

NATIONAL UNIVERSITY OF SINGAPORE

CE5310 - HYDROINFORMATICS

(Semester I: AY2016/2017)

Time Allowed: 2.5 Hours

INSTRUCTIONS TO CANDIDATES

1. Please write your student number only. **Do not write your name.**
2. This assessment paper contains **FIVE** questions and comprises **FIVE** printed pages.
3. Answer **ALL** questions. All questions do not carry equal marks.
4. This is a “CLOSED BOOK” assessment.

Question 1 [25 marks]

Time series of total monthly rainfall depths for Changi station between years 1980 and 2013 are available for analysis. The length of this time series is 408 samples [408= 34 (years) *12 (months)]. Mean, standard deviation, minimum, and maximum values of the time series are 182 mm, 117 mm, 6 mm, and 766 mm, respectively.

- (a) Total rainfall in month of December 2013 is 348 mm.

If the seasonal effects of rainfall in Singapore are not taken into account (i.e. assuming rainfall process is stationary across all months), normalize the total monthly rainfall value for month of December 2013 using “min-max” and “z-score” normalization algorithm.

If the seasonal effects were taken into account, how would you normalize the value using “z-score” algorithm based on monthly total rainfall series from 1980 to 2013?

Justify answers in your own words.

[10 marks]

- (b) Describe process of detrending the monthly total rainfall series for Changi station between 1980 and 2013 in case of presence of a deterministic trend in the data.

What should be done in case of a stochastic trend? Assume in both cases that the trend is linear.

[10 marks]

- (c) Suppose the relationship between daily maximum temperature and daily minimum temperature at Changi station is linear, and you have established a simple linear regression model to describe their relationship mathematically.

What kind of metrics can you use to demonstrate accuracy of the model?

How do you judge your model is valid based on the analysis of the residuals?



[5 marks]

Question 2 [20 marks]

Descriptive statistics is used to describe the basic features of the data under a study. They provide summaries about particular sample data set. Descriptive statistics relies on a number of tools and analysis to describe properties of the data sample. In your own words describe briefly:

- (a) What is histogram? [4 marks]



- (b) What are the measures of central tendency? Briefly describe each of them.



[4 marks]

- (c) What are measures of variability? [4 marks]



- (d) What is skewness? [4 marks]



- (e) What is kurtosis? [4 marks]

**Question 3 [15 marks]**

Name and describe the main features of Genetic Algorithms (GA), including main operators used in GA.

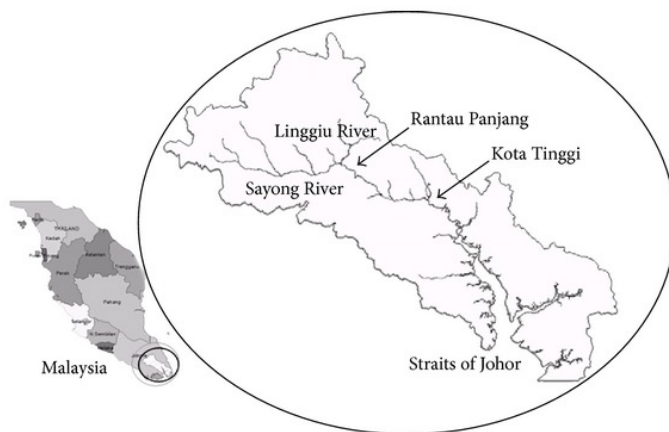
**Question 4 [10 marks]**

Describe covariance and correlation coefficient. What is the key similarity and the difference between covariance and correlation?

Question 5.1 [15 marks]

The water quality in the Singapore coastal region is affected by discharges from the Malaysian state of Johor. One of the major tributaries is the Johor River. The catchment area of Johor River (figure 1) is 2,637 km² large. In order to estimate discharge from this river into the Johor Straits, a lumped rainfall-runoff model is used.

Unlike a distributed hydrological model (such as PCRaster) where each computational cell of the model generates a runoff value, in a lumped hydrological model a single runoff value is generated for the entire catchment area (or sub-catchments). GIS software is used to prepare some of the spatial information required as model inputs.



The following GIS layers are available:

- Catchment delineation;
- River sections;
- Meteorological stations;
- Digital elevation model (DEM);
- Land use.

- (a) Except for the DEM and land-use layer, all layers in this GIS are vector layers. For each of the vector layers, give the most appropriate feature type and list a number of possible attributes for each of the layers.
- (b) Runoff coefficients are attributed to areas within the catchments based on land-use and gradient characteristics. Suppose the DEM has been used to classify areas either as sloped or flat and that the land-use map differentiates between urban and rural areas.

Describe how raster analysis can be used to generate a map classifying areas into either of the four categories:

- 1.) urban, sloped areas;
- 2.) urban, flat areas;
- 3.) rural, sloped areas; and
- 4.) rural, flat areas.

Assume that the DEM and land use raster map align well and can be used directly by GIS raster analysis tools.

Question 5.2 [15 marks]

The rainfall-runoff model requires rainfall data as an input. Suppose there are two different sources of information for rainfall data:

- rainfall intensity observed at ten on ground meteorological stations (you may assume that the stations are adequately distributed to represent the entire catchment area); and
- TRMM (Tropical Rainfall Measuring Mission) satellite images.

TRMM data comes as a raster data file with resolution $0.25^\circ \times 0.25^\circ$ (1° is approximately equal to 110 km.). Each grid cell has a unique value for rainfall intensity. Assume the Johor River catchment area is covered by six such grid cells. Note that the total area covered by these six grids is larger than the Johor River catchment area itself.

- (c) Describe how you would use TRMM rainfall data to generate one rainfall intensity representative for the Johor River catchment using raster statistics.
- (d) Instead of TRMM satellite data the rainfall data from the ten meteorological stations can be used as well. Describe how GIS can be used to distribute the observed rainfall data at the ten stations over the Johor River catchment area. Also, discuss the advantage of using the observed rainfall at the ten meteorological stations over TRMM raster data for the rainfall-runoff model for the Johor River catchment area.

- END OF PAPER -