NATIONAL UNIVERSITY OF SINGAPORE

FACULTY OF ENGINEERING

EXAMINATION FOR

(Semester I: 2013-2014)

CE5310 - HYDROINFORMATICS

Nov/ Dec 2013 - Time allowed: 2.5 hours

INSTRUCTIONS TO CANDIDATES

1. This examination paper contains **FIVE(5)** questions and comprises **FOUR(4)** printed pages.
2. Answer ALL **FIVE(5)** questions.
3. All questions DO NOT carry equal marks.
4. This is a "**CLOSED BOOK**" examination.

Question 1 [20 marks]

Suppose you are involved in a water quality monitoring project. Your job is to manage the water quality data. Your colleagues collect water samples daily at several prescribed locations in a reservior and analyse the water quality.

The attributes of location are: name, latitude, and longitude.
The attributes of water sample are: who, date, time, location, temperature, salinity, turbidity, and pH. Here "who" is the name of the person who takes that water sample.

a) Design a database to manage the data in this project. List the names of the tables, the attributes in your tables, and the data type of each attribute.

(6 marks)

b) For a specific latitude and longitude pair (1.287137, 103.863237) corresponding to one of the fixed locations, you are asked to find all the water quality data of water samples taken at that location. Write the SQL query (or queries) for this task based on your design of the database.

(6 marks)

c) You are requested to find out the average water salinity for each location for each day in the range of 2013 Sep 01 and 2013 Oct 25. The result should be sorted by date first and then location. Write the SQL query (or queries) for this task based on your design of the database.

(8 marks)

Question 2 [6 marks]

Why is metadata important in GIS? (6 marks)

.../3

Question 3 [28 marks]

Project Neptune is a project carried out by NUS and Deltares in collaboration with Singapore's National Environmental Agency. The aim is to create a monitoring system that can monitor changes in marine water quality, combined with an advance computer modelling system that can forecast the extent of marine water quality problems. The project will use eight large buoys equipped with sensors to collect data from coastal waters around Singapore.

As coastal water quality is affected by runoff from land, a GIS can be used to analyse the relationship between land use and runoff water quality.

a) In the analysis the following vector data layers can be used: i) land use, ii) catchments, iii) rivers and canals, and iv) water quality measurement points. For each of these layers give the most appropriate feature type and possible attributes.

(8 marks)

b) The analysis attempts to establish a relationship between land use and water quality at measurement points, which are located at the outlets of catchments (points where rivers and canals flow into the sea). For instance, if a catchment is dominated by industrial land use, it is expected that this results in poorer water quality. Describe the steps in ArcGIS that are required to establish a relationship between land use in a catchment and water quality.

(12 marks)

c) The eight measurement buoys will be linked to a 3D hydrodynamic and water quality model to assess water quality at all locations in Singapore's coastal waters. Instead of using a 3D model, a first quick approach could be to interpolate the measurements at the buoys. Explain why raster data would be most appropriate for this analysis.

(8 marks)

Question 4 [16 marks]

Imagine a situation in which one of the buoys in Neptune monitoring system has been affected by nearby navigation traffic and started producing noisy data.

a) What would be methods for handling such noisy data?

(5 marks)

b) Describe binning as one possible smoothing methods. Discuss advantages and disadvantages of different binning methods.

(5 marks)

c) The following data have been collected by one of sensors:

[13, 17, 25, 19, 20, 21, 23, 23, 24, 24, 17, 31, 29, 30, 19]

Smooth these data sample in three bins of equal depth.

(6 marks)

Question 5 [30 marks]

One of the main purposes of installing combined monitoring and modeling system, such as Neptune, is to combine monitoring data and numerical models in data assimilation sense of the word.

a) What is data assimilation? Describe purpose and main intent behind data assimilation.
(8 marks)

b) Describe different data assimilation approaches. Discuss their advantages and disadvantages.
(10 marks)

c) How would you approach data assimilation problem based on error correction? Would it be possible to estimate uncertainties of assimilated forecast and how?
(12 marks)

- END OF PAPER -