r1 + r2 + c)/2;
11 a_m = s/2;
12
13 % Calculate t_m
14 alpha_m = 2*asin(sqrt(s/(2*a_m)));
15 beta_m = 2*asin((sqrt((s-c)/(2*a_m))));
16 t_m = ((sqrt((au2km(s))^3/8))*(pi-beta_m + sin(beta_m)))/sqrt(mu);
17
18 % Calculate t_f
19 a=5; % Semi-major Axis [au]
20 alpha_o = 2*asin(sqrt(s/(2*a)));
21 beta_o = 2*asin((sqrt((s-c)/(2*a))));
22 t_f = (sqrt((au2km(a)^3)/mu)*(alpha_o-beta_o - sin(alpha_o) + sin(beta_o)));
23
24 % Calculate t_f^#
25 alpha_1 = 2*pi - alpha_o;
26 beta_1 = beta_o;
27 t_fup = (sqrt((au2km(a)^3)/mu)*(alpha_1-beta_1 - sin(alpha_1) + sin(beta_1)));
28
29 % Calculate t_p
30 t_p = (sqrt(2)/(3*sqrt(mu)))*(au2km(s)^(3/2) - sign(sind(th))*(au2km(s)-au2km(c))^(3/2));
31
32 %% Part C
33
34 gamma = asind((r2*sind(th))/c);
35 ui = [1;0];
36 uc = [-cosd(gamma); sind(gamma)];
37
38 A_o = sqrt(1/(4*a))*cot(alpha_o/2);
39 B_o = sqrt(1/(4*a))*cot(beta_o/2);
40 v1_o = (B_o+A_o)*uc + (B_o-A_o)*ui;
41
42 A_1 = sqrt(1/(4*a))*cot(alpha_1/2);
43 B_1 = sqrt(1/(4*a))*cot(beta_1/2);
44 v1_1 = (B_1+A_1)*uc + (B_1-A_1)*ui;
45
46
47 %% Part E
48 p = ((4*a*(s-r1)*(s-r2))/(c^2))*(sin((alpha_o+beta_o)/2))^2;
49 p_tild = ((4*a*(s-r1)*(s-r2))/(c^2))*(sin((alpha_1+beta_1)/2))^2;
50 e = sqrt(1-(p/a));
51 end

```

```

1 function p2
2     r1 = 1; %Earth [au]
3     a_mars = 1.5237; % Mars [au]
4     e_mars = 0.0934; f = 210; th = 120; % deg
5     r2 = (a_mars*(1-e_mars^2))/(1+e_mars*cosd(f));
6 %% Part A
7     c = sqrt(r1^2 + r2^2 - 2*r1*r2*cosd(th));
8     s = (r1 + r2 + c)/2;
9     a_m = s/2;
10    mu = 1.327e11; % Standard Gravitational Parameter of the Sun [km^3/s^2]
11    % Calculate t_m
12    beta_m = 2*asin((sqrt((s-c)/(2*a_m))));
13    t_m = ((sqrt((au2km(s)^3)/8))*(pi-beta_m + sin(beta_m)))/sqrt(mu);
14 %% Part B
15    p = ((4*a_m*(s-r1)*(s-r2))/(c^2))*(sin((pi+beta_m)/2))^2;
16    e = sqrt(1-(p/a_m));
17 %% Part C
18    T_mars = 2*pi*sqrt((au2km(a_mars)^3)/mu); % Mars Orbital Period [s]
19    syms E2 M tx f1
20    f2 = 210;
21    E2 = vpa(solve(tand(f2/2) == sqrt((1+e_mars)/(1-e_mars))*tan(E2/2),E2));
22    M2 = solve(M == E2 - e_mars*(sin(E2)),M);
23    %Time of mars at departure past perigee
24    tx = solve(M2 == sqrt(mu/au2km(a_mars)^3)*(t_m+tx),tx);
25    M1 = sqrt(mu/au2km(a_mars)^3)*tx;
26    [iterations, values] = KeplersEqnNewtonMethod(M1,e_mars,M1,10^-14);
27    E1 = values(end);
28    f1 = rad2deg(double(vpa(solve(tan(f1/2) == sqrt((1+e_mars)/(1-e_mars))*tan(E1/2),f1)
29    )));
30    b_mars = a_mars*sqrt(1-e^2);
31    ra = [a_mars*cos(E1)-e_mars; b_mars*sin(E1);0];
32    %OR
33    %Define a new elapsed time past epoch.
34    t_apogee = T_mars/2; %Time at apogee
35    t_o = t_apogee-(T_mars + tx);
36    a = au2km(a_mars);
37    r_o = [a*(1+e_mars); 0; 0];
38    v_o = [0; sqrt(mu*((2/norm(r_o))-(1/a))); 0];
39    H_o = mu/norm(r_o)^3;
40    P_o = 0;
41    rb = km2au(r_o*(1-(t_o^2/2)*H_o) + v_o*(t_o - (t_o^3/6)*H_o));
42 %% Part D
43    gamma = asind((r2*sind(th))/c);
44    ui = [0;1];
45    uc = [-cosd(gamma); -sind(gamma)]
46    A = sqrt(1/(4*a_m))*cot(pi/2);
47    B = sqrt(1/(4*a_m))*cot(beta_m/2);
48    v1 = (B+A)*uc + (B-A)*ui;
49 %% Part E
50    deltaV1 = v1 - [-1;0];
end

```

```

1
2 function p3
3 r1 = 9.538; % Saturn [au]
4 r2 = 1.523; % Mars [au]
5 th = 90; % deg
6
7 %% Part A
8 c = sqrt(r1^2 + r2^2 - 2*r1*r2*cosd(th));
9 s = (r1 + r2 + c)/2;
10 a_m = s/2;
11 mu = 1; % Standard Gravitational Parameter of the Sun [AU^3/TU^2]
12
13 %% Part B: Calculate t_m
14 alpha_m = 2*asin(sqrt(s/(2*a_m)));
15 beta_m = 2*asin((sqrt((s-c)/(2*a_m))));
16 t_m = ((sqrt((s)^3/8))*(pi-beta_m + sin(beta_m)))/sqrt(mu);
17
18 %% Part C: Calculate t_p
19 t_p = (sqrt(2)/(3*sqrt(mu)))*(s^(3/2) - sign(sind(th))*(s-c)^(3/2));
20
21 %% Part D
22 tf = 67.12; % TU
23 a=fzero(@lambert,10);
24
25 %% Part F
26 alpha = 2*pi - real(2*asin(sqrt(s/(2*a))));
27 beta = 2*asin((sqrt((s-c)/(2*a))));
28 p = ((4*a*(s-r1)*(s-r2))/(c^2))*(sin((alpha+beta)/2))^2;
29 e = sqrt(1-(p/a));
30
31 %% Part G
32 gamma = asind((r2*sind(th))/c);
33 ui = [1;0];
34 uc = [-cosd(gamma); sind(gamma)];
35 A = sqrt(1/(4*a))*cot(alpha/2);
36 B = sqrt(1/(4*a))*cot(beta/2);
37 v1 = (B+A)*uc + (B-A)*ui;
38 aH = (r1+r2)/2;
39 deltaV1 = sqrt(mu*((2/r1)-(1/aH))) - sqrt(mu/r1);
40 end
41
42 function f = lambert(a)
43 r1 = 9.538; % Saturn [au]
44 r2 = 1.523; % Mars [au]
45 th = 90; % deg
46 c = 9.658828759223345;
47 s = 10.359914379611673;
48 alpha = 2*pi + real(2*asin(sqrt(s/(2*a))));
49 beta = 2*asin((sqrt((s-c)/(2*a))));
50 tf = 10.69;
51 f = tf - (a^(3/2)/(2*pi))*(alpha-beta-sin(alpha)+sin(beta));
52 end

```

```

1 function p4
2 r1 = 1; %Earth [au]
3 r2 = 1.524; % Mars [au]
4 a = 1.36; % [au]
5 a_m = 1.14; % [au]
6 th1 = 107; % deg
7 th2 = 253; % deg
8 mu = 1;
9 %% Part A
10
11 c1 = sqrt(r1^2 + r2^2 - 2*r1*r2*cosd(th1));
12 s1 = (r1 + r2 + c1)/2;
13
14 c2 = sqrt(r1^2 + r2^2 - 2*r1*r2*cosd(th2));
15 s2 = (r1 + r2 + c2)/2;
16
17 c = c1;
18 s = s1;
19 mu = 1.327e11; % Standard Gravitational Parameter of the Sun [km^3/s^2]
20 %mu = 1; % Standard Gravitational Parameter of the Sun [AU^3/TU^2]
21
22 % Calculate t_m
23 beta_m = 2*asin((sqrt((s-c)/(2*a_m))));
24 t_m = ((sqrt((au2km(s))^3/8))*(pi-beta_m + sin(beta_m)))/sqrt(mu);
25 fprintf('t_m : %f days\n', t_m/(60*60*24));
26
27 % Calculate t_f
28 alpha_o = 2*asin(sqrt(s/(2*a)))
29 beta_o = 2*asin((sqrt((s-c)/(2*a))));
30 t_f = ((sqrt((au2km(s))^3/8))*(alpha_o-beta_o - sin(alpha_o) + sin(beta_o)))/sqrt(mu);
31 fprintf('t_f : %f days\n', t_f/(60*60*24));
32
33 % Calculate t_f^#
34 alpha_1 = 2*pi - alpha_o;
35 beta_1 = beta_o;
36 t_fup = ((sqrt((au2km(s))^3/8))*(alpha_1-beta_1 - sin(alpha_1) + sin(beta_1)))/sqrt(mu);
37 fprintf('t_f^# : %f days\n', t_fup/(60*60*24));
38
39 end

```