NATIONAL EXAMS MAY 2011

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 candidate prepared $8\frac{1}{2}''$ x $11''$ double sided Aid-Sheet allowed.

3. Candidates may use one of two calculators, the Casio or Sharp approved models. 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 worth a total of 20 marks with the section marks indicated in brackets ( ) at the left margin of the question. The complete Marking Scheme is also provided on the final page. A completed exam consists of five (5) answered questions with a possible maximum score of 100 marks.

Problem 1

Provide answers to the following questions related to *hydrologic processes*, *ground water flow* and *infiltration*.

(i) Define the following hydrologic processes and briefly explain the importance of each component to the hydrologic cycle.

(3) (a) Precipitation

(3) (b) Evaporation

(3) (c) Stream flow

(ii) Briefly compare and/or contrast the following terms as related to *ground water flow*. You may use figures and equations as necessary.

(4) (a) Streamlines and flownets

(4) (b) Confined and unconfined aquifers

(3) (b) Permeability and hydraulic gradient

Problem 2

Provide answers to the following questions related to *runoff hydrographs* and *stream flow measurements*. In your answers use, figures and/or equations as necessary.

(7) (i) The unit hydrograph (UH) is the direct runoff hydrograph produced by a storm of given duration such that the total volume of excess rainfall is 1 mm. The total volume of direct runoff is also 1 mm. Further the unit hydrograph theory assumes that watersheds behave as linear systems. Briefly describe three (3) fundamental assumptions of the UH theory.

(7) (ii) Monitoring stream flow is an integral part of developing water budgets, conducting loading calculations, evaluating the relationship between groundwater and surface water, and critical in evaluating impacts from urban runoff. Briefly explain three (3) important steps in a selected method to determine the stream flow.

(6) (iii) Briefly describe the use of the *slope-area method* or the *stage-fall-discharge method* (only one) for stream flow measurement. In your answer, describe the data that is necessary, any assumptions or estimations and under what conditions the method is most appropriate to use.

Problem 3

Provide answers to the following questions related to *point and area estimates of precipitation* and *basics of hydrologic modeling*.

(6) (i) Briefly compare and/or contrast the *Triangular Area Weighted Mean* method with one other method of estimating areal mean precipitation. In your answer provide one key assumption, one advantage and one disadvantage of each method.

(5) (ii) Identify and briefly discuss three (3) important factors that are necessary to ensure that point or area estimates of precipitation are representative, for a given watershed, regardless of the estimate methods used.

(iii) Compare and/or contrast the following terms related to the basics of hydrologic modeling.

(3) (a) Deterministic and probabilistic modeling

(3) (b) Land use classifications and curve numbers (CN)

(3) (c) Rainfall and runoff data usage

Problem 4

Provide answers to the following questions related to *statistical methods of probability analysis applied to floods and droughts*.

(5) (i) Briefly explain what is wrong with the statement, "The storm caused a 100-year flood" and give a hydrologically correct statement of such an event.

(5) (ii) Briefly explain how the "100-year flood" and the "100-year drought" events may change over time?

(5) (iii) Briefly explain one probabilistic analytical method that may be used to predict the next flood or next drought in a large (> 100 km^2) rural watershed. In your explanation, provide a list of information and major assumptions you would need to make.

(5) (iv) The 7-day low flow is a measure of the lowest stream flow duration each year. The recurrence interval of the 7-day low flow is a statistic commonly used to measure drought severity. Briefly explain two (2) advantages and two (2) disadvantages of this definition. Suggest an improved definition.

Problem 5

Provide answers to the following questions related to *channel routing* and *flood wave behaviour*.

(6) (i) Briefly explain, using figures and equations, the Muskingum method as applied to channel routing. Provide the basic steps in determining the inflow and outflow hydrographs.

(5) (ii) Define the term *channel reach* and explain its importance in channel routing.

(4) (iii) Briefly explain why the behaviour of a flood wave must be handled as an unsteady flow problem. In your explanation, describe <u>one</u> assumption that may be used to simplify the analysis of a flood wave depth and volume.

(5) (iv) The Muskingum routing coefficients for a stream reach are given as: C_0=0.3, C_1=0.4 and C_2=0.3. For the given inflow flood hydrograph, in the table below, complete the predicted outflow flood hydrograph at 0600, 1200 and 1800 hours.

Time (hr)	Inflow (m/s)	Outflow (m/s)
0000	10	10
0600	40	( )
1200	110	( )
1800	80	( )

Problem 6

Compare and/or contrast the following pairs of terms related to *statistical methods of frequency analysis applied to precipitation*. Use figures and equations as necessary.

(5) (i) Cumulative frequency curve and distribution function

(5) (ii) Exceedance interval and exceedance probability

(5) (iii) Pearson Type III function and Gumbel's distribution

(5) (iv) Intensity-Duration-Frequency Curve and plotting position formulae

Problem 7

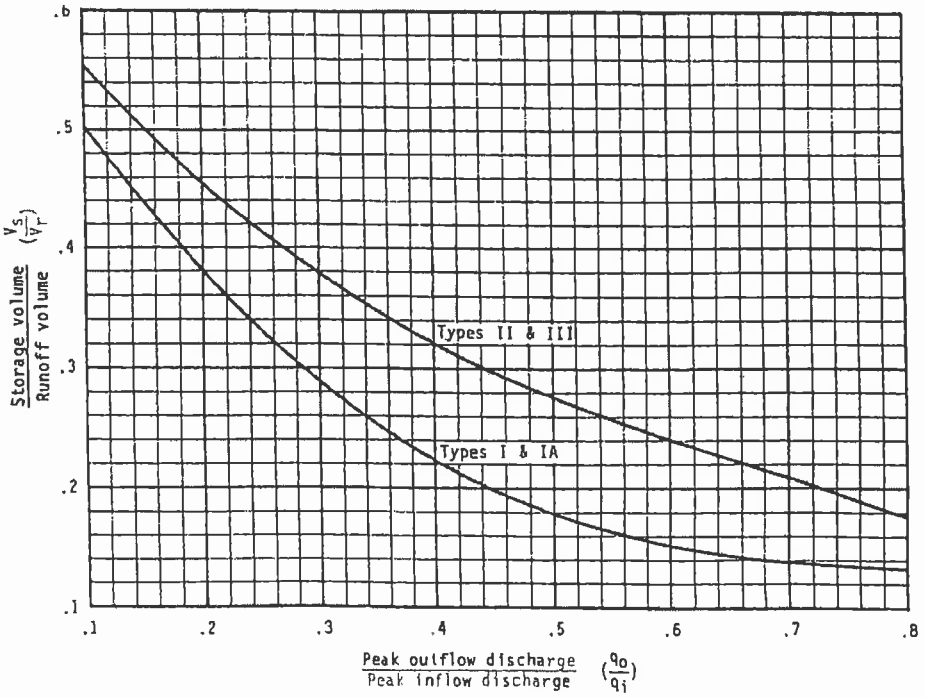
Provide answers to the following questions related to *unit hydrographs* and *reservoir routing*.

(7) (i) State three (3) important principles of the UHG method. You may use figures and equations in your statement of the principles.

(5) (ii) Briefly explain two (2) main differences between *mass curve methods* and the *graphical methods* of reservoir routing techniques.

(4) (iii) A reservoir is planned for a 25 ha site that has a peak inflow discharge of 25 m^3/s. The reservoir outlet structure has to have a peak capacity of 10 m^3/s. The peak runoff volume from a 100 mm rain event is 50 mm. Assuming a Type I storm distribution, what volume of storage is needed to handle this storm event? In answering this question use the figure below.

(4) (iv) If the storm in question (iv) was a Type II storm event, what is the *percent change* in the required reservoir storage volume. In answering this question, use the figure below.



Marking Scheme

1. (i) (a) 3, (b) 3, (c) 3, (ii) (a) 4, (b) 4, (c) 3 marks, 20 marks total

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

3. (i) 6, (ii) 5, (iii) (a) 3, (b) 3, (c) 3 marks, 20 marks total

4. (i) 5, (ii) 5, (iii) 5, (iv) 5 marks, 20 marks total

5. (i) 6, (ii) 5, (iii) 4, (iv) 5 marks, 20 marks total

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

7. (i) 7, (ii) 5, (iii) 4, (iv) 4, (v) 4 marks, 20 marks total