

Homework AE4E08, lecture 4

1.

See the observation file in Appendix A and the GPS calendar from Appendix B.

GPS time is defined by the week number (GPS week) and seconds in GPS week (TOW; GPS week starts at Sunday 0 AM). Give the GPS time for the first observation.

2.

See the observation file in Appendix A.

For the second observation epoch: how many satellites are observed?

3.

For the same observation epoch of question 2, what is the C/A code pseudorange observation of satellite 23?

4.

See the navigation file in Appendix C (for a description see Appendix D)

The satellite clock correction can be calculated with:

$$\delta t^s = t^s - t = a_{f0} + a_{f1}(t - t_{0c}) + a_{f2}(t - t_{0c})^2$$

Find the clock correction parameters ($t_{0c}, a_{f0}, a_{f1}, a_{f2}$) for satellite 18 in the navigation file, and calculate the corresponding clock correction at the time t (TOW) from question 1.

t_{0c} must be given in seconds in GPS week, hence you need to calculate this from the date and time in the navigation file.

5.

See the navigation file in Appendix C (for a description see Appendix D)

Give the square root of the semi-major axis of satellite 3.

6.

The third law of Kepler gives $n = \frac{2\pi}{T} = \sqrt{\frac{\mu}{a^3}}$,

with

n the mean angular velocity of the satellite

T the orbital period of the satellite

a the semi-major axis

$\mu = 398,600,500 \times 10^6 \text{ m}^3/\text{s}^2$ the gravitational constant

Calculate T for satellite 3 (use the result from question 5).

Appendix A
 ObservationFile delf093j.03o

OBSERVATION DATA										G (GPS)		RINEX VERSION / TYPE					
teqc 2002Mar14										20030404		12:37:22UTC					
MSWin2000 IAx86-PII bcc32 5.0 MSWin95/98/NT/2000 486/DX+										COMMENT							
BIT 2 OF LLI FLAGS DATA COLLECTED UNDER A/S CONDITION										COMMENT							
DELFT-16										MARKER NAME							
13502M004										MARKER NUMBER							
96517										TRIMBLE 4700		N1.30/S0.00		REC # / TYPE / VERS			
93258										TRM29659.00		UNAV		ANT # / TYPE			
3924687.7080		301132.7690		5001910.7700		APPROX POSITION XYZ											
0.0000		0.0000		0.0000		ANTENNA: DELTA H/E/N											
1 1		7 L1 L2		C1 P2		P1 S1		S2		WAVELENGTH FACT L1/2							
1.0000		# / TYPES OF OBSERV															
INTERVAL										COMMENT							
-----										2003 4 3 9 0		0.0000000		GPS		TIME OF FIRST OBS	
										END OF HEADER							
03 4 3 9 6 24.0000000 0 12G17G 3G10G15G25G30G23G18G16G 2G 6G13																	
-25597757.49449		-19931828.14948		20900025.6054		20900022.2874											
51.6004		45.5004															
-11349360.06849		-8831627.62947		23397360.9084		23397358.4504											
39.4004		28.3004															
-4644046.25149		-3606885.52146		24496123.4234		24496122.3464											
41.6004		21.8004															
-23293218.09349		-18128825.62148		21279318.1814		21279314.9054											
52.1004		41.9004															
-8146383.44849		-6340726.52347		23917786.4574		23917786.0594											
43.9004		25.9004															
4585885.76348				25712822.9984													
28.6004																	
-5708951.51849		-4655567.93646		24429631.1344		24429633.0374											
39.2004		25.0004															
-3619706.97849		-2813511.57446		24844394.2304		24844396.0124											
37.1004		16.9004															
-25469704.43749		-19835090.55348		20696348.8774		20696343.6464											
48.1004		44.9004															
-18097185.26649		-14091055.82847		22631540.6074		22631537.2114											
50.8004		38.0004															
-11515327.67149		-8943360.03847		22830129.2154		22830127.6714											
43.3004		32.5004															
-737636.54048		-568956.26246		25463210.1084		25463209.4294											
35.4004		16.3004															
03 4 3 9 6 25.0000000 0 11G17G 3G10G15G25G23G18G16G 2G 6G13																	
-25597826.36849		-19931881.81948		20900012.3814		20900009.1104											
51.2004		45.2004															
-11352365.50549		-8833969.54847		23396788.8584		23396786.6214											
39.2004		27.4004															
-4641804.76649		-3605138.94246		24496550.5004		24496548.7844											
41.8004		21.7004															
-23295676.82449		-18130741.50648		21278850.2334		21278847.3704											
52.3004		41.7004															
-8142950.98849		-6338051.92047		23918440.2094		23918439.3304											
43.9004		25.9004															
-5711934.42349		-4657892.27946		24429063.4964		24429065.3404											
39.4004		23.3004															
-3623016.98248		-2816090.78146		24843763.4804		24843765.3434											
35.4004		17.4004															
-25470722.99149		-19835884.23848		20696154.8014		20696149.5744											
48.1004		44.9004															
-18099453.30349		-14092823.13947		22631108.7844		22631105.4244											
51.0004		37.7004															
-11512398.20749		-8941077.34947		22830686.7844		22830685.4184											
42.8004		32.8004															
-735837.09148		-567554.11346		25463552.7574		25463551.2954											
35.8004		14.8004															



2003 GPS Calendar

This calendar will help you convert a typical calendar day to either the Day of Year or GPS Week #.

For example, July 3, 2003 is day of year 184 in GPS Week 1225.

The GPS Week # would be 12254 (the # 4 represents Thursday.)

Sunday=0, Monday=1, Tuesday=2, Wednesday=3, Thursday=4, Friday=5, Saturday=6

Date								Day-of-Year								
Jan 2003								Jan 2003								
GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	
1199				1	2	3	4	1199				1	2	3	4	
1200	5	6	7	8	9	10	11	1200	5	6	7	8	9	10	11	
1201	12	13	14	15	16	17	18	1201	12	13	14	15	16	17	18	
1202	19	20	21	22	23	24	25	1202	19	20	21	22	23	24	25	
1203	26	27	28	29	30	31		1203	26	27	28	29	30	31		
Feb 2003								Feb 2003								
GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	
1203							1	1203								32
1204	2	3	4	5	6	7	8	1204	33	34	35	36	37	38	39	
1205	9	10	11	12	13	14	15	1205	40	41	42	43	44	45	46	
1206	16	17	18	19	20	21	22	1206	47	48	49	50	51	52	53	
1207	23	24	25	26	27	28		1207	54	55	56	57	58	59		
Mar 2003								Mar 2003								
GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	
1207							1	1207								60
1208	2	3	4	5	6	7	8	1208	61	62	63	64	65	66	67	
1209	9	10	11	12	13	14	15	1209	68	69	70	71	72	73	74	
1210	16	17	18	19	20	21	22	1210	75	76	77	78	79	80	81	
1211	23	24	25	26	27	28	29	1211	82	83	84	85	86	87	88	
1212	30	31						1212	89	90						
Apr 2003								Apr 2003								
GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	
1212			1	2	3	4	5	1212			91	92	93	94	95	
1213	6	7	8	9	10	11	12	1213	96	97	98	99	100	101	102	
1214	13	14	15	16	17	18	19	1214	103	104	105	106	107	108	109	
1215	20	21	22	23	24	25	26	1215	110	111	112	113	114	115	116	
1216	27	28	29	30				1216	117	118	119	120				
May 2003								May 2003								
GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	GPS WK	Sun	Mon	Tue	Wed	Thu	Fri	Sat	
1216					1	2	3	1216					121	122	123	
1217	4	5	6	7	8	9	10	1217	124	125	126	127	128	129	130	
1218	11	12	13	14	15	16	17	1218	131	132	133	134	135	136	137	
1219	18	19	20	21	22	23	24	1219	138	139	140	141	142	143	144	
1220	25	26	27	28	29	30	31	1220	145	146	147	148	149	150	151	

Appendix C
NavigationFile delf093k.03n

```
2.10          N: GPS NAV DATA          RINEX VERSION / TYPE
teqc 2002Mar14          20030404 12:37:46UTC / RUN BY / DATE
MSWin2000|IAx86-PII|bcc32 5.0|MSWin95/98/NT/2000|486/DX+ COMMENT
END OF HEADER
1 03 4 3 10 0 0.0 2.786302939057D-04 1.818989403546D-12 0.000000000000D+00
  9.100000000000D+01 5.237500000000D+01 4.319465674030D-09-1.403128074625D+00
  2.941116690636D-06 5.412981612608D-03 7.892027497292D-06 5.153728635788D+03
  3.816000000000D+05-9.313225746155D-09-2.034544295462D+00 1.061707735062D-07
  9.731305272039D-01 2.344687500000D+02-1.679634577739D+00-7.948187885631D-09
  6.228830784494D-10 1.000000000000D+00 1.212000000000D+03 0.000000000000D+00
  4.000000000000D+00 0.000000000000D+00-3.259629011154D-09 3.470000000000D+02
  3.744180000000D+05 4.000000000000D+00
3 03 4 3 9 59 44.0 1.183780841529D-04 3.069544618484D-12 0.000000000000D+00
  1.780000000000D+02 9.668750000000D+01 5.248432799476D-09 5.048428443194D-01
  5.202367901802D-06 4.329028190114D-03 7.053837180138D-06 5.153741949081D+03
  3.815840000000D+05 1.490116119385D-08 1.021305174420D+00 4.097819328308D-08
  9.307468704631D-01 2.228125000000D+02 5.336264290084D-01-8.556784614200D-09
  2.200091636650D-10 1.000000000000D+00 1.212000000000D+03 0.000000000000D+00
  2.000000000000D+00 0.000000000000D+00-4.190951585770D-09 1.780000000000D+02
  3.784380000000D+05 4.000000000000D+00
18 03 4 3 10 0 0.0 6.801914423704D-06 1.364242052659D-12 0.000000000000D+00
  2.100000000000D+02-6.496875000000D+01 4.034453660040D-09-2.888242657346D+00
  -3.131106495857D-06 3.492137417197D-03 1.216307282448D-05 5.153588191986D+03
  3.816000000000D+05-1.303851604462D-08-3.056581110324D+00-2.421438694000D-08
  9.646886077470D-01 1.468750000000D+02-3.101229734369D+00-7.736036700123D-09
  5.250218662600D-11 1.000000000000D+00 1.212000000000D+03 0.000000000000D+00
  2.000000000000D+00 0.000000000000D+00-1.024454832077D-08 2.100000000000D+02
  3.773220000000D+05 4.000000000000D+00
20 03 4 3 6 0 0.0-2.121366560459D-04-5.684341886081D-13 0.000000000000D+00
  1.180000000000D+02-5.150000000000D+01 4.233390527020D-09 4.647179243155D-01
  -2.834945917130D-06 2.051884308457D-03 1.129694283009D-05 5.153681653976D+03
  3.672000000000D+05 0.000000000000D+00-3.108586383660D+00 4.842877388000D-08
  9.650224602818D-01 1.605937500000D+02 1.689352710356D+00-7.910686328216D-09
  3.571577441349D-13 1.000000000000D+00 1.212000000000D+03 0.000000000000D+00
  2.800000000000D+00 0.000000000000D+00-6.519258022308D-09 3.740000000000D+02
  3.611580000000D+05 4.000000000000D+00
```

Appendix D

.....

TABLE A3
 NAVIGATION MESSAGE FILE - HEADER SECTION DESCRIPTION

HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT
RINEX VERSION / TYPE	Format version (2) File type ('W' for Navigation data)	I6,14X, A1,19X
*COMMENT	Comment lines (2)	I6,14X
*ION ALPHA	Ionosphere parameters A0-A3 of almanac (page 18 of subframe 4)	2X,4D12.4
*ION BETA	Ionosphere parameters B0-B3 of almanac	2X,4D12.4
*DELTA UTC: A0,A1,T,W	Almanac parameters to compute time in UTC (page 18 of subframe 4) A0,A1: term of polynomial T : reference time for UTC data W : UTC reference week number	3X,2D 19.12, 219
*LEAP SECONDS	Delta time due to leap seconds	I6
END OF HEADER	Last record in the header section.	60X

TABLE A4
 NAVIGATION MESSAGE FILE - DATA RECORD DESCRIPTION

PRN / EPOCH / SV CLK	- Satellite PRN number	I2,5I3, F5.1,3D19.12
	- Epoch: TOC - Time of Clock year (2 digits) month day hour minute second	
	- SV clock bias (seconds)	
	- Sv clock drift (sec/sec)	
	- SV clock drift rate (sec/sec ²)	
BROADCAST ORBIT - 1	- AODE (age of data ephemeris) - Crs (meters) - [EQN "Delta n"] (radians/sec) - No (radians)	3X.4D19.12
BROADCAST ORBIT - 2	- Cuc (radians) - Eccentricity - Cus (radians)	3X,4D19.12

- A1/2 (meter 1/2)

```
.....  
BROADCAST ORBIT - 3 - TOE Time of Ephemeris          3X,4D19.12  
                    (seconds into GPS week)  
                    - Cuc (radians)  
                    - [EQN "Omega sub o"] (radians)  
                    - Cis (radians)  
.....  
BROADCAST ORBIT - 4 - io (radians)                  3X,4D19.12  
                    - Crc (meters)  
                    - [EGN "omega:] (radians)  
                    - [EQN "omega dot"] (radians/sec)  
.....  
BROADCAST ORBIT - 5 - IDOT (radians/sec)           3X.4D19.12  
                    - Codes on L2 channel  
                    - GPS Week # (to go with TOE)  
                    - L2 P data flag  
.....  
BROADCAST ORBIT - 6 - SV accuracy                   3X,4D19.12  
                    - SV health (MSB only)  
                    - TGD (seconds)  
                    - AODC (seconds)  
.....  
BROADCAST ORBIT - 7 - Transmission time of message 3X,4D19.12  
                    (seconds into GPS week, derived e.g.  
                    from Z-count in Hand Over Word (HOW))  
                    - spare  
                    - spare  
                    - spare  
.....
```