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% this is the same program as Ch_6_Lesson_11_Ex_1 with a few parameter changes
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 = 2.094;                 %  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 x 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 x velocity

dt=1;

n=186000/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;   % stop when rocket hits moon

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

axis equal
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