HACETTEPE UNIVERSITY

GEOMATICS ENGINEERING

GMT 312 – GLOBAL NAVIGATION AND SATELLITE SYSTEMS

PROJECT

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Step – 1 Calculating my epoch and getting input values:

Epoch from student number: 2+1+6+3+2+7+3+4=28 and 28*660=18480 that means 5 hours and 8 minute.

In this epoch There is 9 GPS satellite in here. I got this data from .rnx file. The satellites are G02-G04-G05-G07-G08-G09-G27-G28-G30

```
> 2020 04 01 05 08  0.0000000  0 25
G02  25231555.823
G04  23922754.021   125714898.64207
G05  22451786.599   117984938.28807
G07  20889500.770   109775070.38608
G08  24359879.080   128012027.28106
G09  21351722.419   112204052.45508
G27  24932824.640   131022877.14016
G28  22653202.271   119043377.06307
G30  20951453.885   110100628.73108
R12  22935223.989   122515840.82307
E02  26364242.870   138545022.91847
```

In my homework I made an 3D Matrix and each layer represent a one satellite. I use my all broadcast values from here and I got those datas from 'brdc0920.20n'

```
Matrix(:,:,1)=[          Matrix(:,:,2)=          Matrix(:,:,3)=
```

For the pseudoranges I make a 1D new matrix and each column represent a one satellite's C/A code. I got those values from 'MERS00TUR_R_20200920000_01D_30S_MO.rnx'.

Workflow:

Step – 2 Getting satellite's coordinates from broadcast ephemeris values:

I identfy elements of data matricies and with for loop calculate the satellite coordinates for the each satellites with emission time epoch. After that I include earth rotation rate to this coordinates and find the final satellite coordinates. (unit of meter)

X	Y	Z
22107531.4391518	-14615147.179383	1654751.96473779
-110551.964201407	26376679.0130249	3000312.89845786
15267103.0778424	-7625701.14851773	20265684.522862
12734692.0096245	10479862.2489481	21198327.4298369
-6712721.21319645	24118326.446445	8497313.33160232
8175674.18802981	21856811.1242014	12618192.6759245
-12197733.1043852	16143116.2646536	16891811.8725527
22451388.0614499	12114094.5470372	-6530685.1079283
21479881.9881033	2559171.5571406	15579310.924969

Step - 3 Calculating lat lon h values for the MERS station:

With the previous homework's formulas I calculated it. Results are below here. (unit of degree)

Latitude	Longtitude
36.5663855333258	34.2558628374097

Step - 4 Calculating zenith and azimuth:

Zenith Values for each satellite (unit of degree):

```
Columns 1 through 5

    83.8625846912416     72.2967274772153     56.5003182991529     20.8639519959001     77.8161734432321

Columns 6 through 9

    39.4002015779332      83.314921723092     63.7394529723072     28.7048700118089
```

Azimuth Values for each satellite (unit of degree):

```
Columns 1 through 5

   -100.703415289875     106.221021077394    -52.7277682343601     11.6242666071019     85.0285973739621

Columns 6 through 9

    95.0948345646251     54.9432440758119    -172.647257613971    -83.7179886032619
```

Step - 5 Calculating Ionosphere effect:

Firstly I calculate the tgps with cal2gpstime.m function and then with the unit of radian lat,lon,zenith,azimuth and alpha beta I calculated the Ionosphere effect with cal_klob.m function.

Alpha and beta values gathered from brdc0920.20n file's header.

```
alpha=[0.1118D-07  0.7451D-08 -0.5960D-07 -0.5960D-07 ];
beta=[0.9011D+05  0.1638D+05 -0.1966D+06 -0.6554D+05];
```

Ionosphere effect values (unit of meter):

```
Columns 1 through 5

    1.50672089307735     1.56541470165287     1.75893744263038     3.23029943453219     1.52989423988238

Columns 6 through 9

    2.20198669044199     1.50817405740572     1.65123127547274     2.69811520605192
```

Step - 6 Adjusting MERS Station's Coordinates:

I made and iteration and it won't stop the condition until gonna be real.

The Condition:

```
if sqrt((unknown(1,1)^2+unknown(2,1)^2+unknown(3,1)^2))<0.001
```

Unknown is the x parameter from x=(AtA)^-1(AtL) least square formula. Its a 4x1 matrix that shows

[dx dy dz cdt]. In A matrix each row represent a satellite. L is Rj (calculated range) – ro0 – Dj (clock error effect + ionosphere effect +TGD effect. I multply TGD with c because TGD's unit if second and I made it (meter/second). Now in Dj element all the elements in meter unit.

If the condition not true it will update the previous values with previous+unknown values.

The latest [dx dy dz cdt] values are:

```
-0.000282635201812315
-0.000429644389831278
-0.000268399551166982
     -36427.7605023956
```

Those are coordinate changes which is means adjustment values. I added them to our initial MERS coordinates and found the final MERS coordinates.

```
Xfinal =

          4239146.64111737


Yfinal =

          2886967.12407036


Zfinal =

           3778874.4797316
```

Now I calculate the distance between my XYZ and XYZ in the pdf.

XYZ in the pdf:

$$X = 4239149.23905405\text{m},\ Y = 2886968.03012480\text{m},\ Z = 3778877.17820202\text{m}$$

The Result (unit of meter):

```
3.85382307355328
```

Also unknow's 4th column means cdt so I divide it to c and find the receiver clock error:

```
-0.000121509929720766
```

Without TDG and Ionosphere effect:

Unknown matrix [dx dy dz cdt]:

```
 -0.000282635548942543
 -0.000429644195051262
  -0.00026839522112198
     -36425.5118718322
```

MERS Final XYZ:

```
Xfinal =

          4239146.64111736


Yfinal =

          2886967.12407036


Zfinal =

           3778874.4797316
```

Calculating distance between MERS Final xyz and referance xyz (unit of meter):

3.85382307092052

Receiver clock error:

-0.000121502429096573