ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2023
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALISATION PAPER FOR SURVEY ENGINEERING

Date : October 7, 2023
Total Marks : 100
Writing Time : 150 minutes (2.5 hours)
Reading Time : 15 minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.
3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:
   - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions
     Part II - 4 Short Answer Questions
     All questions under SECTION A are **COMPULSORY.**
4. **SECTION B** consists of **THREE** Case Studies. Attempt any **TWO** case study
5. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
6. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.
7. Begin each Section and Part on a fresh page of the Answer Booklet.
8. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
9. Use of any other paper including paper for rough work is not permitted.
10. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**
11. This paper has **7 printed pages**, including this instruction page.

GOOD LUCK

SECTION A

PART I: Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. The national geodetic datum of Bhutan is Drukref 03 and is realized on ITRF:
   a) 1990
   b) 2000
   c) 2003
   d) 2010

2. Which instrument is commonly used for accurate angle and distance measurements in cadastral surveying?
   a) Total station
   b) Theodolite
   c) EDM (Electronic Distance Measurement)
   d) GPS receiver

3. What is the process of distributing errors in measured data across a network of survey measurements called?
   a) Error analysis
   b) Error propagation
   c) Least squares adjustment
   d) Error matrix

4. What is the EPSG code for Drukref03 projected coordinate system?
   a) 5266
   b) 5326
   c) 5200
   d) 4545

5. What is the height provided by GPS/GNSS?
   a) Normal height
   b) Ellipsoidal height
   c) Orthometric height
   d) Geoidal height

6. In the region of Bhutan, the ellipsoid surface for height model lies_____.
   a) above geoid
   b) below geoid
   c) above terrain
   d) on terrain

7. In general, the primary classification of surveying is based on the consideration or neglect of
   a) Curvature of earth
   b) Scale Factor
   c) Distance
   d) Angle

8. One of the principles of surveying is working from_____.
   a) part to whole
   b) whole to part
   c) whole only
   d) part only

9. In Whole Circle Bearing (WCB), the value of angle varies from_____.
   a) 0 to 90
   b) 0 to 180
   c) 0 to 270
   d) 0 to 360

10. What is the preliminary inspection of survey called?
   a) Reconnaissance
   b) Preliminary check
   c) Pre-check
   d) All of the above

11. When the traversing is used in surveying?
   a) To form a network of lines
   b) To form a network of points
   c) To densify the control points
   d) All of the above

12. While performing the traverse, the closing of line on known station is called
   a) Open Traverse
   b) Closed Traverse
   c) Known Traverse
   d) Fixed Traverse

13. Datum transformation require transformation parameters that define the mathematical relationship between the old and new datums. What are the transformation parameters?
   a) Translations
   b) Rotations
   c) Scale factor
   d) All of the above

14. Which ellipsoid model is used for the National map projection of Bhutan?
   a) WGS 84 (World Geodetic System 1984)
   b) GRS 80 (Geodetic Reference System 1980)
   c) Everest 1956
   d) Clarke 1866

15. What is the value of central meridian for the National Grid projection of Bhutan 'DrukRef 03'?
   a) 0^0
   b) 90^0
   c) 180^0
   d) 360^0

16. Which bands are used in the dual frequency GPS?
    a) L1 and L3
    b) L1 and L2
    c) L2 and L3
    d) L1 and L4

17. Use of dual frequency GPS is mainly to
    a) Significantly reduce the ionospheric effect.
    b) Faster ambiguity resolution.
    c) Both (a) and (b)
    d) None of the above

18. For a map of 1:25000, what is the plottable error of the map?
    a) 6.25 m
    b) 5 m
    c) 2.5 m
    d) 10 m

19. The total station machine has the horizontal accuracy specification as 3 mm + 2ppm. What would be the maximum potential error when the horizontal distance measured is 5 km?
    a) ±10 mm
    b) ±11 mm
    c) ±12 mm
    d) ±13 mm

20. Generally, what is the minimum number of satellites required for GPS or GNSS instrument to obtain 3D position on the ground?
    a) 3
    b) 4
    c) 5
    d) 6

21. In GPS which Dilution of Precision (DOP) represents the overall geometric quality of the satellite constellation in determining a 3D position?
    a) Position Dilution of Precision (PDOP)
    b) Horizontal Dilution of Precision (HDOP)
    c) Vertical Dilution of Precision (VDOP)
    d) Time Dilution of Precision (TDOP)

22. What is the spatial resolution for the visible and near-infrared bands of Sentinel2 image available freely to the general public?
    a) 15 m
    b) 10 m
    c) 30 m
    d) 60 m

23. What type of analysis in GIS calculates the shortest path between two points on a road network?
    a) Buffer analysis
    b) Network analysis
    c) Proximity analysis
    d) Overlay analysis

24. Which GIS operation involves combining two or more layers based on their spatial relationships?
    a) Geocoding
    b) Spatial analysis
    c) Georeferencing
    d) Remote sensing

25. What is the process of aligning geographic data to a known coordinate system called?
    a) Spatial analysis
    b) Geocoding
    c) Georeferencing
    d) Remote Sensing

26. Which remote sensing sensor is commonly used for capturing high-resolution images of Earth's surface?
    a) LiDAR
    b) Radar
    c) Sonar
    d) Optical sensor

27. What is the main advantage and use of using LiDAR in remote sensing?
    a) It can capture multispectral images
    b) It is suitable for night-time data collection
    c) It provides precise elevation data
    d) It can penetrate through dense cloud cover

28. 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

29. The unique identifier or primary key that is used to link cadastral data to Thram data is
    a) Plot ID
    b) Thram number
    c) Plot area
    d) CID

30. Destroying, damaging, altering or removing survey monuments in contravention of Sections 40, 41 and 42 of Land Act 2007 shall be guilty of an offence of
    a) Misdemeanor
    b) Petty misdemeanor
    c) Violation
    d) Felony

PART II – Short Answer Questions [20 marks]

This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks.

1. In the precision survey using the Total Station, explain the process of converting the ground distance into the map distance. In the case scenario, the slope distance (ground distance) provided by total station is 1000 m. Following values are given for the corrections:
   - Atmospheric correction: 0.062
   - MSL correction: -0.277
   - Projection correction: 0.001

   Deduce the map distance using the given correction values.

2. Explain the principle of least squares adjustment in surveying. Describe how it is used to improve the accuracy of measurements and provide an example scenario where least squares adjustment would be necessary.

3. Discuss the significance of the National Spatial Data Infrastructure (NSDI) in the context of GIS data standards, management, sharing and accessibility. Explain how NSDI promotes collaboration among various organizations and levels of government.

4. Compare and contrast the Global Navigation Satellite System (GNSS) with the traditional land surveying methods. Discuss the advantages and limitations of using GNSS for positioning and mapping.

SECTION B: Case Study [50 marks]

This section consists of THREE Case study. <u>ATTEMPT ANY TWO CASES</u>. Each case study carries 25 marks.

CASE I

Imagine being the in-charge of Surveying and Mapping at NLCS. The government has presented an urgent requirement to provide specific data and information essential for conducting a prefeasibility study for a hydro power construction project. The following details encompass the required information and project deliverables:

- Detailed topographic data and information at a scale of 1:1000.
- Vertical and horizontal accuracy of 0.5 meters.
- Contour interval of 1 meter.
- The designated Area of Interest (AOI) contains sections covered by dense vegetation.
- The Area of Interest (AOI) spans 5 square kilometers.
- The project must be completed within a one-month timeline.

Your task is to formulate a comprehensive project proposal that addresses these stipulated tasks, shedding light on your chosen methodology, technical approach, and strategic considerations. This response should aptly demonstrate your proficiency in survey engineering, adeptness in project management, and adept problem-solving abilities. **(25 marks)**

CASE II

Many agencies including the NLCS has a rich repository of geospatial data and information, encompassing various aspects such as environment, topography, infrastructure, cadastral details, and more. Despite the wealth of available data, a significant portion remains underutilized, failing to seamlessly integrate into our day-to-day operations and planning processes. What factors could be attributed to this underutilization? How profound is the potential impact of unlocking the power of geospatial information across social, economic, and environmental dimensions? In consideration of these matters, present a comprehensive project proposal designed to harness geospatial information effectively, thereby enhancing evidence-based decision-making in the country. **(25 marks)**

CASE III

You've been tasked with establishing a functional land registration system, known as the 'Land Titling Project,' in a country lacking legal land records. The government has outlined the following project goals:

- Survey of cadastral boundaries based on established geodetic control points.
- Ensure cadastral boundaries with a precision of less than 10 cm.
- Develop a Thram (land title certificate) containing owner and landholding details, guided by your recommendations.
- Ensure compatibility between cadastral and Thram data for seamless integration.
- Address security concerns to safeguard datasets against theft and accidents.

Based on these requirements, please provide a comprehensive project proposal for the successful execution of the 'Land Titling Project'. **(25 Marks)**

TASHI DELEK