NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF NATURAL RESOURCES AND SPATIAL SCIENCES

DEPARTMENT OF GEO-SPATIAL SCIENCES AND TECHNOLOGY

QUALIFICATION: **BACHELOR OF GEOINFORMATION TECHNOLOGY** **BACHELOR OF LAND ADMINISTRATION**	
QUALIFICATION CODE: **07GITB** **07BLAD**	**LEVEL:** 6
COURSE CODE: GMN621S	**COURSE NAME:** GEOINFORMATION MANAGEMENT
SESSION: NOVEMBER 2019	**PAPER:** THEORY
DURATION: 3 HOURS	**MARKS:** 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	**DR LAMECK MWEWA**
MODERATOR:	**DR THOMAS CHRISTIANSEN**

INSTRUCTIONS
1. Fill in the exam sheet. Write your student number on each answer sheet used. 2. This exam paper has five questions. Answer ALL the questions. 3. Read each question carefully before attempting to answer. 4. Write clearly and neatly.

PERMISSIBLE MATERIALS

1. Non-programmable Calculator
2. Ruler, Pen, Pencil, Eraser (rubber), Standard Normal Distribution Tables (attached)

THIS QUESTION PAPER CONSISTS OF (4) PAGES (Excluding this front page)

Question 1: Problem and Objective Analysis

Namibia has been experiencing rapid growth of informal settlements in urban areas. The causes of this problem has been researched and debated for a long time. You are part of the team that is conducting a desktop analysis to determine the causes of this problem. Answer the following questions below:

1.1. Identify four main reasons/causes of informal settlement growth (i.e. 1st level). For each of the main reasons/causes identify two sub-causes (2nd level). (8)

1.2. Develop the problem tree depicting the above showing possible effects as well. (12)

[20]

Question 2: GIS establishment and planning

The establishment of a GIS is a complex process which needs careful planning, based on a thorough analysis of the respective institution and its requirements. This is influenced by the type, purpose and level of GIS implementation.

2.1. Give four reasons why proper planning of GIS is needed. (4)

2.2. Identify and explain four cases that may trigger introduction of an enterprise GIS in an organisation (8)

2.3. List and explain the four main phases (not the 9 stages) of a GIS planning methodology and for each, mention a possible problem that can arise if not properly done. (8)

[20]

Question 3: Project Planning Tools [20 marks]

Implementation of a GIS project involved utilisation of project management tools. You are hired as a consultant to implement a multi-user GIS for a very large organisation.

3.1. What are the seven main GIS aspects (or components) that you will need to consider in the planning process? (7)

3.2. Draw the Logical Frame template and indicate with numbers the logical process of filling content in the table. (13)

[20]

Question 4: GIS Quality Aspects [20 marks]

The quality of an GIS analysis depends on the quality of data and the skills of the person doing the analysis. One of the characteristics of data that needs to be managed is errors.

4.1. What is the difference between accuracy and precision of spatial data? Use a simple diagram or example to support your answer. [6]

4.2. List and briefly explain the four main types of spatial errors that are possible in in GIS. You may use illustrations as well to help if you can't express yourself. [8]

4.3. What is a metadata and why is it an important aspect of GIS standards? [6]

[20]

Question 5: PERT and Critical Path Analysis [20 marks]

You have been hired as a consultant to spearhead the implementation of a mobile GIS App for the NSA. After conducting a needs assessment and a technology development seminar, you came up with six activities and their duration (in weeks) as shown in the table below.

Task	Description	Predecessor	Optimistic Time, O_T	Most likely Time, M_T	Pessimistic Time, P_T	Expected Time, E_T	σ_{Path}^2
A	Develop specification		4	7	10		1.00
B	Write test plans	A	7	23	27		11.11
C	Design Mobile App	A	11	14	17		1.00
D	Write software code	B	10	22	28		9.00
E	Test the App	C	7	23	27		11.11
F	Deploy the App	D, E	22	29	30		1.78

5.1. Calculate the expected time for each activity (6)

5.2. Construct the PERT diagram (4)

5.3. Identify and determine the duration for the critical path (2)

5.4. Calculate the specified time if the probability of completing the project is 95% (4)

5.5. Calculate the probability of completing the project in 82 weeks? (4)

Below are the given formulae:

$$z = \frac{\text{specified time} - \text{critical path expected time}}{\text{path standard time}} = \left(\frac{DT - \mathrm{E_T}}{\sqrt{\sigma path^2}}\right)$$

Where **DT** = the specified time

$\mathbf{E_T}$ Path = the expected completion time of the critical path

$$\sigma_{Path}^{\ 2} = \text{variance of path}$$

Variance of each task, $Var^2 = \sigma^2 = \left(\frac{p - o}{6}\right)^2$

Where **P** = pessimistic time and **O** = optimistic time and **M** = Most likely time

[20]

STANDARD NORMAL DISTRIBUTION: Table Values Represent AREA to the LEFT of the Z score.

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1.5	.93319	.93448	.93574	.93699	.93822	.93943	.94062	.94179	.94295	.94408
1.6	.94520	.94630	.94738	.94845	.94950	.95053	.95154	.95254	.95352	.95449
1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997

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QUALIFICATIONS CODES: 07GITB 07BLAD	**LEVEL: 6**
COURSE CODE: GMN621S	**COURSE NAME:** GEOINFORMATION MANAGEMENT
Session: NOVEMBER 2019	**PAPER:** THEORY
DURATION: 3 hours	**MARKS:** 100

FIRST OPPORTUNITY EXAMINATION PAPER		
EXAMINER	**DR LAMECK MWEWA**	
MODERATOR	**DR THOMAS CHRISTIANSEN**	

INSTRUCTIONS

1. **Fill in the exam sheet. Write your student number on each answer sheet used**
2. **This exam paper has five questions. Answer ALL the questions.**
3. Read each question carefully before attempting to answer.
4. Write clearly and neatly.
5. **Materials allowed:** Non-programmable calculator, Ruler, Pen, Pencil, Eraser (rubber), Standard Normal Distribution Tables (attached)

THIS PAPER CONSISTS OF FOUR (4) PAGES (EXCLUDING THIS COVER PAGE)

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FIRST OPPORTUNITY EXAMINATION MEMORANDUM		
EXAMINER	**DR LAMECK MWEWA**	
MODERATOR	**DR THOMAS CHRISTIANSEN**	

INSTRUCTIONS

1. **Use this memorandum to guide your moderation**
2. This memorandum has five questions with 20 marks each.
3. Marks are allocated per question and must guide your mark allocation
4. Where the answer is not the same, marks may be allocated based on the students reasoning, argument or analysis provided in the answer
5. For calculations, workings must be shown and NOT only the solution.

THIS MEMORANDUM CONSISTS OF NINE (9) PAGES (EXCLUDING THIS COVER PAGE)

Question 1: Problem and Objective Analysis

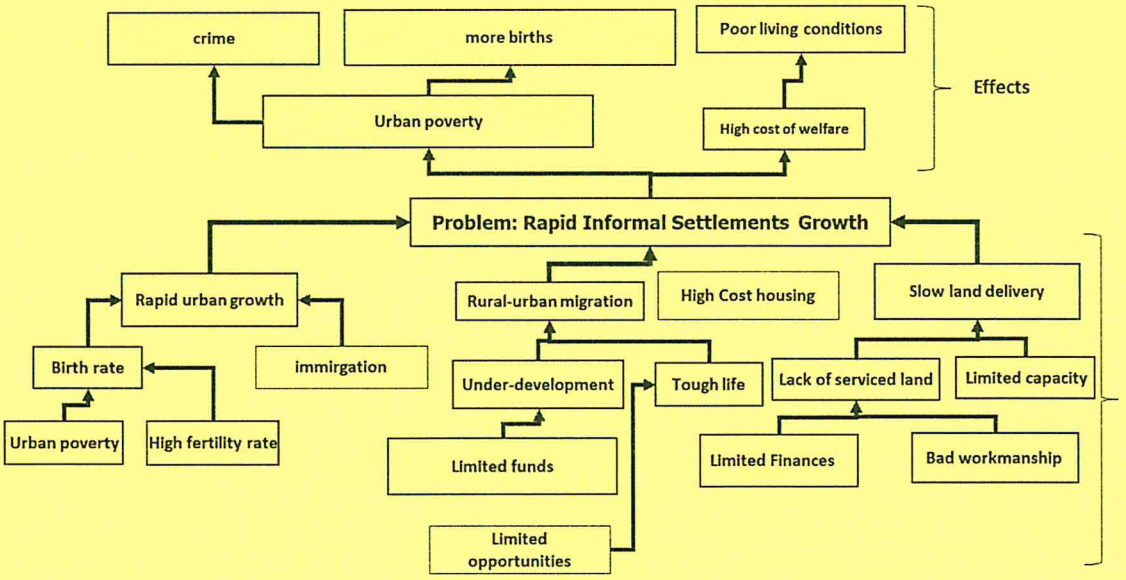
Namibia has been experiencing rapid growth of informal settlements in urban areas. The causes of this problem has been researched and debated for a long time. You are part of the team that is conducting a desktop analysis to determine the causes of this problem. Answer the following questions below:

1.1. Identify four main reasons/causes of informal settlement growth (i.e. 1st level). For each of the main reasons/causes identify two sub-causes (2nd level). (8)

Model Answer:

- ***Rapid urban growth:*** *(high births, immigration, concentration of industries, more possibilities for educated people)*
- ***Slow land delivery process:*** *(slow servicing of land, slow and cumbersome regulatory framework, limited capacity)*
- ***Rural-urban migration:*** *(rural under-development, services, tough rural life, 'apparent good' urban life, opportunities)*
- ***High cost of land and housing****: (high cost of servicing land, curtails, high interest rates, high professional fees)*

1.2. Develop the problem tree depicting the above showing possible effects as well. (12)



[20]

Question 2: GIS establishment and planning

The establishment of a GIS is a complex process which needs careful planning, based on a thorough analysis of the respective institution and its requirements. This is influenced by the type, purpose and level of GIS implementation.

2.1. Give four reasons why proper planning of GIS is needed. (4)

Model Answer (any four of these)

- *GIS requires the building of large databases before becoming useful*
- *GIS requires large spatial databases to be created or compiled*
- *GIS requires appropriate hardware and software to be purchased and installed*
- *GIS requires applications (tailored software) to be developed*
- *Setting up a GIS is a large and complex task which requires substantial planning before any data, hardware or software is acquired*
- *GIS implementation and maintenance is costly – good planning leads to less costs and increasing benefits for an organization*

2.2. Identify and explain four cases that may trigger introduction of an enterprise GIS in an organisation (8)

Model Answer

- *Consulting company with massive collection of site plans wants to automate delivery of plans to developers to save money and this may lead to implementation of departmental or small enterprise GIS to meet this demand.*
- *Environmental NGO frequently carries out scientific spatial studies and EIAs. The bigger the assignment is, the more data and functionalities it requires. Therefore, a departmental or small enterprise GIS may provide the solution.*
- *Government wants to support census/elections with automated mapping, analysis and Internet-based publishing/searching of new data (multi-user, decentralized corporate system GIS)*
- *New, big utility company starts setting up a new network in Namibia that requires collection and integration of multiple thematic data and analysis of multiple layers. Doing so manually or with simple GIS may not be efficient and effective. So a multi-user, multi-purpose, corporate GIS may be the solution.*

2.3. List and explain the four main phases (not the 9 stages) of a GIS planning methodology and for each, mention a possible problem that can arise if not properly done. (8)

Model Answer

- *Needs Assessment: This involves understanding strategic purpose introducing GIS and the various users, uses, services and products that may be needed. Failure to do this, may lead to mismatch between products and services on one hand and the user needs on the other.*
- *Conceptual design: This involves describing specific information products, data designs and logical models that can be used to develop system specifications. This is crucial to make sure the system to be implemented has ability and capacity to deliver the products*
- *Physical design: Involves specification of systems requirements and leads into actual design of the system (like database, extraction tools). A very well thought through physical design avoid expensive retooling later.*
- *Implementation: Involves planning and management of system migration issues, considers cost-benefits and risks. While automation is desirable, it can create major functional issues if not integrated well. For instance, it may lead to suspension of services that can lead to loss of business.*

[20]

Question 3: Project Planning Tools

Implementation of a GIS project involved utilisation of project management tools. You are hired as a consultant to implement a multi-user GIS for a very large organisation.

3.1. What are the seven main GIS aspects (or components) that you will need to consider in the planning process? (7)

Model Answer

- *Hardware: Costs become lower by the day but short lifespan (replacement cycle about every 4 years for computers)*
- *Software: Still high investment for proprietary software*
- *Data: Initially requiring high investment and is the heartbeat of any GIS implementation*
- *People: Staffing will be highest cost factor over time but can be mitigated against with automation of processes*
- *Procedures: Hard to implement especially in large organisations and government agencies*

- *Information Products (Dissemination): Various Maps, reports, graphs, tables, lists etc must be generated from the system to suit different users*
- *Governing regulations and laws: Important to consider this aspect to avoid infringing on related data/information production and distribution standards.*

3.2. Draw the Logical Framework template and indicate with numbers the logical process of filling content in the table. (13)

Model Answer

Project Description	Indicators	Sources of verification	Assumptions
Overall objective (1)	(8)	(9)	
Purpose (2)	(10)	(11)	(7)
Results (3)	(12)	(13)	(6)
Activities (4) *(optional inclusion in the matrix)*	*Not included*	*Not included*	(5) *(optional inclusion in the matrix)*

[20]

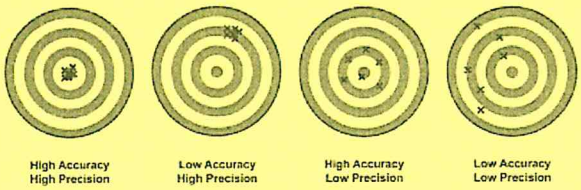
Question 4: GIS Quality Aspects

The quality of an GIS analysis depends on the quality of data and the skills of the person doing the analysis. One of the characteristics of data that needs to be managed is errors.

4.1. What is the difference between accuracy and precision of spatial data? Use a simple diagram or example to support your answer. (6)

Model Answer

- *Accuracy is the closeness of the measured value to the true value while precision is the closeness of the measurements together.*



4.2. List and briefly explain the four main types of spatial errors that are possible in in GIS. You may use illustrations as well to help if you can't express yourself. (8)

Model Answer

- ***Referential errors or mistakes:*** *These are blunders that can be caused by fatigue or carelessness on the part of the data encoders.*
- ***Topological errors:*** *These are errors that may lead to topological inconsistencies in the data caused by interrupted lines, unclosed polygons and crossing lines when not required.*
- ***Relative errors:*** *These can be inaccuracy in positions of two related objects such as a bus station captured wrongly and so appears on the wrong side of the road.*
- ***Absolute errors:*** *These can be misidentification of the "true value of a position" of an object or capturing wrong size of an object while digitizing.*

4.3. What is a metadata and why this is an important aspects of GIS standards? (6)

Model Answer

- *A metadata is data about a data set. It describes the content of the dataset and how it is organised including lineage of the data set and how it can be distributed.*
- *it forms part of an important aspect of spatial data infrastructure to facilitate data sharing and utilisation.*
- *Therefore, Metadata standards are important as they guide how GIS data is described within the GIS community*

[20]

Question 5: PERT and Critical Path Analysis

You have been hired as a consultant to spearhead the implementation of a mobile GIS App for the NSA. After conducting a needs assessment and a technology development seminar, you came up with six activities and their duration (in days) as shown in the table below.

Task	Description	Predecessor	Optimistic Time, O_T	Most likely Time, M_T	Pessimistic Time, P_T	Expected Time, E_T	σ_{Path}^2
A	Develop specification		4	7	10		1.00
B	Write test plans	A	7	23	27		11.11
C	Design Mobile App	A	11	14	17		1.00
D	Write software code	B	10	22	28		9.00
E	Test the App	C	7	23	27		11.11
F	Deploy the App	D, E	22	29	30		1.78

5.1. Calculate the expected time for each activity (6)

5.2. Construct the PERT diagram (4)

5.3. Identify and determine the duration for the critical path (2)

5.4. Calculate the specified time if the probability of completing the project is 95% (4)

5.5. Calculate the probability of completing the project in 82 weeks? (4)

Below are the given formulae:

$$z = \frac{\text{specified time} - \text{critical path expected time}}{\text{path standard time}} = \left(\frac{DT - \mathrm{E_T}}{\sqrt{\sigma path^2}}\right)$$

Where **DT** = the specified time

E_T Path = the expected completion time of the critical path

$$\sigma_{Path}^{\ 2} = \text{variance of path}$$

Variance of each task, $Var^2 = \sigma^2 = \left(\frac{p - o}{6}\right)^2$

Where **P** = pessimistic time and **O** = optimistic time and **M** = Most likely time

Model Answer

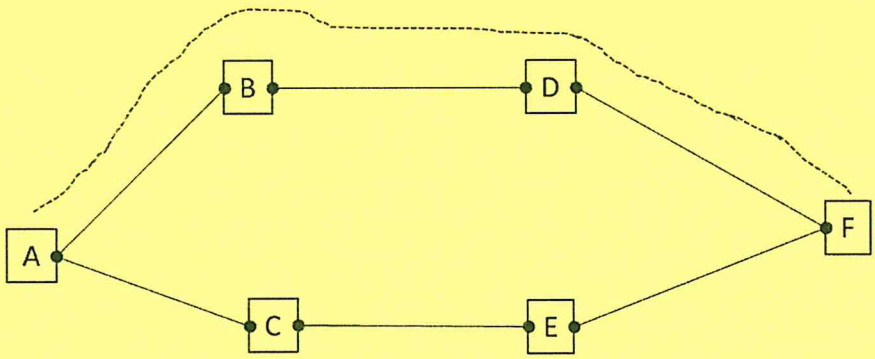
Task	Description	Predecessor	O	M	P	T_E	σ_{Path}^2
A	Develop specification		4	7	10	**7**	1.00
B	Write test plans	A	7	23	27	**21**	11.11
C	Design Mobile App	A	11	14	17	**14**	1.00
D	Write software code	B	10	22	28	**21**	9.00
E	Test the App	C	7	23	27	**21**	11.11
F	Deploy the App	D,E	22	29	30	**28**	1.78

a) Expected time for each activity = Column T_E (6)

$T_E = (O + 4M + P) / 6$

Answers are in the table column T_E

b) Construct PERT diagram (4)



c) Identify and determine duration of critical path (2)

duration = 7 + 21 +21 + 28 = 77 weeks

d) Calculate the specified time for 95% probability of completing the project (4)

$$\sigma_{Path}{}^{2} = \text{variance of path}$$

= 22.89

$Z = (DT - T_E) / (22.89^{1/2})$

$DT = Z \times (22.89^{1/2}) + 77 = 1.645 \times 4.7843 + 77 =$ ***84.87 weeks***

e) Calculate the probability of completing the project in 82 weeks? (4)

$$z = \frac{\text{specified time} - \text{critical path expected time}}{\text{path standard time}} = \left(\frac{DT - E_T}{\sqrt{\sigma path^2}}\right)$$

$Z = (82 - 77) / (22.89^{1/2})$

= 1.045

Reading the tables: (0.85083+0.85314)/2 = 0.851985

Therefore, probability to complete project in 82 weeks ***= 85.2%***

[20]

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1.7	.95543	.95637	.95728	.95818	.95907	.95994	.96080	.96164	.96246	.96327
1.8	.96407	.96485	.96562	.96638	.96712	.96784	.96856	.96926	.96995	.97062
1.9	.97128	.97193	.97257	.97320	.97381	.97441	.97500	.97558	.97615	.97670
2.0	.97725	.97778	.97831	.97882	.97932	.97982	.98030	.98077	.98124	.98169
2.1	.98214	.98257	.98300	.98341	.98382	.98422	.98461	.98500	.98537	.98574
2.2	.98610	.98645	.98679	.98713	.98745	.98778	.98809	.98840	.98870	.98899
2.3	.98928	.98956	.98983	.99010	.99036	.99061	.99086	.99111	.99134	.99158
2.4	.99180	.99202	.99224	.99245	.99266	.99286	.99305	.99324	.99343	.99361
2.5	.99379	.99396	.99413	.99430	.99446	.99461	.99477	.99492	.99506	.99520
2.6	.99534	.99547	.99560	.99573	.99585	.99598	.99609	.99621	.99632	.99643
2.7	.99653	.99664	.99674	.99683	.99693	.99702	.99711	.99720	.99728	.99736
2.8	.99744	.99752	.99760	.99767	.99774	.99781	.99788	.99795	.99801	.99807
2.9	.99813	.99819	.99825	.99831	.99836	.99841	.99846	.99851	.99856	.99861
3.0	.99865	.99869	.99874	.99878	.99882	.99886	.99889	.99893	.99896	.99900
3.1	.99903	.99906	.99910	.99913	.99916	.99918	.99921	.99924	.99926	.99929
3.2	.99931	.99934	.99936	.99938	.99940	.99942	.99944	.99946	.99948	.99950
3.3	.99952	.99953	.99955	.99957	.99958	.99960	.99961	.99962	.99964	.99965
3.4	.99966	.99968	.99969	.99970	.99971	.99972	.99973	.99974	.99975	.99976
3.5	.99977	.99978	.99978	.99979	.99980	.99981	.99981	.99982	.99983	.99983
3.6	.99984	.99985	.99985	.99986	.99986	.99987	.99987	.99988	.99988	.99989
3.7	.99989	.99990	.99990	.99990	.99991	.99991	.99992	.99992	.99992	.99992
3.8	.99993	.99993	.99993	.99994	.99994	.99994	.99994	.99995	.99995	.99995
3.9	.99995	.99995	.99996	.99996	.99996	.99996	.99996	.99996	.99997	.99997