NATIONAL EXAMS DECEMBER 2017

16-Civ-B4, Engineering Hydrology

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 with a 2-sided ($8\frac{1}{2}'' \times 11''$) AID SHEET prepared by the candidate allowed.

3. The candidate may use one of two calculators, the Casio or Sharp approved models. Note that you must indicate the type of calculator being used. Write the name and model designation of the calculator on the first inside left hand sheet of the exam work book.

4. Any five(5) questions constitute a complete paper. Only the first five(5) answers as they appear in your work book(s), will be marked.

5. Each question is equally weighted at twenty (20) points for a total of a possible one-hundred (100) points for a complete paper. Marking Scheme is on page 6.

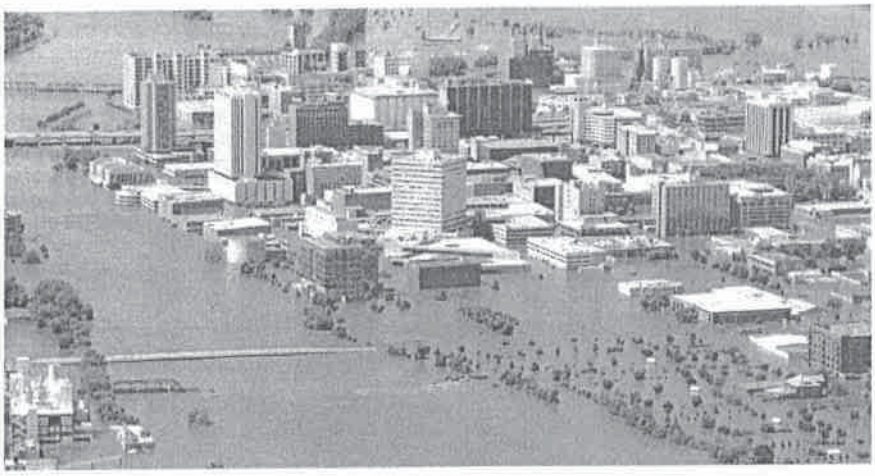
Problem 1

Provide answers to the following questions related to *hydrologic cycle processes*, *groundwater flow* and *surface runoff* :

(7) (i) Briefly explain three (3) ways in which the hydrologic processes may be influenced by global warming. As part of your explanation, include a labelled schematic which shows the hydrologic cycle with the main processes identified.

(7) (ii) Groundwater may be found below ground in confined or unconfined aquifers. Briefly explain three (3) important differences in water management issues when using a confined or unconfined aquifer as a potable water supply source.

(6) (iii) Briefly explain three (3) key reasons why only a small percentage of the overall precipitation generally results in surface runoff.



Problem 2

Provide answers to the following questions related to *runoff hydrographs*, *unit hydrographs* and *conceptual models of runoff* :

(6) (i) Provide a concise graphical explanation of how a runoff hydrograph is generated from a unit hydrograph or provide a clear point form explanation of this. *Do only one, not both.*

(7) (ii) Briefly explain: (a) how a unit hydrograph may be generated for a given watershed; (b) how a unit hydrograph may be used in engineering applications such as the design of a culvert to protect a highway from washing out during a major storm; and (c) provide two (2) general assumptions an engineer needs to be aware of when applying the unit hydrograph technique.

(7) (iii) Briefly explain a method where a conceptual model of a watershed may be calibrated for use in simulating peak rainfall-runoff. In your explanation, also provide two (2) limitations of the model.

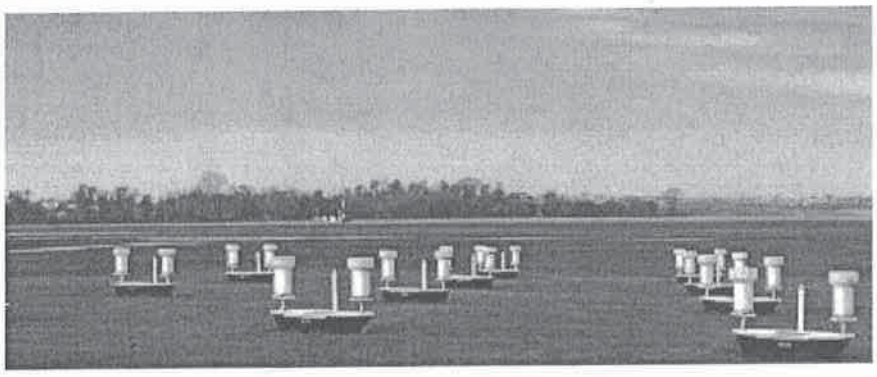
Problem 3

Provide answers to the following questions related to *point* and *areal estimates of precipitation* and *stream flow measurements* :

(6) (i) Briefly describe how the Theissen Polygons technique works in estimating the total precipitation over a large watershed and how its accuracy is affected if there is only a limited number of rain gauges as the information source.

(6) (ii) Briefly explain how the Stream Stage and Rating Curves may be used to measure the stream flow following a storm event within the drainage area of a stream. As part of your explanation, provide one (1) technique that may improve the accuracy of the stream flow measured.

(8) (iii) Compare and contrast two (2) mechanisms that cause changes in stream flow. Select one (1) natural and one (1) human-induced mechanism for comparison.



Problem 4

Provide answers to the following questions related to *basics of hydrologic modelling* and *reservoir* and *lake routing* :

(8) (i) Briefly explain: (1) How the hydrologic transport model may be used to simulate river flow and calculate water quality parameters; and (2) Two key assumptions an engineer needs to be aware of when using the input, output-storage equation given as:

$$\frac{dS}{dT} = I(t) - Q(t)$$

(6) (ii) Explain three key steps in calibrating a rainfall-runoff model.

(6) (iii) Explain the fundamentals of the Muskingum Crest Segment Routing method or a similar method used for reservoir or lake routing.

Problem 5

Provide answers to the following questions related to *channel* or *river routing* and *flood wave behaviour* :

(6) (i) Briefly explain three (3) key steps in the application of the Level Pool Method or a similar method useful for channel or river routing and provide a brief example of its use.

(7) (ii) Briefly explain two (2) main differences between a *lumped hydrologic approach* and a *distributed hydraulic method* in flow routing. As part of your explanation, indicate under what conditions one method is preferred over the other.

(7) (iii) Consider a flood wave, caused by a sudden snow melt in a mountainous region, resulting in a wave propagating in a river. Assume that the river goes through a highly populated urban area at risk of spilling over its banks and causing urban floods. Explain three (3) routing techniques you would use to predict the wave flooding potential and one (1) engineering strategy you would recommend to minimize downstream flooding.

Problem 6

Provide answers to the following questions related to *statistical methods of frequency* and *probability analysis applied to precipitation* and *floods* :

(6) (i) Briefly explain how an intensity-duration frequency (IDF) curve integrates the storm duration with its frequency and intensity. As part of your explanation, provide a clearly labelled schematic of a typical IDF-curve.

(6) (ii) Explain three (3) important parts of a statistical method that can be used in flood-frequency analysis to predict the peak discharge of both a transient (short term) and annual flood event.

(8) (iii) Explain why frequency and probability distributions are used to characterize hydrologic variables. Identify two (2) hydrologic variables and their commonly applied distributions.

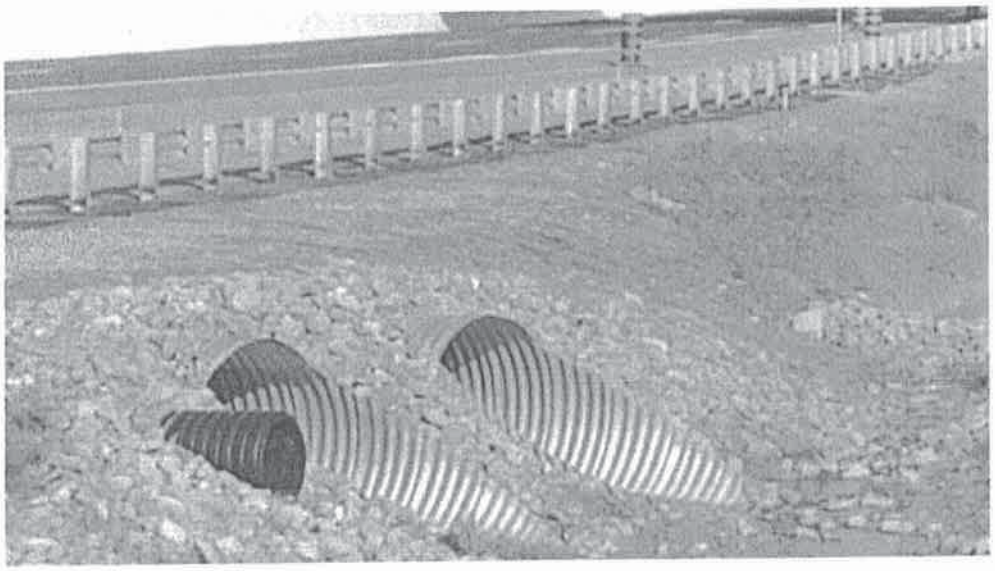
Problem 7

Provide answers to the following questions related to the *urban and highway drainage structure design* :

(10) (i) Briefly explain three (3) key design principles when using a dry pond and three (3) different design principles when using a wet pond to control the quantity and/or quality of stormwater flow potentially affecting the urban and highway drainage system.

(5) (ii) Briefly explain two (2) key reasons for the use of grassed or vegetated ditches in the design of highway drainage structures.

(5) (iii) Briefly explain two (2) key reasons for the use of underground oi-grit separators in the development of roadways in urban areas where storage cannot be easily incorporated.



Marking Scheme

1. (i) 7, (ii) 7, (iii) 6 marks, 20 marks total

2. (i) 6, (ii) 7, (iii) 7 marks, 20 marks total

3. (i) 6, (ii) 6, (iii) 8 marks, 20 marks total

4. (i) 8, (ii) 6, (iii) 6 marks, 20 marks total

5. (i) 6, (ii) 7, (iii) 7 marks, 20 marks total

6. (i) 6, (ii) 6, (iii) 8 marks, 20 marks total

7. (i) 10, (ii) 5, (iii) 5 marks, 20 marks total