NATIONAL EXAMS MAY 2015

98-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.

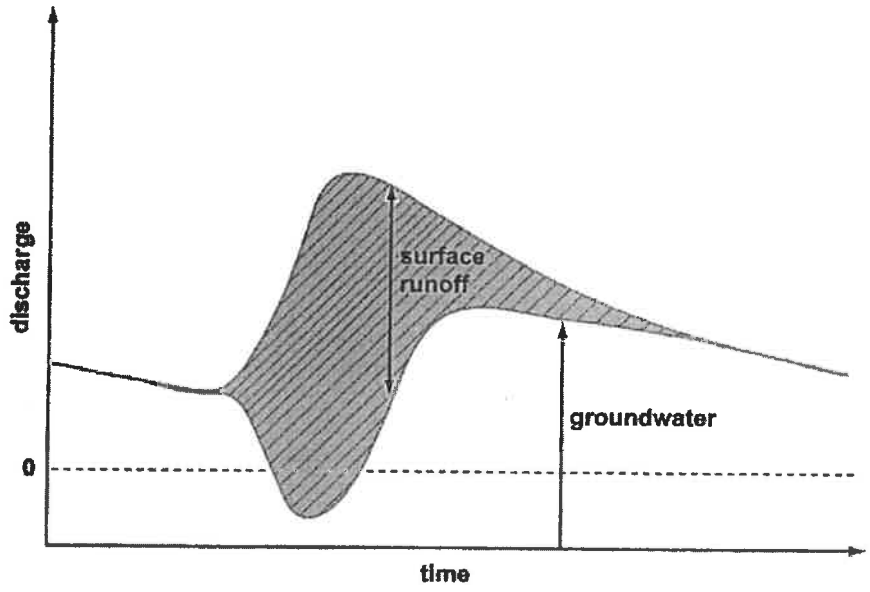
Problem 1

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

(7) (i) Describe four (4) major hydrologic processes and briefly explain the importance of each component to the hydrologic cycle. Use a clearly labelled schematic as part of your answer.

(7) (ii) Briefly explain the main differences between confined and unconfined aquifers as they relate to source waters and potential surface contamination due to advective transport.

(6) (iii) Explain how a surface runoff hydrograph may be used to predict a river discharge rate. Consider the figure below in your explanation.



Problem 2

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

(6) (i) Briefly explain how a runoff hydrograph is generated for a large watershed and give two (2) main properties of a watershed that influence a runoff hydrograph significantly.

(7) (ii) Give an engineering application of the use of the unit hydrograph in a watershed and briefly explain two (2) major assumptions or limitations of its use.

(7) (iii) A watershed has shown rapid growth and development recently and a watershed plan, which included a conceptual model for runoff, is to be developed as a way to assist decision makers about surfacewater and groundwater quality and quantity impacts. Describe three (3) major tasks in the development of a conceptual model for the watershed and give two (2) limitations on its use by decision makers.

Problem 3

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

(6) (i) Briefly describe two (2) main differences between the Thiessen Mean and Isohyetal Analysis techniques used to calculate areal precipitation. As part of your description, provide a clearly labelled schematic for each technique showing how each technique is different.

(6) (ii) Briefly explain how stage information may be readily converted to stream flow. As part of your explanation, provide a schematic of a typical rating curve and explain how a stream gauge is used to develop a rating curve.

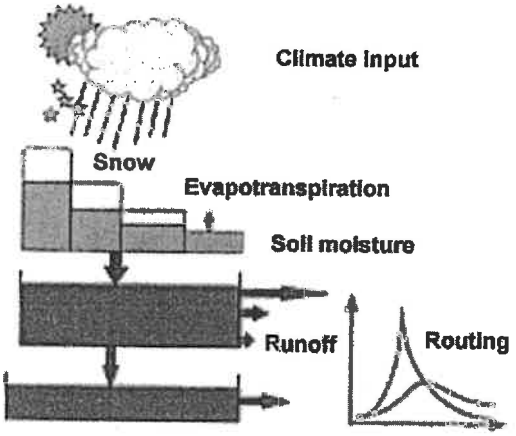
(8) (iii) Briefly explain how a stream discharge hydrograph may be generated from a stream rating curve and other related watershed information. Provide a labelled schematic of a typical stream discharge hydrograph and explain how it may be used for flood predictions.

Problem 4

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

(8) (i) Explain how the water balance equation may be applied for basic hydrological modelling. Give appropriate equations and an example as part of your explanation.

(6) (ii) Following the development of a model, validation of the model for a specific watershed is required before its application. Explain three (3) key steps in validating a watershed rainfall-runoff model by considering the conceptual diagram below.



(6) (iii) Explain the application of the Muskingum Routing method, continuity equation or similar method used for reservoir or lake routing. As part of your answer, provide the equations or diagrams as necessary.

Problem 5

Provide answers to the following questions related to *channel* or *river routing* and *flood wave behavior*.

(10) (i) Briefly explain how the Manning equation or a similar equation in conjunction with the continuity equation may be used to analyze channel or river routing and provide three (3) important considerations in the application of such a method.

(10) (ii) As part of the flood prevention program, you are asked to consider a flood wave propagating in a river due to a dam collapse and predict the height of a flood prevention wall downstream of the dam. Provide a **method** with appropriate diagrams and equations of how you would solve this problem. Note that **only the method** is asked for.

Problem 6

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

(5) (i) Briefly explain how an intensity-duration frequency (IDF) curve may be derived and give one (1) limitation or assumption in its application.

(5) (ii) Explain how flood-frequency analysis is used to predict the period and characteristics of future floods.

(5) (iii) Show by equations and diagrams how probability distributions are used to characterize two (2) hydrologic variables commonly used to predict precipitation and flood events.

(5) (iv) Briefly explain the use of the Pearson Type III model to predict floods and/or peak flow events.

Problem 7

Provide answers to the following questions related to the *hydrologic equation*, *energy budget equation* and *infiltration simulation*:

(10) (i) Estimate the amount of evapotranspiration (ET) for the year (mm) from a watershed with a 10,000 km^2 surface area. Consider the drainage area receives 50 mm of rain over the year and the river draining the area has an annual flowrate of 200 m^3/s. Justify any assumptions you make and use the basic equation of hydrology (BEH). Recall that the BEH may be written as:

$$P - R - G - E - T = \Delta S$$

Where P = Precipitation, R = Surface runoff, G = Groundwater flow
E = Evaporation, T = Transpiration, ΔS = Change in Storage

(5) (ii) Provide an example to show how the Energy budget equation (in conjunction with other watershed information) may be used to predict runoff in cold climates.

(5) (iii) Infiltration is a key component of the hydrologic components. Using the Green-Ampt or similar model, explain the key features of the model in predicting infiltration in a developing watershed.

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) 10, (ii) 10 marks, 20 marks total

6. (i) 5, (ii) 5 (iii) 5, (iv) 5 marks, 6 marks total

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