

ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2025
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALISATION PAPER FOR SURVEY ENGINEERING

Date	:	October 11, 2025
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 - 5 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 **8 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. Which positioning method is used by GPS to determine location?
 - a) Triangulation
 - b) Trilateration
 - c) Traversing
 - d) Intersection
2. Geoid is best described as...
 - a) Perfect sphere
 - b) An equipotential surface that approximates mean sea level
 - c) Mathematical Ellipsoid
 - d) Earth surface model
3. Which ellipsoid is used for DrukRef03 datum?
 - a) WGS 1984
 - b) Everest 1981
 - c) GRS 1980
 - d) Bessel 1841
4. Which of the following is a common error source that RTK surveying must correct for?
 - a) Ephemeris errors
 - b) Clock drift
 - c) Multi-path effects
 - d) All of above
5. In GPS surveying, the ambiguity is resolved by?
 - a) Calculating Doppler shift from satellite signals
 - b) Using only the L2 frequency
 - c) Determining the integer number of carrier wave cycles
 - d) Averaging multiple pseudo-range positions
6. Which error in surveying is not systematic?
 - a) Temperature effect.
 - b) Instrument miscalibration.
 - c) Collimation error.
 - d) Human error
7. In which portion of the electromagnetic spectrum do GPS signals operate?
 - a) Infrared
 - b) Visible light
 - c) Radio wave
 - d) Ultraviolet

8. Stereoscopic vision in photogrammetry is possible due to...
 - a) Digital image processing.
 - b) Camera distortion.
 - c) Color enhancement.
 - d) Overlap in successive images
9. Orthophotos are generated to...
 - a) Reduce the image file size.
 - b) Remove image distortions and terrain relief.
 - c) Enhance 3D modeling.
 - d) Correct orientations.
10. What is 'parallax' refers to in photogrammetry?
 - a) Measurement error
 - b) Camera distortion
 - c) Refraction effect
 - d) Apparent displacement due to different viewpoints
11. What are the transformation parameters?
 - a) Translations
 - b) Rotations
 - c) Scale factor
 - d) All above
12. What type of data is produced directly by LIDAR?
 - a) Raster
 - b) Vector
 - c) Point cloud
 - d) Image
13. For a map of 1:5000, what is the minimum size of the features that can be plotted in the map?
 - a) 2 m
 - b) 1.25 m
 - c) 2.5 m
 - d) 3.5 m
14. In control network what is horizontal accuracy of the secondary control point in control network in Bhutan?
 - a) ≤ 2 cm
 - b) ≤ 4 cm
 - c) ≤ 5 cm
 - d) ≤ 8 cm
15. The total station machine has the horizontal accuracy specification as $2 \text{ mm} + 2 \text{ ppm}$. What would be the maximum potential error when the horizontal distance measured is 1 km?
 - a) ± 2 mm
 - b) ± 4 mm
 - c) ± 6 mm
 - d) ± 8 mm

16. In surveying, trilateration refers to measuring...
- Angle
 - Distance
 - Time
 - All above
17. What does Dilution of Precision (DOP) in GPS surveying represent?
- The number of visible satellites
 - The strength of satellite signal
 - The effect of satellite geometry on positional accuracy
 - The number of frequency bands used
18. What is the main cause of systematic errors in surveying?
- Random fluctuations in measurements
 - Instrumental imperfections or environmental factors
 - Human mistakes during data recording
 - Variations in the gravitational field
19. Which map projection system is more accurate to be used for the cadastral mapping in Bhutan?
- Local grid projection defined for every Dzongkhag
 - National grid projection
 - Universal Transverse Mercator (UTM)
 - Plane projection
20. What is the maximum positional tolerance accepted for cadastral survey in Bhutan?
- 1 decimeter
 - 0.1 decimeter
 - 0.01 m
 - 10 mm
21. Which communication method is commonly used to transmit RTK corrections?
- Bluetooth
 - UHF/VHF radio or NTRIP via Internet
 - Fiber optic cable
 - Infrared
22. What measurement technique is primarily used in GNSS-RTK surveying to achieve centimeter-level accuracy?
- Pseudo-range positioning
 - Doppler shift tracking
 - Carrier-phase measurement
 - code-based ranging
23. Which part of the electromagnetic spectrum is typically emitted by Electronic Distance Measurement (EDM) instruments?
- Gamma rays
 - Radio waves
 - Ultraviolet rays
 - Infrared and microwave signals

24. EDM (Electronic Distance Measurement) works on the principle of...
- a) Triangulation
 - b) Traversing
 - c) Resection
 - d) Travel time and phase shift of electromagnetic waves
25. What is equivalent value of area in hectare for 1 acre plot?
- a) 0.405 ha
 - b) 0.505 ha
 - c) 0.605 ha
 - d) 0.705 ha
26. A GNSS receiver measures an ellipsoidal height of 2000 m at a survey point in Bhutan. Given the geoid height at that location is 35 m what is the orthometric height at the survey point?
- a) 2000
 - b) 2035
 - c) 1965
 - d) 2010
27. The Land Act 2007 of Bhutan mandates all the cadastral survey is conducted on National Geodetic reference datum. The current datum (DrukRef03) is realized at the tectonic plate epoch of
- a) 2000
 - b) 2003
 - c) 2005
 - d) 2010
28. To achieve a positional accuracy of a cadastral survey as per the Land Rules and Regulation 2007 of Bhutan, what would be the maximum recommended baseline distance when using a single-base CORS RTK setup?
- a) 20 km
 - b) 30 km
 - c) 40 km
 - d) 50 km
29. As per the Land Rules and Regulation 2007 of Bhutan, what is the frequency of all survey equipment must be calibrated....
- a) Annually
 - b) Biannually
 - c) Quarterly
 - d) Every 3 years
30. What is the significant digit of rounding area used for cadastral parcel in LISCAD?
- a) 0.001
 - b) 0.005
 - c) 0.01
 - d) 0.05

PART II – Short Answer Questions [20 marks]

This part has 6 Short Answer Questions. Choose any FIVE questions. Each question carries 4 marks.

1. Describe the difference between the Carrier-Phase and Pseudo-Range (Code) Techniques for GNSS Measurement. Include their principle, key features, advantage and limitations. **(4 marks)**
2. What is scale factor? Explain how it acts as a multiplier in Total station and divider in GPS. **(4 marks)**
3. What is plottable error and map accuracy. Compute plottable error and map accuracy for the map scale of 1:5000. **(4 marks)**
4. Describe the process of Differential GNSS positioning and its advantages over standard GPS. Suppose the base station coordinates are known as (X: 500 m, Y: 300 m, Z: 200 m). The rover receives the following correction values from the base station: (ΔX : -5 m, ΔY : 3.0 m, ΔZ : -2.5 m). Calculate the corrected coordinates for the rover. **(4 marks)**
5. Explain the National Grid Projection System of Bhutan. Discuss the role and impact of the scale factor in this system. Illustrate your explanation with appropriate examples. **(4 marks)**

SECTION B: CASE STUDY [50 marks]

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

CASE I

Bhutan currently operates 14 GNSS Continuously Operating Reference Stations (CORS) to support geodetic and surveying applications. As a lead survey engineer, you are tasked with proposing a national-level project to modernize and expand the GNSS-CORS network to meet the growing demand for high-accuracy positioning and geospatial services across the country. **(25 marks)**

Your proposal should include:

- Current limitations of the existing CORS network.
- Proposed technical enhancements
- Expansion strategy, including optimal station density, location criteria
- Expected improvements in geodetic reference frame maintenance, real-time and post-processed positioning accuracy.
- Applications and benefits in key sectors.
- Resource and implementation plan

CASE II

Accurate height information is crucial for infrastructure development, flood modeling, engineering design, and sustainable land management. Current geoid model has some accuracies issues up to 25 cm. As a lead geodetic engineer at the National Land Commission Secretariat (NLCS), you are tasked to propose a comprehensive national project to develop a high-accuracy geoid model tailored for Bhutan's rugged terrain and geodetic infrastructure. **(25 marks)**

Your proposal should cover:

- Need and significance of a local geoid model and its benefits for surveying and national development.
- Data requirements and methods of acquisition.
- Methodology for geoid computation and fitting.
- Validation and accuracy assessment procedures.
- Implementation and applications, including institutional responsibilities and data dissemination.

Justify your approach with relevance to Bhutan's topography, CORS network, and geodetic capacity.

CASE III

The government has an urgent requirement to obtain large scale topographical survey for the Gelephu Mindfulness City (GMC), which spans 2000 square kilometers, which would be a unique city in the world. The following details encompass the required information and key deliverables:

- Detailed topographic data and information at a scale of 1:1000.
- Land use and land cover detail
- Vertical and horizontal accuracy of 0.5 meters.
- Contour interval of 1 meter.
- The designated Area of Interest (AOI) includes urban areas, agricultural land, dense vegetation and hilly terrain.
- The project must be completed within a two-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, required resource inputs and project deliverables. The proposal should aptly demonstrate your proficiency in survey engineering, adeptness in project management, and adept problem-solving abilities. **(25 marks)**

TASHI DELEK