



11. The electron density is maximum at the \_\_\_\_\_ in the ionosphere.  
 a. D1-layer                      b. E1-layer                      c. F1-layer                      d. F2-layer
12. The weightage of measurements is inherited in \_\_\_\_\_.  
 a. Confusion matrix                      b. Innovation Matrix  
 c. Covariance matrix                      d. Kalman Gain
13. Cycle slips can be of half integers due to:  
 a. multipath effect                      b. integer ambiguity  
 c. missed satellite message                      d. satellite position error
14. The unit vector along line of sight of GNSS signal is directed from:  
 a. receiver to satellite                      b. rover to reference receiver  
 c. reference to rover receiver                      d. satellite to receiver
15. A white noise means \_\_\_\_\_.  
 a. zero mean, zero standard deviation                      b. certain mean and standard deviation  
 c. zero mean, certain standard deviation                      d. certain mean and variance.
16. The noise in triple differencing is \_\_\_\_\_ times larger than that of the single differencing measurement, when the differences to both are measured with respect to zero difference measurement.  
 a. one                      b. two                      c. three                      d. four
17. The receiver bias in carrier phase measurements can be eliminated upon \_\_\_\_\_.  
 a. single differencing                      b. triple differencing only  
 c. double differencing only                      d. cannot be eliminated.
18. The slant tropospheric delay at 30° elevation is about \_\_\_\_\_ greater than that at zenith.  
 a. 2 times                      b. 3 times                      c. 4 times                      d. 5 times
19. Which of the following statement is **CORRECT**?  
 a. The precision of GNSS-RTK is higher than post-processed GNSS.  
 b. The total effect of ionospheric delay is less than the total zenith delay  
 c. The multipath effect is same for stations that are within 1km distance  
 d. The phase centre offset is same for signals of all frequencies.
20. The effect of elevation in distance reduction (from ground to grid) is:  
 a. small for short and flat baseline  
 b. small for short baseline with significant height difference  
 c. small for long baseline with significant height difference  
 d. large for long and flat baseline

KATHMANDU UNIVERSITY  
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For precise point positioning using GNSS technology, either we estimate all the unknowns or uses the ones that are derived from the existing models and estimate only the remaining unknowns.

SECTION "B"

[7Q. × 4 = 28 marks]

Attempt *ANY SEVEN* questions.

1. Express the observation equation for carrier observation of single frequency GPS signals. Mention the sources of errors included in the observation model. [2+2=4]
2. Consider the multi-frequency (L1, L2) GNSS observations. Express the observation equation for pseudorange measurements. Mention the frequency dependent sources of errors. [2+2=4]
3. Discuss the effect of tropospheric delay on short baseline with significant height delay. Explain the Saastamoinen and Hopfield Delay model. [1+3=4]
4. Explain briefly on any three types of technique specific problems of using GNSS for point positioning. [2+2=4]
5. What is Kalman Filter? Explain about the state space model and observation model. Mention a few applications of Kalman Filter algorithm. [4]
6. Derive the mathematical expression for the double difference pseudorange measurements. [2+2=4]
7. Describe about the different ionospheric delay estimation techniques. Explain with illustrations. [4]
8. What is a CORS? Explain about its significance in readjusting the national geodetic control network after major seismic events? [4]
9. What is an Error Budget in GNSS measurements? Prepare the table that shows sources of errors, approximate errors and method to reduce/correct these errors. [4]

**P.T.O.**

SECTION "C"

[2Q. × 6 = 12 marks]

Attempt *ANY TWO* questions.

10. Consider the following observation equations for carrier phase and pseudorange measurements.

$$L_1 = \rho' - I + \frac{c}{f_1} N_1$$

$$L_2 = \rho' - \frac{f_1^2}{f_2^2} I + \frac{c}{f_2} N_2$$

$$P_1 = \rho' + I + b_1$$

$$P_2 = \rho' + \frac{f_1^2}{f_2^2} I + b_2$$

with

$$\rho' = \rho + c\delta r_r - c\delta r^s + T$$

Discuss the mathematical expressions and applications of geometry-free, ionosphere-free, wide-lane and Melbourne-Wübbena linear combinations. [6]

11. Assume that you have a low-cost single frequency GPS receiver that is capable of performing pseudorange and carrier phase measurements. You are using it for GPS-RTK. The GPS-RTK is differential positioning technique, whereby the rover receiver estimates baseline, tropospheric zenith delay, integer ambiguities, and pseudorange multipath so as to prevent such errors being propagated to other estimates. An additional precaution of a prior knowledge on tropospheric delay is also used while conducting this survey. Under these circumstances, prepare a matrix-vector notation showing the size of each matrix. [6]
12. Describe about the different types of GNSS positioning techniques. Explain with appropriate comparative diagrams. [6]