

National Exams December 2008

04-Geom-A3, Geodesy and Positioning

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a CLOSED BOOK EXAM.
No calculator is needed nor permitted in this exam.
3. SIX (6) questions constitute a complete exam paper.
The first six questions as they appear in the answer book will be marked.
4. Each question is of equal value.
5. Most questions require an answer in essay format. Clarity and organization of the answer are important.

1. Coordinate Systems

Define the orbital (OR) and the instantaneous terrestrial (IT) coordinate systems. Give the transformation equation between them in matrix format. Please use rotation matrices and define all rotation angles involved in this transformation.

2. Height systems

- a) Define geopotential number. What does it express physically?
- b) Define *dynamic* and *orthometric* heights and discuss their conceptual difference.
- c) In what type of applications do we use dynamic heights?

3. Conformal mapping and Mercator projection

- a) Tissot's indicatrix: what is it and what does it express? Using simple sketches show the shape of the indicatrix on a global conformal map. Please explain your sketches.
- b) Present briefly the specifications of the Universal Transverse Mercator (UTM) projection.

4. Inertial positioning, or Inertial Navigation Systems – INS

- a) What is the principle of an INS? Briefly describe its components and their roles in the measurements. You can use sketches if necessary.
- b) Why is it important to know accurately the gravity field of the Earth when using an inertial navigation system?
- c) Why is it important to maintain parallelism of the INS instrument frame when the vehicle pitches, rolls and yaws?

5. Satellite Positioning

- a) One of the major sources of errors in GPS positioning is multipath. Please describe how this error occurs, give its order of magnitude and describe practical way(s) you can follow in the field to minimize it.
- b) Describe how GPS carrier beat phase measurements are used in positioning. Use sketches if necessary to illustrate your answer.

6. Gravity field

What is *gravimetry* and what *gradiometry*? What kind instrument(s) do we use for each and what do we measure with each method? Can an *accelerometer* be used to measure gravity? How?

7. Briefly describe the terms below (2-3 sentences). Sketches or graphs, wherever possible, are acceptable:

- | | |
|---------------------|--------------------------------|
| a) Earth precession | f) Geodetic datum |
| b) Atomic time | g) Canadian Base Network (CBN) |
| c) Sidereal time | h) ITRF |
| d) GPS-RTK | i) RINEX |
| e) Gravity anomaly | j) IGS |

Marking Scheme

1. 20 marks total (5 for each definition and 10 for the transformation)

2. 20 marks total
 - (a) 5 marks
 - (b) 8 marks
 - (c) 7 marks

3. 20 marks total (10 for each section)

4. 20 marks total
 - (a) 6 marks
 - (b) 7 marks
 - (c) 7 marks

5. 20 marks total (10 marks for each section)

6. 20 marks total

7. 20 marks total (2 marks each item)