

## Ch\_6\_Lesson\_10\_Ex\_1

clear

```

G=6.7e-11;           % gravitational constant
mEarth = 5.9742e24;  % mass of the earth
rEarth = 6.378e6;    % radius of the earth

rMoon = 1.737e6;     % radius of moon
mMoon = 7.35e22;     % mass of moon

Rmoon = 385000000 + rEarth + rMoon; % earth moon distance center to center

per = 27.5;          % moon's period in days

% back up moon L days

L = 2.14;           % hit at 2.14
Ltheta = pi/2 - (L/per)*2*pi; % L/per = theta/2*pi radians

% initial parameters for moon orbit
t(1) = 0;
x(1) = Rmoon*cos(Ltheta); % initial x position
y(1) = Rmoon*sin(Ltheta); % initial y position
vx(1) = -1023*sin(Ltheta); % initial x velocity
vy(1) = 1023*cos(Ltheta); % initial y velocity

% initial parameters for rocket
xR(1) = 0;           % initial x position
yR(1) = rEarth;     % initial y position at alt. 300km
vxR(1) = 0;         % initial x velocity
vyR(1) = 11200;    % initial y velocity

dt=1;

n=184000/dt          % enough time to reach moon's orbit

for i=2:n
    t(i) = t(i-1) + dt;
    x(i) = x(i-1) + vx(i-1)*dt; % project moon position to start of subinterval i
    y(i) = y(i-1) + vy(i-1)*dt;

    Rm = sqrt(x(i-1)^2+y(i-1)^2); % calculate moon's accel due to earth gravity
    AgME = G*mEarth/Rm^2;         % interval i-1

    vx(i)= vx(i-1) - AgME*(x(i-1))/Rm*dt; % project moon's velocity
    vy(i)= vy(i-1) - AgME*(y(i-1))/Rm*dt;

    xR(i) = xR(i-1) + vxR(i-1)*dt; % project rocket's position to
    yR(i) = yR(i-1) + vyR(i-1)*dt; % start of interval i

    Rr = sqrt(xR(i-1)^2+yR(i-1)^2); % calculate rocket's accel due to
    AgRE = G*mEarth/Rr^2;         % earth gravity at start of interval i-1

    Rm = sqrt((xR(i-1)-x(i-1))^2+(yR(i-1)-y(i-1))^2); % calculate rocket accel
    AgRM = G*mMoon/Rm^2;         % due to moon at start of interval i-1

    % update rocket velocity due to accel due to earth and moon
    vxR(i)= vxR(i-1) - AgRE*xR(i-1)/Rr*dt - AgRM*(xR(i-1) - x(i-1))/Rm*dt;
    vyR(i)= vyR(i-1) - AgRE*yR(i-1)/Rr*dt - AgRM*(yR(i-1) - y(i-1))/Rm*dt;

```

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```
    if (Rm < rMoon) break end;

end

II=[i-8000:i]; % show last 8000 seconds of flight

plot(x(II),y(II)) % plot moon's trajectory
hold on
plot(xR(II),yR(II)) % plot rocket's trajectory
% here we draw a circle for the moon
for j=1:101
    ang=2*pi*j/100;
    xE(j)= rMoon*cos(ang);
    yE(j)= rMoon*sin(ang);
end
plot(xE + x(i),yE + y(i)) % draw the moon at its last position
hold off
```