UNIVERSITY OF KWAZULU-NATAL

EXAMINATIONS: DECEMBER 2016

ENSV1G2 H2: GEOMATICS 2 BSc (Surv)

DURATION: 3 HOURS

TOTAL MARKS: 105

FULL MARKS: 100

Date: 5th December 2016

Time: 09:00 to 12:00

INTERNAL EXAMINER: Mr. E. Musonda

EXTERNAL EXAMINER: Mr. S. M. Chilufya

INSTRUCTIONS:

1. MAKE SURE YOU READ ALL INSTRUCTIONS AND THE NOTES VERY CAREFULLY, BEFORE ATTEMPTING THE QUESTIONS.
2. ANSWER ALL FIVE (5) QUESTIONS IN THIS PAPER.
3. ALL SOLUTIONS MUST BE WRITTEN IN INK - PENCIL WORK WILL NOT BE MARKED.
4. PLEASE WRITE CLEARLY AND ORDERLY. UNTIDY AND DISORGANISED WORK WILL NOT BE MARKED AT ALL.

IMPORTANT NOTES:

1. THIS IS A CLOSED BOOK EXAM, ONLY SOME RELEVANT FORMULAE ARE INCLUDED ON PAGE 4.
2. This examination paper accounts for 70% towards the final mark for this module.
3. This Question Paper consists of 4 pages, including the cover page.
4. THE QUESTION PAPER MUST BE HANDED IN WITH THE ANSWER BOOK.

YOUR STUDENT NUMBER MUST BE WRITTEN ON EACH PAGE.
Question 1  (38 Marks)

a) What is the purpose of the circular bubble on the tribrach or instrument plate level?  

b) Table 1 shows the vertical angle observations from traverse point T3 to T2 and T4.

i) Complete the booking form to obtain the reduced mean vertical angles.

<table>
<thead>
<tr>
<th>PNT</th>
<th>READINGS</th>
<th>REDUCED FL</th>
<th>REDUCED FR</th>
<th>REDUCED FR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At:</td>
<td>FL</td>
<td>FR</td>
<td>FL</td>
</tr>
<tr>
<td>T3</td>
<td>T2</td>
<td>95</td>
<td>13</td>
<td>41</td>
</tr>
<tr>
<td>T4</td>
<td>T2</td>
<td>84</td>
<td>44</td>
<td>48</td>
</tr>
<tr>
<td>T2</td>
<td>95</td>
<td>13</td>
<td>38</td>
<td>264</td>
</tr>
</tbody>
</table>

ii) Illustrate, with a figure, the position of targets at T2 and T4 with respect to the instrument station.  

c) Explain the following instrument errors, related to angle measurements, and indicated how each one may be avoided or eliminated:

i) Vertical circle error  

ii) Pointing errors  

iii) Recording errors  

d) Generally, there are two categories of errors in Field Surveying: Systematic and Random errors. Give two (2) practical examples of each of these errors.  

e) Using figure 1, explain the procedure of obtaining the coordinates of the new point T. Include the knowledge you have from Geomatics 1 on polar and joint calculations in your explanation.

f) Compute the corrected horizontal distance given the following values:

Temperature, 10°C; Tape length, 30.064m; Slope at, 1.5%; slope measurement, 300.600m

Assuming that standard temperature is 20°C, and used standard tape length is 30.000m

Question 2  (15 Marks)

Figure 2 depicts a triangulation survey to determine the coordinates of an unknown point P from T1 and T2, in which distances were measured from T1 to P (a) and T2 to P(b). The survey was done at Shongweni Dam and the given coordinates for the control points T1 and T2 were observed by GPS transformed into South African WGS84 coordinate system.

a) Using the coordinates for points T1 and T2 given in table 2, determine the distance c and use the cosine and sine rule methods to calculate coordinates for point P. a = 59.056m; b = 76.763m.

<table>
<thead>
<tr>
<th>Table 2: Coordinate list</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point</td>
</tr>
<tr>
<td>T1</td>
</tr>
<tr>
<td>T2</td>
</tr>
</tbody>
</table>

b) What type of triangulation control survey is applied in this case?
**Question 3**  
(16 Marks)

![Diagram](image)

*Figure 3: Effects of (a) refraction and (b) earth’s curvature on line of sight*

Figure 3 represents the effects of (a) refraction and (b) earth’s curvature on the observed line of sight. With the following assumption:

- The coefficient of refraction “k” is given by \( \frac{R}{R_s} \); where \( R \) is the radius of the earth and \( R_s \) is the radius of refracted line of sight.
- The measured distance “S” is approximately equal to the horizontal line AB'.

a) Derive the equation for the effect of refraction “r” on the measured distance.  
\[ \text{Equation} \]

b) Derive the equation for the effect of earth’s curvature “c” on the measured distance.  
\[ \text{Equation} \]

c) Derive the equation for the combined effects of refraction and earth’s curvature “(c - r)”.

\[ \text{Equation} \]

**Question 4**  
(22 Marks)

![Diagram](image)

*Figure 4: Trigonometric heighting*

a) Figure 4 represents configuration of trigonometric heighting from point A to B, where “α” is the vertical angle at A, and “S” is the measured slope distance from A to B assumed to be less than 100m. Derive an expression to determine height difference (ΔH) between point A and B, then use it to show the reduced level at station B given reduced level of station A.

\[ \text{Equation} \]

b) Determine from first principles, the approximate distance at which correction for curvature and refraction in leveling amounts to 1mm.

\[ \text{Equation} \]

c) Two survey stations A and B on opposite side of a river are 780m apart, and the reciprocal levels have been taken between them with the following results:

<table>
<thead>
<tr>
<th>Instrument Station</th>
<th>Height of instrument (m)</th>
<th>Staff Station (m)</th>
<th>Staff reading (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.472</td>
<td>A</td>
<td>1.835</td>
</tr>
<tr>
<td>B</td>
<td>1.496</td>
<td>A</td>
<td>1.213</td>
</tr>
</tbody>
</table>

Calculate the:

i). True height difference between the stations

\[ \text{Equation} \]

ii). The ratio of refraction correction to curvature correction

\[ \text{Equation} \]

d) The dimensions of an A4 paper are given as 210mm x 297mm. What would be the dimensions of an associated A1 paper size in portrait orientation? Hint: *Indicate as (width x height).*

\[ \text{Equation} \]

e) A drainage system with uniform cross section as shown in figure 5 is to be constructed extending a distance of 100.02m. Calculate the volume of soil to be dug out from the cut section of the drain to be constructed.

\[ \text{Equation} \]

*Figure 5: Proposed cut section for drainage system, with dimensions in metres (m)*
Question 5  (14 Marks)

a) Explain two (2) differences between the Helmert and Affine transformations.

b) The coordinates of point LE are given on the cape datum as:

\[ \text{LE}_\text{CAPE}: \quad Y = +1\,654.070 \quad X = +3\,304\,999.960 \]

Then, the following information was derived from a Helmert Transformation that used five points in the vicinity of point "LE" and had common coordinates in the Cape and WGS84 systems:

- CAPE mean coordinates of the common control points: \[ Y_{\text{CAPE}} = +1\,594.606 \quad X_{\text{CAPE}} = +3\,306\,164.026 \]
- WGS84 mean coordinates of the common control points: \[ Y_{\text{WGS}} = +1\,620.517 \quad X_{\text{WGS}} = +3\,306\,460.147 \]

Scale \( \lambda = 0.9999864372 \), Rotation \( \theta = \pm 0^\circ 0' 0" \)

Now, transform point "LE" from the cape datum onto the new WGS84 coordinate system.

End of examination

Some useful formulae

1) \[ C_t = k(T - T_s)L \]. Where \( C_t \) = temperature correction, \( k = 0.0000116 \), \( T \) = temperature during measurement, \( T_s \) = standard tape temperature and \( L \) = Distance measured.
2) \[ a^2 = b^2 + c^2 - 2bc \cos(\theta) \],
3) \[ c - r = \frac{6S^2}{14R} \], Where \( R = 6370 \)km, \( S \) is measured distance.
4) \[ V = \frac{1}{2}(A_1 + A_2)L \], where \( A_1 \) and \( A_2 \) are cross-sectional areas at beginning and end, while \( L \) is the extent.
5) Transformation equations:
   i) \( Y_{\text{LE}} = Y_C + Y_0 - qx + py \)
   ii) \( X_{\text{LE}} = X_C + X_0 + px + qy \)
   iii) \( p = \lambda \cos \theta, q = \lambda \sin \theta \), \[ x = (X_{\text{LE}} - X_{\text{mean}})_\text{CAPE}, \] and \[ y = (Y_{\text{LE}} - Y_{\text{mean}})_\text{CAPE} \]