HACETTEPE UNIVERSITY

GEOMATICS ENGINEERING

GMT 312 – GLOBAL NAVIGATION SATELLITE SYSTEMS

HOMEWORK – 4

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DESCRIBING INPUT VALUES:

Epoch: My summation of students number is 28 and 28*720=20160 that means 5 hours and 36 min but in this epoch ANKR station not detect 5 satellite so I added it to 720 and my new epoch is 20880 which is means 5 hours and 48 minutes.

5 hours 36 minutes epoch. There is only G05,G07,G09,G30's pseudoranges in here.

```
> 2020 04 01 05 36  0.0000000  0 23
G04
G05  21751987.549   114307463.25207
G07  21062096.616   110682061.63207
G09  22149521.650   116396521.26916
G30  20596708.841   108236436.58107
R02  22744310.467   121367973.53506
R03  19397438.638   103836001.89707
```

So I used G05,G07,G09,G28 and G30 satellites for this homework.

```
> 2020 04 01 05 48  0.0000000  0 24
G05  21668962.829   113871165.07007
G07  21223566.242   111530589.15607
G09  22495445.424
G28  21565550.382   113327733.28406
G30  20531203.306   107892202.40707
```

Lagrange Epochs: My epoch is 5.48 so my previous observation in 5.45 and next observation in 6.00 and my epoch range is 4.45-7.00 for 9th lagrange interpolation. In unit of second value matrix below here that I used this matrix in lagrange code. I can use variables like (epoch*900)+900+900… but I used it for better explanation in next steps.

```
lagrangeEpoch=[17100 18000 18900 19800 20700 21600 22500 23400 24300 25200];
```

5x2 Matrix (GPS Numbers and C/A Pseudoranges for each satellite):

```
%gps number and pseudo range
NumC1=[5 21668962.829;
       7 21223566.242;
       9 22495445.424;
       28 21565550.382;
       30 20531203.306];
```

Getting Data from .mat File:

```
format long g
Mat=load('igs20993.mat')
deneme(:,:,:)=Mat.sat.gps(:,:,:);
```

I used it like that below here first element of the deneme i is my epoch which is in 20-29th row range that Show 4.45-7.00 epochs, xyz or 4 thats the column of the matrix like X,Y,Z or clock error and NumC1(J,1) got the values from 5x2 matrixes first column like 5,7,9 for the layer. Each satellite has their unique layer.

```
+deneme(i,xyz,NumC1(j,1))*
```

EXPLANATION OF FOR LOOPS:

Import Information: My code calculate the solution for all satellite in one run so if there is XYZ variables in here for a satellite like 1x3, there is a matrix for 5 satellite so variable matrixes like 5x3 or like that.

This for loop run from 1 to 5 for satellite numbers. Uydusayisi come from rows of the NumC1 Matrix.

```
for j=1:uydusayisi %
```

This loop geting previous and next 5 epoch for the lagrange. So I started from 20 and end in 29.

```
for i=epoch-4:epoch+5 %
```

In lagrange I must use lagrangeEpoch Matrix [17100 18000 …] and this is 1x10 matrix so lagrangeEpoch can't start from 20. I use (i-19) to fix it and now it starts from 1 and end to 10 instead of 20 to 29 for getting lagrangeEpoch values correctly.

```
A=A*((t1-lagrangeEpoch(1,k-19))/(lagrangeEpoch(1,i-19)-lagrangeEpoch(1,k-19)));
```

WORKFLOW OF THE CODE:

Clock error lagrange and emition time:

The time I used for the clock error lagrange is [t (my epoch from student number) - pseudorange/c]

```
t1=t-(NumC1(j,2)/c);
```

Clock Error Results for the each satellite:

-1.00992998434105e-05	-0.00024861873035431	-0.000188617927567905	0.000728717262723032	-0.000188405902167416

Emission Time Results for the each satellite (t1-clock error) – (unit of second):

20879.9277302195	20879.929454422	20879.9251518889	20879.9273363497	20879.9317036834

Calculating Satellite Position XYZ's (unit of meter): I used lagrange and rotation formulas again and did everyting same from previous homework. Results below here and in unit of meter.

X	Y	Z
20231717.2753674	-4769308.91479142	16511263.8620754
7241243.0008105	13836996.1960205	21745336.9801287
7626500.84286329	24746620.2373454	5817804.29412984
22960524.0849605	13181105.7515202	1103775.4018578
17023871.0973711	5656458.05434593	19680845.6639361

Converting Global Cartesian to Elipsoidal System:

My first initial fii value's h=0. Without h my fii formula below here.

```
fiapprox=atand(ANKR(3)/p*((1-ekare))^-1); %h=0 iken
```

With h.

```
fii=atand(ANKR(3)/p*((1-ekare*(N/(N+h)))^-1));
```

Calculation will be continue until the condition not >10^-12 so it will be done when fii-fiiapp<10^-12:

```
if abs(fii-fiapprox)>10^-12
```

Results: Fii , Lambda and h values of the ANKR station.

Fii	lambda	h
39.8875116916142	33.0962381550206	974.76629152894

Calculating Zenith and Azimuth:

I used formula below here to calculate Xe,Ye,Ze.

$$A = \begin{pmatrix} -\sin\varphi\cos\lambda & -\sin\lambda & \cos\varphi\cos\lambda \\ -\sin\varphi\sin\lambda & \cos\lambda & \cos\varphi\sin\lambda \\ \cos\varphi & 0 & \sin\varphi \end{pmatrix}$$

$$A^T \Delta X$$

Results:

Azimuths for the 5 satellites:

```
-76.9104706223235
 43.886711706906
 116.509044980171
-174.791369102091
-48.5754726367323
```

S (Distance between satellite and receiver):

```
21665936.707767
21149033.919014
22438895.6303452
21784014.8138755
20474721.8983061
```

Zeniths for the 5 satellites:

```
45.3544206620535
31.5291301529927
55.7415344611132
47.8468214761369
17.1545344318165
```