

The University of Melbourne

Semester 2 Assessment 2005

Department: Geomatics
Subject Number: 451-337
Subject Title: Satellite Positioning and Geodesy
Reading Time : 15 minutes
Writing Time : 3 hours

This paper has 3 pages including this cover page

Authorised Materials:

Electronic calculators are permitted

Instructions to Invigilators:

Students require script books

Instructions to Students:

All five (5) questions are to be attempted
All answers are to be written in the script books provided
All questions carry equal marks

Baillieu Library:

Paper is to be archived in the Baillieu Library

1. (a) GPS is a truly 3D measurement system, providing baselines (vectors) between points. However, the height component of a GPS baseline is not immediately useful for most surveying applications. Explain why this is so and illustrate the problem with an appropriately annotated diagram. (5 marks)
- (b) Two significant advantages emerge if the GPS heighting problem alluded to in Question 1 (a) can be overcome. Provide an explanation of these advantages and, in this context, briefly outline options for solution of the problem. (5 marks)
- (c) A grid-based approach has been adopted in Australia for the distribution of a transformation model to move spatial data from AGD66 to GDA94 and vice versa. Describe the main differences between AGD66 and GDA94. (5 marks)
- (d) In relation to Question 1(c), outline the rationale and the methodology behind the development of the grid-based approach to coordinate transformation. (5 marks)

2. (a) The observation equation for the GPS carrier phase observable is given below (in units of metres) :

$$\Phi = c(dt - dT) + R - d_{\text{ion}} + d_{\text{trop}} - \lambda N(t_0)$$

Give a detailed definition of each term in this equation.

- (5 marks)
- (b) Using the observation equation given in Question 2(a), develop an expression for the GPS double difference observable. In presenting this derivation, take particular care to explain and justify each step. (10 marks)
- (c) What advantages does the double difference observable have over raw carrier phase observations? (5 marks)

3. (a) In describing the basic structure of the Global Positioning System, it is usual to subdivide the system it into three parts – the space segment, the control segment and the user segment. Describe each segment and their inter-relationships. (10 marks)
- (b) The C/A-code transmitted by GPS satellites gives rise to the code pseudo-range observable. Develop the pseudo-range observation equation. Show how the pseudo-range observation equation relates to the various Dilution of Precision (DOP) factors. (10 marks)
4. (a) Give complete definitions for each of the following :
- MGA
 - Cycle slip repair
 - Triple difference observable
 - Multipath error
 - Broadcast ephemeris
- (10 marks)
- (b) The summit of Mt Everest is 8850 m above MSL. The deflection of the vertical at this point is 2'. Show that even in this extreme case, the approximation inherent in the following formula is valid :
- $$h = H + N$$
- (5 marks)
- (c) Differential GPS (DGPS) based on the C/A-code offers a means of reducing the effect of spatially correlated errors. Discuss and illustrate this statement. Outline the fundamental requirements of utilising a commercial DGPS service. (5 marks)
5. (a) In moving from code-based GPS positioning to the carrier phase, it is possible to make significant improvements in achievable precision. However, to maximise the potential gains, it is necessary to carefully model or eliminate all known sources of error. Of particular note in this regard is the impact of the earth's atmosphere. Give a comprehensive description of how the atmosphere interferes with GPS signals and the options that exist to overcome this source of error. (15 marks)
- (b) In an era well before the advent of GPS, somebody said "time is of the essence". This quote could aptly be applied to GPS. Explain the role of time in the operation of GPS for positioning and navigation purposes. (5 marks)