

ROYAL CIVIL SERVICE COMMISSION  
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2011  
EXAMINATION CATEGORY: **TECHNICAL**

**PAPER III: SUBJECT SPECIALIZATION PAPER for SURVEY ENGINEERING**

Date: 30<sup>th</sup> October 2011

Total Marks: 100

Examination Time: 150 minutes (2 hours and 30 minutes)

Reading Time: 15 minutes (Prior to examination time)

**INSTRUCTIONS**

1. Write your roll numbers clearly on the answer booklet in the space provided.
2. The first 15 minutes is provided to check the number of pages, printing errors, clarify doubts and to read the instructions. **YOU ARE NOT PERMITTED TO WRITE** during this time.
3. Use either **Blue** or **Black** ink pen or ball point pen for the written part and HB pencils for drawing diagrams and sketches.
4. All answers must be written on the answer booklet provided. Candidates are not allowed to write anything on the question paper.
5. This question booklet consists of **eleven (11) pages including instructions**. It is divided into two sections- namely **SECTION A** and **SECTION B**.
6. **SECTION A** consists of two parts, namely **PART I** and **PART II**.  
**PART I** consists of **30 multiple choice** questions each carrying **one (1) mark** and all questions are **compulsory**. The answer of your choice must be written clearly in whole along with the question and the option number on your answer booklet.  
**PART II** consists of four (4) short questions of five (5) marks each. **All four questions are compulsory**.
7. **SECTION B** consists of two case studies. Choose only one case and answer the question of your choice. The case study carries **fifty (50) marks**.

**GOOD LUCK**

**SECTION A**  
**PART I**

Answer all questions in the answer booklet provided. Each question carries one (1) mark and all questions are compulsory (Total mark- 30).

1. The ellipsoid used for the national geodetic datum of Bhutan Drukref 03 is
  - a. Everest 1856
  - b. WGS84
  - c. GRS80
  - d. UTM Zone 45N
  
2. Which of the following electromagnetic waves is used by GNSS satellites for positioning?
  - a. Microwaves
  - b. Radiowaves
  - c. X-rays
  - d. Gamma rays
  
3. The positioning surveying principle used by GNSS surveying is
  - a. Triangulation
  - b. Resection
  - c. Traversing
  - d. Intersection
  
4. The approximate precision expected of EGM2008 gravimetric geoid model over Bhutan is
  - a. 10 metres
  - b. 5 metres
  - c. 1 metre
  - d. 0.5 metre
  
5. Which height system best approximates the mean sea level?
  - a. Normal height
  - b. Ellipsoidal height
  - c. Orthometric height
  - d. Geoidal height

6. If a map has a scale of 1:50,000, what is the scale error of such a map?
  - a. 12.5 m
  - b. 25 m
  - c. 6.25 m
  - d. 3.13 m
  
7. The spatial resolution of GeoEye satellite imagery available to general public is
  - a. 50 cm
  - b. 1 m
  - c. 2.5 m
  - d. 5 m
  
8. Which of the following characteristic of a satellite imagery is most relevant for studying change detection over a period of time
  - a. Spatial resolution
  - b. Spectral resolution
  - c. Temporal resolution
  - d. All of the above
  
9. The mathematical process used for generation of contour maps using a set of spot heights is
  - a. Interpolation
  - b. Extrapolation
  - c. Linearization
  - d. Adjustment
  
10. In order to determine the 2D coordinates of a point in an adjustment program, the minimum measurements required are
  - a. 1
  - b. 2
  - c. 3
  - d. 4
  
11. Least squares adjustment works on the principle of
  - a. Minimizing squares of errors
  - b. Minimizing sum of squares of errors
  - c. Minimizing sum of errors
  - d. Minimizing errors

12. Ground control points are used in photogrammetric processing for
- Interior orientation
  - Exterior orientation
  - Removal of edge effects
  - Edge enhancement
13. The shortest distance between the imaging sensor and the object is called
- Tangent point
  - Nadir point
  - Fiducial point
  - Exposure point
14. Which of the following is true?
- While the contour map has height information, the DEM provides elevation information
  - Contour map represents height information discretely, while DEM provides it continuously
  - Contour is a raster dataset and DEM is a vector dataset
  - A contour map is more precise than a DEM
15. The two key components of GIS consists of
- Generalization and symbolization
  - Spatial and attribute datasets
  - Theory and practical knowledge of mapping science
  - Operator and GIS hardware and software
16. Key requirement for integration of GIS datasets existing in different agencies is that
- The datasets must have compatible accuracy standard
  - The datasets must have compatible coordinate system
  - The datasets must have compatible symbolization standards
  - All of the above
17. Which of the following forms the core spatial dataset of GIS in as much as the accuracy is concerned?
- Large scale topographical database
  - The satellite imagery with a very good resolution
  - Cadastral database based on ground surveying

- d. An up-to-date land use land cover map
18. Georeferencing is defined as
- a. Relating the coordinate system of a data to WGS84 coordinate system
  - b. Relating the coordinate system of a data to Everest coordinate system
  - c. Relating the coordinate system of a data to National coordinate system
  - d. Relating the coordinate system of a data to Arbitrary coordinate system
19. The error in leveling is
- a. Proportional to the distance
  - b. Proportional to square of the distance
  - c. Proportional to square root of the distance
  - d. Proportional to the cube root of the distance
20. The observables in adjustment of Total Station data for computation of easting and northing of a station are
- a. Vertical and horizontal angles
  - b. Vertical angle and slope distance
  - c. Horizontal distance and horizontal angle
  - d. Horizontal distance and zenith angle
21. The unique identifier or primary key that is used to link cadastral data to Thram data is
- a. Plot number
  - b. Thram number
  - c. Plot area
  - d. Thram area
22. The legislation pertaining to surveying and registration of land in Bhutan in force is
- a. Land Act 1979
  - b. Land Act 2007
  - c. Resolution of the 87<sup>th</sup> National Assembly
  - d. All of the above
23. As per the Land Rules and Regulations 2007 of the Kingdom of Bhutan, the tolerance for cadastral boundary marker is set at
- a. 5 cm
  - b. 10 cm
  - c. 50 cm
  - d. 100 cm

24. The National Cadastral Resurveying Program is based on
- Everest coordinate system
  - Drukref 03 coordinate system
  - WGS84 coordinate system
  - Arbitrary coordinate system based on different dzongkhag's longitude
25. The land registration system existing in Bhutan is based on
- Deeds
  - Certificate of Title
  - Internal Agreement
  - All of the above
26. In a Coordinated Cadastre system, the boundary positions are defined by
- Boundary lines with distance and bearing dimensions
  - Boundary lines with distance and internal angle dimensions
  - Coordinates based on national geodetic datum
  - Boundary monuments captured using high resolution satellite imagery
27. Restriction for construction of house applies to
- Chhuzhing
  - Kamzhing
  - Urban lands
  - Pangzhing
28. The 25 acre land ceiling applies to all except
- Individual ownership
  - Joint ownership
  - Institutional ownership
  - Family ownership
29. All of the following can own land on freehold in Bhutan except
- Individuals
  - Government agencies
  - Gerab Dratshangs
  - Corporations

30. As per Land Act 2007, the Thram in the name of deceased cannot be maintained for more than

- a. 30 days
- b. 90 days
- c. 6 months
- d. 1 year

**PART II (Compulsory)**

**Marks (4 X 5)**

1. Demonstrate the mathematical relationship between the ellipsoidal height, the Orthometric height and the geoid-ellipsoid separation with the aid of a diagram. Express the relationship in the form of a mathematical equation in the ideal situation where there are no errors associated with any quantity.
2. State 5 different error sources that affect GNSS observations and suggest a technique to minimize each error source.
3. What are the different basic resources that you would need if you were to start up a GIS consultancy firm?
4. Land Act 2007 empowers NLCS to make changes in cadastral or the Thram data. Suppose there is a discrepancy between the cadastral map and the Thram record for a particular plot, how would you approach towards trying to correct either the Thram or the map?

## SECTION B

Marks 50

Attempt only one case study.

1. Imagine that you are managing a surveying and mapping consultancy firm. An agency has approached you to carry out a detailed topographical base mapping of an urban environment like Thimphu City. Their specific requirements are as follows:
  - a. The finished product must be based on national coordinate system both in the horizontal and the vertical dimensions.
  - b. One of the products is a contour map with a contour interval of 1 metre.
  - c. Contours must be based on mean sea level.
  - d. The features must have a horizontal precision of around 1 m.
  - e. All the natural and the manmade features must be properly coded, captured and mapped.
  - f. The finished product must be in digital format.
  - g. The agency also has some existing data in their own coordinate system, which needs to be integrated with the data that you have captured.
  - h. The final map must have all the map elements.
  - i. The final map must be delivered both in hard and soft copies.
  - j. The extent of the area to be captured is large beyond the scope of conventional ground surveying, but the project is time bound and you are expected to complete it in 6 months in all aspects.

With these specifications, prepare a project proposal to execute the project so that all the products are generated as desired by the client within the stipulated deadline. You must concisely list the resources that you need and elaborate on methodology that you would adopt to fulfill the requirements of the client. (50 Marks)

2. Imagine that you are in a country that has no legal land records either in the form of cadastral map or Thram (certificate of land title). You have been assigned the task of setting up a functional land registration system for the country to support land management, development and marketing through a project called 'Land Titling Project.' The government of the country has the following terms of reference for you to be accomplished by the end of the project timeline:
- a. The land titling project must be based on a sound geodetic network on a modern geodetic datum.
  - b. Geodetic network on the ground must be realized through construction of permanent survey marks.
  - c. For cadastral surveying, a number of control marks must be established through appropriate techniques to give an accuracy of around 2-3 cm.
  - d. Control marks must also be permanently monumented.
  - e. All control marks along with attributes must be archived in a database.
  - f. The cadastral boundaries must be surveyed and mapped based on the control marks.
  - g. Cadastral boundaries must be surveyed to a precision of about  $\pm 5-10$  cm.
  - h. Cadastral boundaries thus surveyed and mapped must be in the digital format.
  - i. All cadastral plots must have a unique plot number.
  - j. Develop Thram or land title certificate based on the cadastral map.
  - k. The Thram must have relevant information about the plot owner as well the landholding details and the consultant is expected to advise the government on what all information to include in the Thram data.
  - l. The cadastral and the Thram data must be compatible with each other so that they can be linked or integrated for various analyses. The consultant must incorporate in the design of the project how this can be achieved.
  - m. Suggest a sample format for a copy of Thram to be provided to each land owner as evidence of land ownership. You as the consultant must recommend what all

information from the Thram and the cadastral databases must be presented in the copy of the Thram to be given to the land owners.

- n. The government also needs to secure the datasets generated from theft and accidents and thus needs to be advised by you on how to overcome these security issues.

Based on the detailed terms of reference above, prepare a project proposal to execute the 'Land Titling Project' in the country. While some items above are specifications, others contain information on specific requirements from you as the consultant. It is important for you to propose specific solutions to these requirements. (50 Marks)

**TASHI DELEK**