UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: July 2017

Module Number: CE5255 **Module Name: Remote Sensing and GIS**

[Three Hours]

[Answer all questions. Each question carries TWELVE marks]
All Standard Notations denote their regular meanings

Q1. a) Starting from cosine rule for spherical triangle, derive the Sine rule for a spherical triangle.

[2.0 Marks]

b) A plane leaves Katunayake international airport, Sri Lanka (7° 10' 11.71" N, 79° 53' 18.13" E) for Doha international airport, Qatar (25° 17' 9.98" N, 51° 32' 5.34" E). With current restrictions on Qatar by neighbouring countries plane has to first reach the sky over Bam city (29° 6' 25.56" N, 58° 20' 44.78" E) in Iran then proceed to Doha (This is to avoid entering the skies over UAE and Saudi Arabiya). Assuming that the radius of Earth to be 6,371 km, and all flight paths are along shortest path determine the following:

i. Distance between Katunayake and Bam
ii. Distance between Bam and Doha
iii. Determine the heading required to reach Bam from Katunayake.

[4.0 Marks]

c) A special broadcasting is to be carried out from SLBC tower in Deniyaya (6° 20' 30.12" N, 80° 33' 32.26" E) to Faculty of Engineering. An antenna is placed on the water tower of Faculty of Engineering (6° 4'47.62" N, 80° 11'30.1"E) to receive this transmission. It is needed to point the Hapugala antenna towards SLBC tower in Deniyaya and vice versa. Using the Earth curvature data given in Table Q1-1, determine:

i. Mean latitude (φ_m)
ii. Correction due to convergence of meridians ($\delta\alpha$)
iii. Length of the 1″arc of latitude (λ) at mean latitude
iv. Length of the 1″arc of longitude (μ) at mean latitude
v. Antenna direction in Hapugala and
vi. Transmitter direction in Deniyaya

[6.0 Marks]

Q2. a) Rigel ($05^h\ 14^m\ 32.27210^s$, -08° 12′ 05.8981″) a star in the constellation of Orion was observed at a place in Sri Lanka when the star was crossing the meridian. Observed altitude was 74° 17′ 25″ and the Greenwich sidereal time was $23^{hrs}\ 50^{min}\ 18.25^{sec}$. Answer the following using the data given above.

i. Construct the semicircle with the diameter as the north south plane of the observation and indicate the position of the star, zenith, and pole and indicate relevant values.
ii. Determine the corrected altitude of the star.
iii. Determine the latitude of the point.
iv. Construct a diagram as seen from north pole and indicate the local point, Greenwich, star and the first point of Aires.
v. Determine the longitude of the point.

[10.0 Marks]

b) Determine the difference between local time and Sri Lankan standard time (GMT+5:30) at the place of observation stated in Q2(a).

[2.0 Marks]

Q3. a) Prove that angle α on an aerial photograph, between line through the isocentre and any point a (ia) and the line of greatest tilt (pi) is related to corresponding horizontal angle β on the ground by

$$\tan\beta = \tan\alpha\cos\theta$$

where, θ is the angle of tilt of the photo (Refer Figure Q3-1).

[3.0 Marks]

b) Photo coordinates of the plumb point v, and the images a and b of ground control points A and B on a tilted photograph taken with 250 mm focal length camera is shown in Table Q3-1. Use this information to:

i. indicate $p, i, a, b, a\hat{i}p$ and $b\hat{i}p$ in schematic diagram of photo;
ii. determine tilt of the photo;
iii. determine photo coordinate of isocentre;
iv. determine photo angles $a\hat{i}p$, $b\hat{i}p$ and $a\hat{i}b$; and
v. determine ground angles $A\hat{I}P$ and $B\hat{I}P$.

[7.0 Marks]

c) On a certain vertical aerial photo, a section line (assumed to be 1250 m long) is imaged. Its photographic length is 75.5 mm. On this same photo, a rectangular parcel of land measures 25.7 mm by 18.9 mm. Calculate the approximate ground dimensions of the parcel and its area.

[2.0 Marks]

Q4. It is proposed that the remote sensing data should be used to quantify the amount of deforestation in Sri Lanka. Landsat 8 was selected for this purpose (Refer Table Q4-1 for details). Normalized Difference Vegetation Index (NDVI) was among suggested indices to detect changes in vegetation cover. Answer the following questions related to remote sensing.

a) Briefly explain following terms of remote sensing

i. Sky appears blue in colour during day time

ii. 8-bit and 16-bit radiometric resolutions

iii. False colour composite

iv. It is not possible to photograph Cygnus Loop Nebula from the surface of the Earth (Cygnus Loop Nebula mainly emits in UV range).

[4.0 Marks]

b) i. State the equation used to calculate NDVI and define all parameters.

ii. Explain, with reference to spectral reflection curves of healthy and unhealthy vegetation, how NDVI can help to detect healthy and unhealthy vegetation.

iii. Determine raw NDVIs for the part of the raster given in Figure Q4-1. (Raster calculations can be done as matrix operations.)

iv. Based on 3×3 region average what is a best determination on the middle cell?

v. If the ground resolution of Lansat-8 band 1-5 is 30 m, what is the area covered by the data given in Figure Q4-1?

[6.0 Marks]

c) List six applications of remote sensing, other than the applications mentioned in Q4. a) and b).

[2.0 Marks]

Q5. a) GPS is a sophisticated surveying method, however, it is not without errors. Briefly explain two possible errors in GPS.

[2.5 Marks]

b) State the main reason how the use of GPS has helped to overcome problems with traverse and detailed surveying.

[2.0 Marks]

c) Briefly explain the difference between GPS and GIS.

[3.0 Marks]

d) List five functions of a typical GIS software.

[2.5 Marks]

e) Describe two types of data used in GIS.

[2.0 Marks]

Figures, Tables and Equations

Table Q1-1 Earth curvature data

At Latitude	Length of 1" of Latitude (m)	Length of 1" of Longitude (m)
6° 00′ 00″	30.71845	30.75380
6° 25′ 00″	30.71903	30.72462

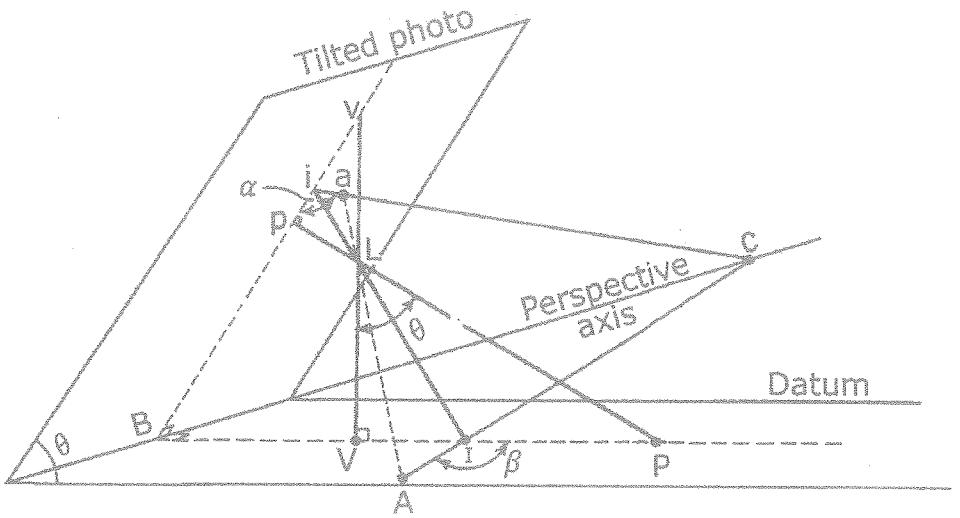

Figure Q3-1 Construction to prove angular distortion

Table Q3-1 Photo coordinates of in a tilted aerial photo

Point	x (mm)	y (mm)
v	-10.4	-11.4
a	-19.5	32.2
b	56.3	21.3

Table Q4-1 Bands of Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)

Band	Wavelength	Useful for mapping
Band 1 – Coastal Aerosol	0.43 - 0.45	Coastal and aerosol studies
Band 2 – Blue	0.45 - 0.51	Bathymetric mapping, distinguishing soil from vegetation, and deciduous from coniferous vegetation
Band 3 - Green	0.53 - 0.59	Emphasizes peak vegetation, which is useful for assessing plant vigour
Band 4 - Red	0.64 - 0.67	Discriminates vegetation slopes
Band 5 - Near Infrared (NIR)	0.85 - 0.88	Emphasizes biomass content and shorelines
Band 6 - Short-wave Infrared (SWIR) 1	1.57 - 1.65	Discriminates moisture content of soil and vegetation; penetrates thin clouds
Band 7 - Short-wave Infrared (SWIR) 2	2.11 - 2.29	Improved moisture content of soil and vegetation and thin cloud penetration
Band 8 - Panchromatic	0.50 - 0.68	15-meter resolution, sharper image definition
Band 9 – Cirrus	1.36 - 1.38	Improved detection of cirrus cloud contamination
Band 10 – TIRS 1	10.60 – 11.19	100-meter resolution, thermal mapping and estimated soil moisture
Band 11 – TIRS 2	11.5 - 12.51	100-meter resolution, Improved thermal mapping and estimated soil moisture

Band 1

10	5	0
20	10	5
25	15	5

Band 2

10,657	4,000	200
23,000	21,836	18,000
170	20,000	9,000

Band 3

14,000	6,000	350
29,456	36,133	48,566
317	29,000	11,375

Band 4

1,200	4,500	200
12,000	24,000	40,000
200	27,000	10,000

Band 5

58,000	6,000	1,200
40,000	42,000	63,400
45,000	42,600	29,900

Figure Q4-1 Parts of 16-bit raster data for different bands (values indicate raw reflectance values)

$$L = \frac{\lambda\delta\phi}{\cos\left(\alpha_m + \frac{\delta\alpha}{2}\right)}$$

$$r = -58\cot H_O$$

$$\delta\alpha = \Delta L \sin(\varphi_m)$$

$$GSrT = RA - \lambda_E$$

$$BC^2 = AB^2 + AC^2 - 2AB \times AC \cos A$$

$$\varphi_m = \frac{\varphi_A + \varphi_B}{2}$$

$$\alpha_m = \tan^{-1}\left(\frac{\mu\Delta L}{\lambda\delta\phi}\right)$$

$$H = H_o + r$$

$$\cos A = \frac{\cos a - \cos(b) \times \cos(c)}{\sin(b) \times \sin(c)}$$

$$\frac{\sin K}{\sin k} = \frac{\sin N}{\sin n}$$