COMPGX04: ROBOT VISION AND NAVIGATION
Workshop 1: Mobile GNSS Positioning using Least-Squares Estimation
ANSWERS

Task 1: Single-epoch Positioning

a) The mobile phone cell ID Cartesian ECEF position is −46 47 794.6, 2 556 362.1, −3530042.6 m.

b) The Cartesian ECEF satellite positions are

Satellite	x (m)	y (m)	z (m)
2	−15733856.4	20916688.8	4523765.8
17	−15733856.4	20916688.8	−4523765.8
18	−24265366.1	−6196711.6	−8849821.4
22	−8444285.4	14353129.6	−20693194.0
23	−14510015.9	−5171383.0	−21638918.6
26	4785957.9	18098607.6	−18843077.6
27	−17773279.9	11321955.5	−16169428.2
28	−18499730.4	−14132428.3	−12789097.2

c) The predicted ranges are

Satellite	(m)
2	22909972.3
17	21470688.1
18	22130623.1
22	21169584.3
23	22020721.9
26	23770722.3
27	20220188.0
28	23582210.42

d) The line-of-sight unit vectors are

Satellite	x (m)	y (m)	z (m)
2	-0.483892	0.801416	0.351542
17	-0.516330	0.855138	-0.046283
18	-0.886446	-0.395513	-0.240381
22	-0.179334	0.557253	-0.810746
23	-0.447862	-0.350927	-0.822356
26	0.396869	0.653839	-0.644197
27	-0.649115	0.433505	-0.625078
28	-0.587393	-0.707681	-0.392629

f) The ECEF position solution is −4 648 608.3, 2 555 877.8, −3 529 219.8 m. The receiver clock offset solution is 10 000.2m.

g) The latitude is −33.812506°, the longitude is 151.197314° and the height is 60.7 m.

Task 2: Multi-epoch Positioning

The position solution is as follows:

Time (s)	Latitude (°)	Longitude (°)	Height (m)
0	−33.812506	151.197314	60.7
60	−33.818981	151.203052	75.5
120	−33.824311	151.211323	79.7
180	−33.832773	151.212105	86.0
240	−33.842909	151.211400	37.1
300	−33.852106	151.210752	67.4
360	−33.859548	151.206084	28.34
420	−33.861464	151.213089	23.64
480	−33.858764	151.213666	14.24
540	−33.857782	151.214299	12.0
600	−33.856750	151.214538	12.2

Task 3: Outlier Detection

An outlier is present on the measurement from satellite 18 at 360s. You may detect outliers on some of the other measurements at the same time because the outlier has contaminated the position solution. However, the satellite 18 measurement will have the largest residual. Removing the measurement from satellite 18 changes the position solution to:

Time (s)	Latitude (°)	Longitude (°)	Height (m)
360	-33.859416	151.206359	38.53

If you then repeat the outlier detection test with satellite 18 removed you should then find that all measurements now past the test.

Task 4: Velocity determination

The velocity solution is as follows:

Time (s)	North (m/s)	East (m/s)	Down (m/s)
0	−8.49	18.10	0.04
60	−12.92	15.29	−0.01
120	−10.00	17.33	−0.01
180	−19.67	−3.50	0.01
240	−19.30	5.21	−0.03
300	−13.59	−6.29	0.03
360	−14.50	−3.88	−0.01
420	14.79	2.58	−0.01
480	1.08	1.09	−0.02
540	1.50	0.40	−0.03
600	−0.01	−0.00	−0.01