REPORT

Homework IV

Attitude Determination and Control

UZB421E - 21265

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n = 48

Earth's Magnetic Field Vector through the Orbit of the Satellite Using Dipole Model

I will explain the required information in the code.

```
n=48; % Student Number
N=540000; % Iteration Number
dt=0.1; % (s) The sample time
t(1)=0; % (s) Initial time
Me=7.943*(10^15); % (Wb*m) The magnetic dipole moment of the Earth
mu=3.98601*(10^14); % (m^3/s^2) The Earth gravitational constant
i=(80+0.5*n)*(pi/180); % (rad) The Orbit inclination (Multiply by
(pi / 180) to convert it to radians)
We=7.29*(10^-5); % (rad/s) The Spin Rate of the Earth
E=(11.7)*(pi/180); % (rad) The Magnetic Dipole Tilt
Ro=(6378.14+500+2*n)*1000; % (m) The distance between the center of
mass of the satellite and the Earth.
Wo=sqrt(mu/Ro^3); % (rad/s) The angular velocity of the orbit with
respect to the inertial frame
```

```
 for x=1:N % for loop to perform iteration

   % Time increases per iteration
   t(x+1)=t(x)+dt;


   % Earth's Magnetic Field Vector Components
   Hx(x)=(Me/Ro^3)*(cos(Wo*t(x))*(cos(E)*sin(i)-sin(E)*cos(i)*
   cos(We*t(x)))-sin(Wo*t(x))*sin(E)*sin(We*t(x)));
```

$$H_1(t)=\frac{M_e}{r_0^3}\left\{\cos(\omega_0 t)\left[\cos(\varepsilon)\sin(i)-\sin(\varepsilon)\cos(i)\cos(\omega_e t)\right]-\sin(\omega_0 t)\sin(\varepsilon)\sin(\omega_e t)\right\}$$

```
   Hy(x)=(-Me/Ro^3)*(cos(E)*cos(i)+sin(E)*sin(i)*cos(We*t(x)));
```

$$H_2(t)=-\frac{M_e}{r_0^3}\left[\cos(\varepsilon)\cos(i)+\sin(\varepsilon)\sin(i)\cos(\omega_e t)\right],$$

```
   Hz(x)=2*(Me/Ro^3)*(sin(Wo*t(x))*(cos(E)*sin(i)-sin(E)*cos(i)*
   cos(We*t(x)))-2*sin(Wo*t(x))*sin(E)*sin(We*t(x)));
```

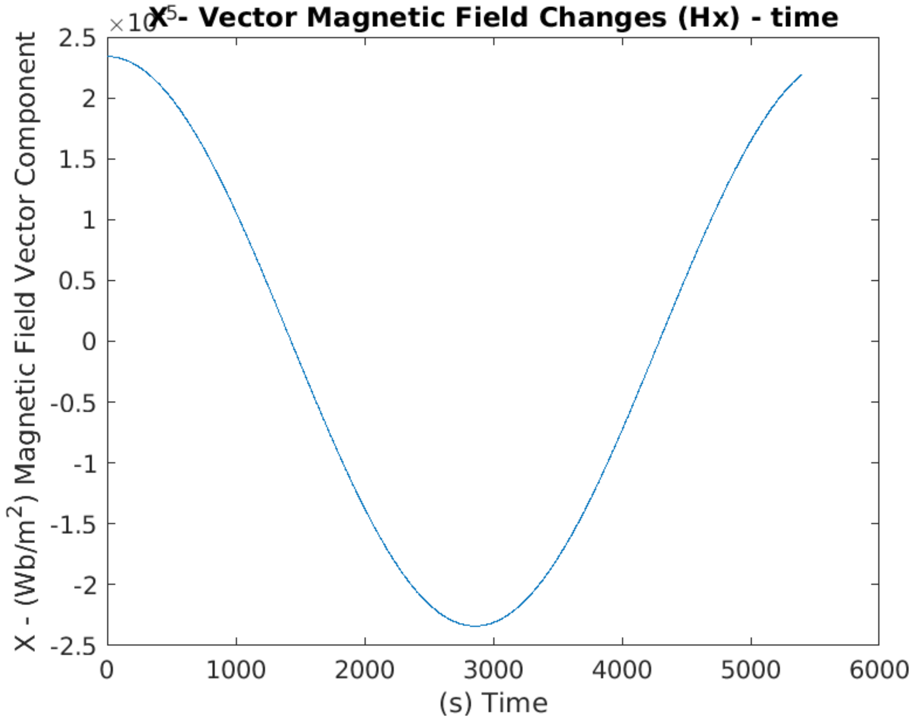
$$H_3(t)=\frac{2M_e}{r_0^3}\left\{\sin(\omega_0 t)\left[\cos(\varepsilon)\sin(i)-\sin(\varepsilon)\cos(i)\cos(\omega_e t)\right]-2\sin(\omega_0 t)\sin(\varepsilon)\sin(\omega_e t)\right\}$$

```matlab
    % Direction cosine elements of the magnetic field vector
    Hx0(x)=(1/sqrt(Hx(x)^2+Hy(x)^2+Hz(x)^2))*Hx(x);
    Hy0(x)=(1/sqrt(Hx(x)^2+Hy(x)^2+Hz(x)^2))*Hy(x);
    Hz0(x)=(1/sqrt(Hx(x)^2+Hy(x)^2+Hz(x)^2))*Hz(x);
```

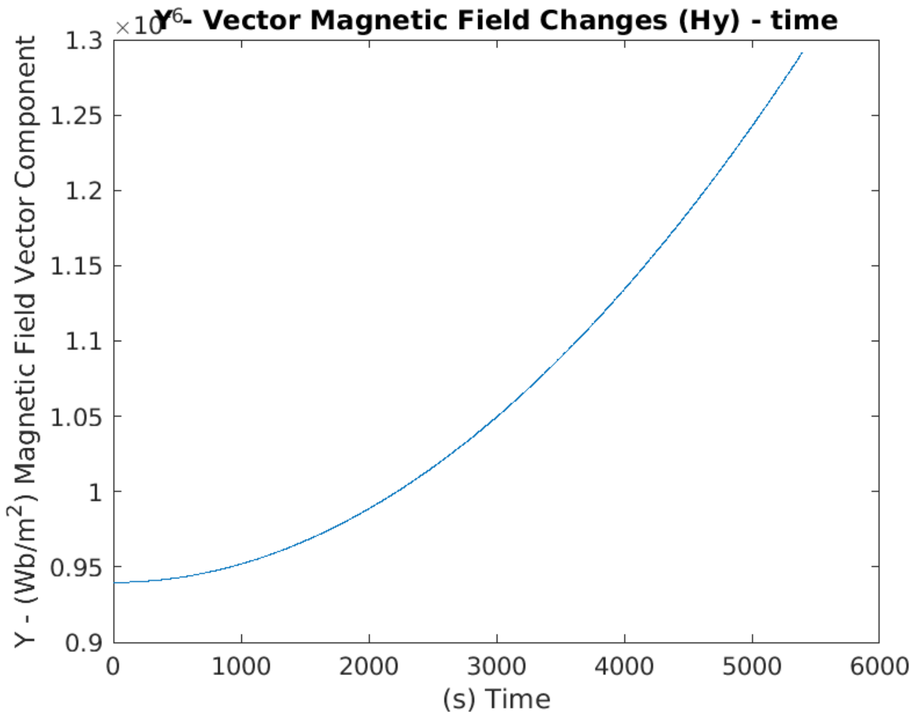
$$H_0 = \begin{bmatrix} H_{x0} \\ H_{y0} \\ H_{z0} \end{bmatrix} = \frac{1}{\sqrt{H_x^2 + H_y^2 + H_z^2}} \begin{bmatrix} H_x \\ H_y \\ H_z \end{bmatrix}$$

```matlab
end

% Earth's magnetic field vector components graphs
figure
plot(t(1:54000),Hx);
title('X - Vector Magnetic Field Changes (Hx) - time');
xlabel(' (s) Time ');
ylabel('X - (Wb/m^2) Magnetic Field Vector Component');
figure
plot(t(1:54000),Hy);
title('Y - Vector Magnetic Field Changes (Hy) - time');
xlabel(' (s) Time ');
ylabel('Y - (Wb/m^2) Magnetic Field Vector Component');
figure
plot(t(1:54000),Hz);
title('Z - Vector Magnetic Field Changes (Hz) - time');
xlabel(' (s) Time ');
ylabel('Z - (Wb/m^2) Magnetic Field Vector Component ');

% Direction cosine elements of the magnetic field vector graphs
figure
plot(t(1:54000),Hx0);
title('X - Axis Cosine Element Direction Changes (Hx0) - time');
xlabel(' (s) Time ');
ylabel('X - Cosine Element Direction');
figure
plot(t(1:54000),Hy0);
title('Y - Axis Cosine Element Direction Changes (Hy0) - time');
xlabel(' (s) Time ');
ylabel('Y - Cosine Element Direction');
figure
plot(t(1:54000),Hz0);
title('Z - Axis Cosine Element Direction Changes (Hz0) - time');
xlabel(' (s) Time ');
ylabel('Z - Cosine Element Direction');
```

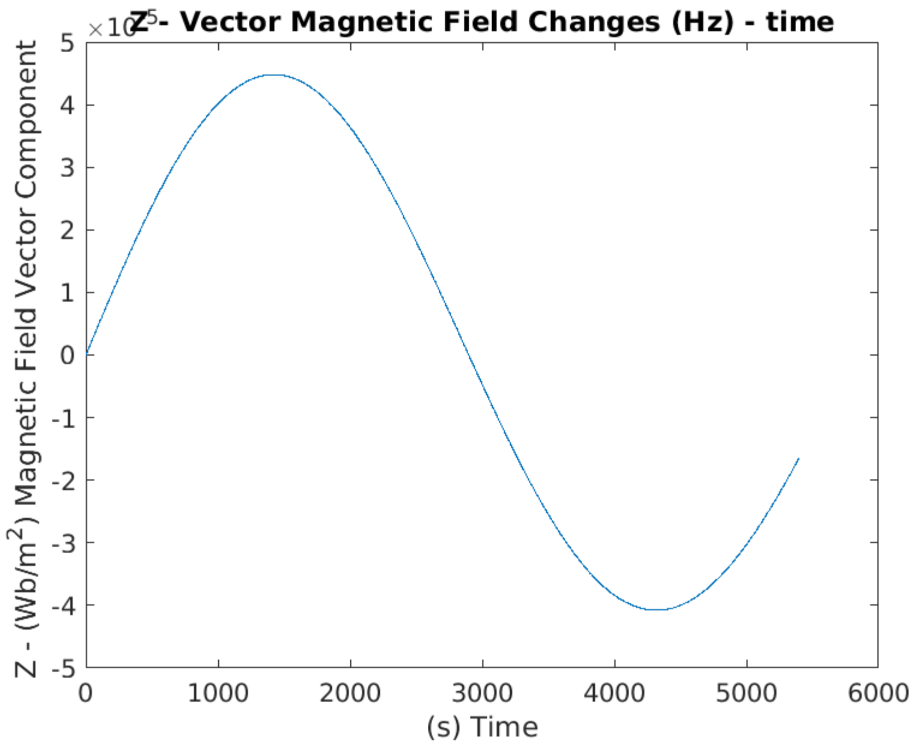
Graphs



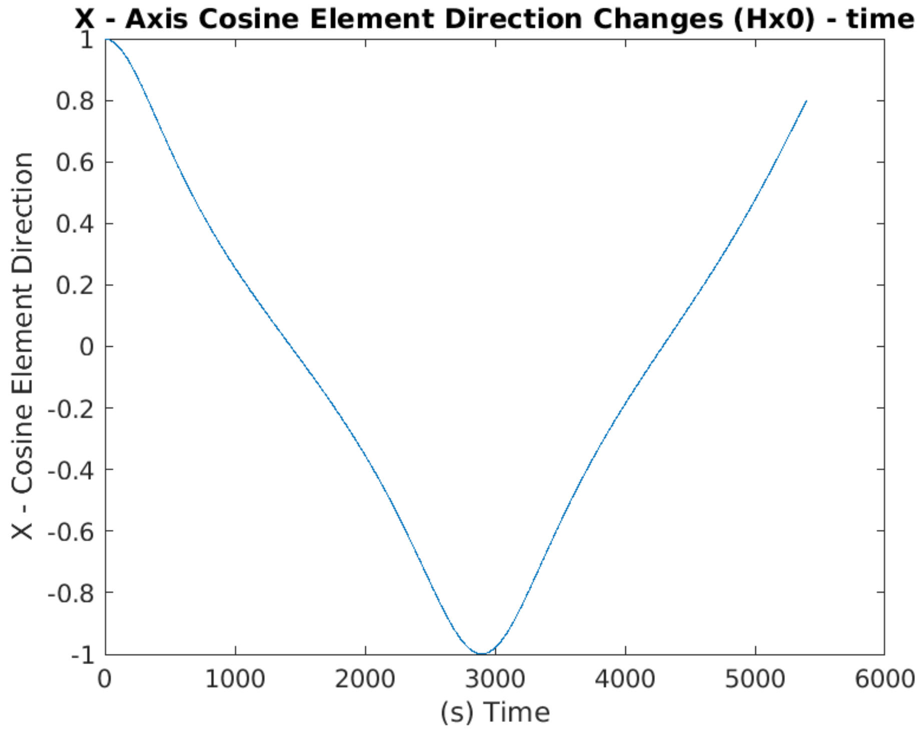
X - Vector Magnetic Field Changes (Hx) - time
×10^5
X - (Wb/m^2) Magnetic Field Vector Component
(s) Time



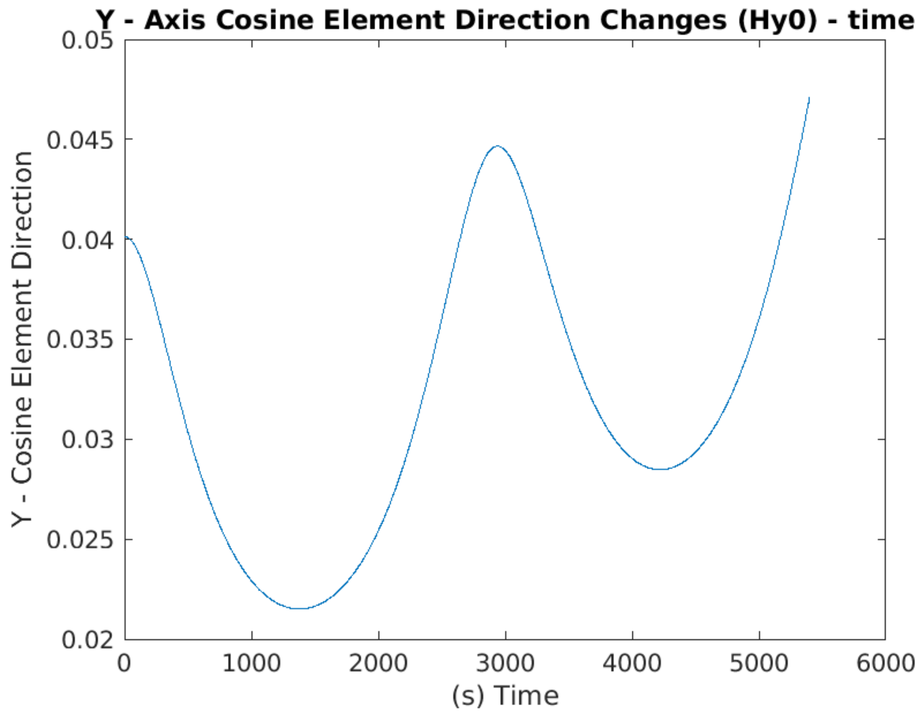
Y - Vector Magnetic Field Changes (Hy) - time
×10^6
Y - (Wb/m^2) Magnetic Field Vector Component
(s) Time

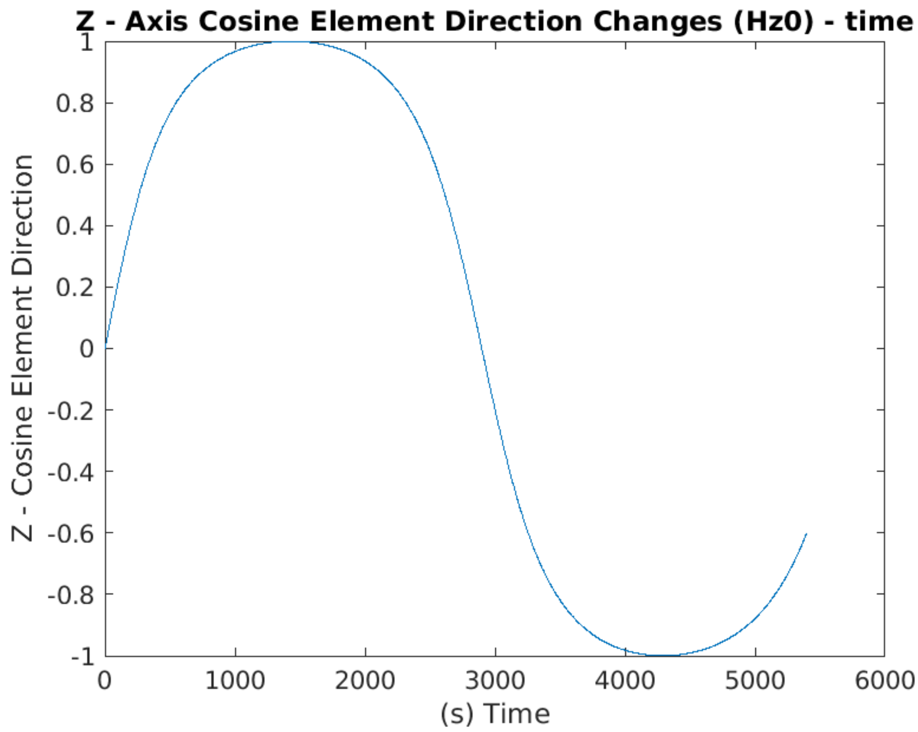


Z - Vector Magnetic Field Changes (Hz) - time
×10⁻⁵
Z - (Wb/m²) Magnetic Field Vector Component
5
4
3
2
1
0
-1
-2
-3
-4
-5
0
1000
2000
3000
4000
5000
6000
(s) Time



X - Axis Cosine Element Direction Changes (Hx0) - time
X - Cosine Element Direction
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
1000
2000
3000
4000
5000
6000
(s) Time


Y - Axis Cosine Element Direction Changes (Hy0) - time
Y - Cosine Element Direction
0.05
0.045
0.04
0.035
0.03
0.025
0.02
0
1000
2000
3000
4000
5000
6000
(s) Time


Z - Axis Cosine Element Direction Changes (Hz0) - time
Z - Cosine Element Direction
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
1000
2000
3000
4000
5000
6000
(s) Time