



The University of Zambia
School of Engineering
Department of Geomatic Engineering
2015/2016 Academic Year Examinations

Monday, 5th September, 2016

GEE 3622: PRINCIPLES OF DATA ACQUISITION AND PROCESSING

Time: Three (3) Hours

Instructions:

1. This Examination is Closed Book
 2. Calculators are permitted
 3. Time allowed is Three (3) Hours
 4. Answer: **BOTH** Questions from Section A and **TWO (2)** from Section B
 5. **Answers to Section A and B MUST be answered in separate booklets.**
 6. Show all the work leading to the solution
 7. Total marks for this Examination paper is 100
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WARNING! WARNING!

Bringing unauthorized material or pre-written notes in the examination venue will render you expelled indefinitely from the University. Being involved in any way in a leakage of an examination question paper will also render you expelled indefinitely.

Be Honest.

Be Confident.

Enhance the image of the University

SECTION A (Answer both questions 1 and 2)

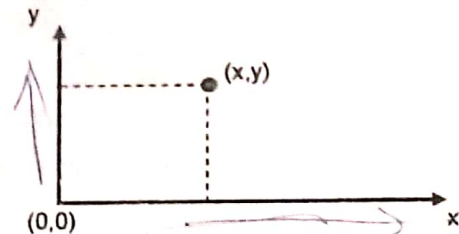
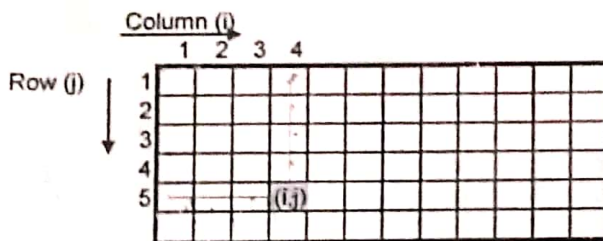
Question 1 (6+14+ 3+2) marks

(a) State whether each of the following is **true** or **false** about remote sensing.

- i. Provides only image data – DN values **T**
- ii. Requires ground data for georeferencing. **T**
- iii. It is a technique used to determine position (X, Y, Z) by the use of a minimum of three satellites. **F**
- iv. Measurements relate to the surface reflectance characteristics. **T**
- v. Measurements are done in-situ. **F**
- vi. It is weather independent. **F**

(b) Georeferencing is an important component of geometric correction in image processing.

- i. What is georeferencing?
- ii. Study the image and map coordinate systems below. Image uses column-row (I,j) coordinate system whereas map uses a Cartesian coordinate system with (x,y)



- iii. Calculate the map position (x,y) for image position (10,20) using the following equations:

$$i. \quad x = -10 + 5i - j \text{ and } y = 5 + 2i + 2j$$

- iv. Given the map coordinates of the top left corner of the image as $x = 642785\text{m}$, $y = 8298133\text{m}$ and the resolution of 10m for the image, calculate map coordinates of the image coordinates (i,j) using the given coordinates and resolution. (Do not use the equations above).

(c) What is the purpose of resampling in image processing?

(d) What is the difference between linear contrast stretch and Histogram equalisation?

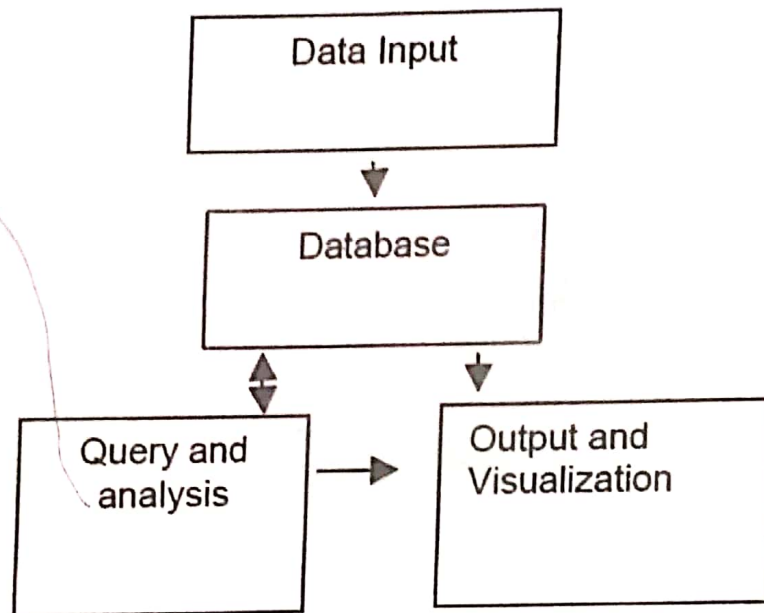
Question 2 (4+8+10+3) marks

(a) State whether each of the following is best represented as **Vector** or **Raster** model in a Geographic Information System (GIS).

- i. For analysis of a road network **Vector**
- ii. For analysis of satellite images. **Raster**

(b) The figure below depicts the function components of a GIS. Associate each of the following terms with the appropriate functional component. (The first term Paper Map is used as Input and serves as an example).

- i. DBMS (Database Management System)
- ii. Scanner
- iii. Buffer
- iv. What....if...?



(c) Analytical GIS functions are classified into five groups of functional classes. List the **five (5)** classes.

(d) What are the **three (3)** challenges one would face when using secondary data in a GIS?

- ① - Data Capture.
 - Data Compiler
 - Data Storage
 - Data Manu
 - Data representat.

①

②

③

SECTION B (Answer any two questions)

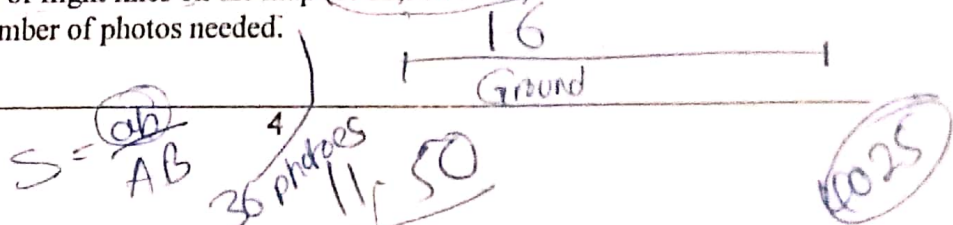
Question 3 (3+4+3+6+9) marks

- Explain the meaning of stereoscopic depth perception.
- Given that the shortest distance of clear stereoscopic depth perception for the average eye base of 65 mm is 250 mm and that the minimum distance at which the stereoscopic depth perception is possible is approximately 600m:
Compute,
 - The maximum Parallax angle, $\phi(\max)$.
 - The minimum Parallax angle, $\phi(\min)$.
- Define the term "Vertical Exaggeration".
- What is the approximate vertical exaggeration for a vertical photo taken with 152.4-mm focal length camera having a 23-cm square format if the photos were taken with 60% endlap. Assume b_e/h is 0.15.
- Assuming the principle point to be at the intersection of lines joining opposite corner fiducial points, calculate the coordinates of those fiducial points in the conventional xy coordinate system if their comparator coordinates XY are as in the table below.

Fiducial points	X(mm)	Y(mm)
A	87.294	210.223
B	199.826	96.996
C	313.054	209.555
D	200.512	322.768

Question 4 (3+2+2+3+3+2+2+2+2+2+2) marks

- List **three (3)** parameters of inner orientation?
- A study area is 10 km wide in the east-west direction and 16 km long in the north-south direction. A camera having a 152.4-mm-focal-length lens and a 230-mm format is to be used. The desired photo scale is 1:25,000 and the nominal endlap and sidelap are to be 60 and 30 percent. Beginning and ending flight lines are to be positioned along the boundaries of the study area. The only map available for the area is at a scale of 1: 62,500. This map indicates that the average terrain elevation is 300 m above datum.
- In which direction must the aircraft fly and why?
- Find the flying height (**H**) above terrain.
- Determine ground coverage per image.
- Determine ground separation between photos on a line for 40 percent advance per photo
- Assuming an aircraft speed of 160 km/hr, calculate the time between exposures
- Compute the average number of photos per 16-km line
- Determine the separation distance between flight lines
- Find the number of flight lines required to cover the 10-km study area width
- Find the spacing of flight lines on the map (1: 62,500 scale)
- Find the total number of photos needed.



Question 5 (2+3+4+2+14) marks

- a) The image-to-ground coordinate relationship of a point P is established through the collinearity model and is represented by the collinearity equations:

$$x = x_p - c \cdot \frac{r_{11}(X-X_0) + r_{21}(Y-Y_0) + r_{31}(Z-Z_0)}{r_{13}(X-X_0) + r_{23}(Y-Y_0) + r_{33}(Z-Z_0)}$$

$$y = y_p - c \cdot \frac{r_{12}(X-X_0) + r_{22}(Y-Y_0) + r_{32}(Z-Z_0)}{r_{13}(X-X_0) + r_{23}(Y-Y_0) + r_{33}(Z-Z_0)}$$

Identify the quantities involved in the above equations which refer to the following:

- The measured image point coordinates $\rightarrow x, y, c$
- Interior orientation parameters of the camera $\rightarrow x_0, y_0, z_0, \omega, \phi, \kappa$
- Exterior orientation parameters of the image under consideration $\rightarrow x, y, z$
- The ground coordinates of point $\rightarrow x, y, z$

- b) A pair of overlapping vertical photographs was taken from a flying height of 1,233 m above sea level with a 154.4-mm-focal-length camera. The air base was 390 m. With the photos properly oriented, parallax bar readings of 12.57 mm and 13.04 mm were obtained with the floating mark set on the principle points O_1 and O_2 , respectively. On the left photo b was measured as 93.73 mm and on the right photo b' was measured as 93.30 mm. Parallax bar readings of 10.96 mm and 15.27 mm were taken on points A and B. Also, the x and y photo coordinates of points A and B measured with respect to the flight axes on the left photo were $x_a = 53.41$ mm, $y_a = 50.84$ mm, $x_b = 88.92$ mm, and $y_b = -46.69$ mm. Calculate the elevations of points A and B and the horizontal length of line AB.

$$h_A = H - \frac{B f}{p_a} \quad X_A = B \left(\frac{x_a}{f} \right)$$

END OF EXAM

$$X_A =$$

$$C = b' - r_{01}$$

$$C = b - r_{02}$$

$$C = \frac{C_1 + C_2}{2}$$

$$\frac{x_a}{x_A} = \frac{f}{H - h_A}$$

$$X_A = \frac{x_a f}{H - h_A}$$

$$p_a = C + r_a$$

$$p_b = C + r_b$$

$$197827.6887$$

$$230208.9917$$

$$227272.0099$$