NATIONAL EXAMS MAY 2018

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. Full Marking Scheme on page 6.

Problem 1

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

(6) (i) Provide a schematic of a typical runoff hydrograph identifying three (3) key parts. For each part, briefly explain what each component corresponds to physically in the drainage and/or rainfall characteristics.

(7) (ii) Briefly provide three (3) fundamental assumptions implicit in the use of the unit hydrograph technique to a large watershed and two (2) ways engineers may use empirical techniques to correct for the assumptions in real systems.

(7) (iii) In the absence of direct watershed observations, synthetic or conceptual based models of runoff are needed. Briefly describe three (3) key differences in the watershed storage based models (e.g., Nash and Dooge Models) versus the models relating hydrographs to watershed characteristics (e.g., Snyder's synthetic unit hydrograph).

Problem 2

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 watershed characteristics influence the hydrologic processes that influence surface runoff. As part of your answer, provide a clear schematic showing the main hydrologic cycle processes.

(8) (ii) Considering Darcy's Law (below) used to compute groundwater flow, briefly explain the meaning and typical consistent dimensions of each term of this equation.

$$Q = K \cdot Z \cdot W \cdot \frac{\Delta H}{\Delta L}$$

(5) (iii) A new 7 ha suburban development is to be serviced by a trunk storm sewer that discharges to a local stream. Use the rational method ($Q = CiA$) to estimate the peak surface runoff in m^3/d. Assume a typical runoff coefficient (C) for a suburban development, time of concentration is 30 minutes and the local IDF relationship is given by $i = 6 - 0.3t_d$, where t_d is the rainfall duration in hours and i is the intensity in mm/hr. Clearly state any assumptions made in your answer.

Problem 3

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

(8) (i) Briefly explain two (2) main differences between distributed and lumped hydrologic models and under what conditions one type of model is preferred over the other.

(6) (ii) Explain how a reservoir or lake routing technique allows you to predict the variations in the reservoir/lake elevations and the corresponding outflow. Provide key equations and diagrams to clearly explain your answer as necessary.

(6) (ii) Briefly explain two (2) types of reservoir/lake field information that is important to collect as input to the reservoir/lake routing model to improve its predictive value.

Problem 4

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

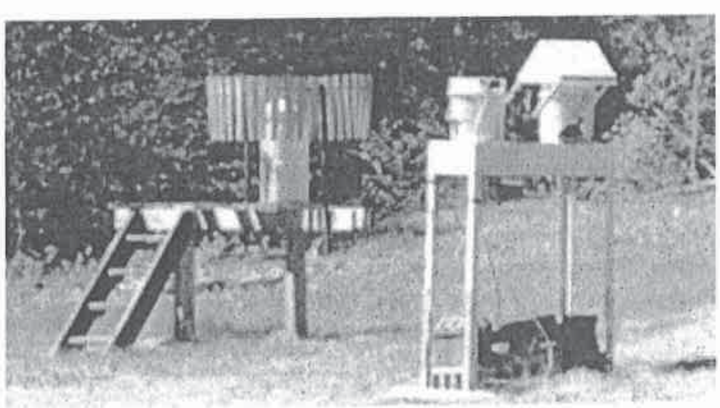
(8) (i) Generally, quantifying precipitation over a large watershed has to be inferred based on a weighted average ($\bar{P}$) of available point measurements $P(x_i)$ where:

$$\bar{P} = \sum_{i=i}^{N} \lambda_i P(x_i)$$

Briefly describe two (2) methods of determining weights (i.e., λ_i) and give two (2) advantages of using each type of method.

(6) (ii) Briefly explain two (2) main differences between a point and an areal method of estimating precipitation in a large watershed.

(6) (iii) Briefly define stream flow discharge and compare two (2) important methods commonly used to measure stream flow discharge.



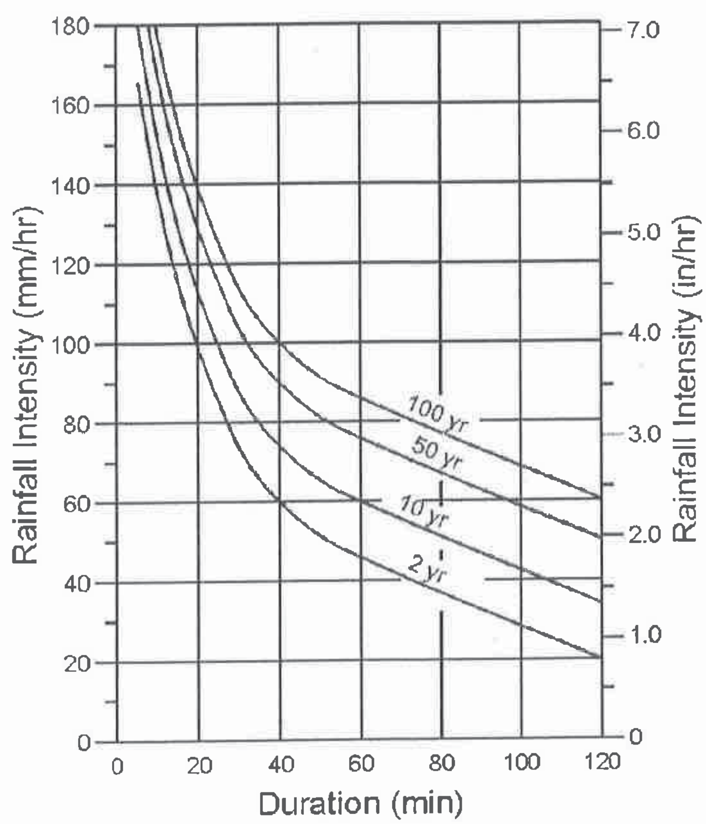
Problem 5

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

(7) (i) A complete urban or highway drainage structure design includes consideration of both *major* and *minor* drainage systems. Define what is meanth by *major* and *minor* systems and briefly describe two (2) important differences between the systems.

(7) (ii) Detention and retention facilities are used to control the quantity of runoff discharged to receiving waters. Give one (1) example of a detention and a retention facility and briefly explain two (2) important design differences between them.

(6) (iii) Considering the IDF curve below, briefley explain how it is derived and how it can be used to determine the 50-yr peak flow from a watershed area A (ha) from a storm with a duration of 80 minutes.



Problem 6

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

(7) (i) Briefly explain how *statistical methods of frequency analysis* work, give an example of one (1) such method and how it can be applied to predict the magnitude and return period of an extreme event like a flood.

(8) (ii) Briefly explain the main objective of *probability analysis applied to precipitation* and provide two (2) important assumptions about the data used for such an analysis.

(5) (iii) Given that the probability of flood event is $p = 1/T$ where the the return period $T = 50$ years, what is the probability that such a flood will occur at least once in the next $N = 10$ years?

Problem 7

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

(6) (i) Briefly explain a technique of *channel* or *river routing* and how it can be used to predict two (2) important elements of a flood propagating through a channel or river.

(7) (ii) The Muskingum method is one of the most widely used methods of lumped, channel flow routing. Briefly describe two (2) important assumptions of the method and explain the significance of the *storage time constant k* in the method.

(7) (iii) Briefly explain three (3) main aspects that are included or neglected during event-based modelling to predict a *flood wave behavior*. In your explanation, you may consider the importance of the time/space magnitude of various hydrological processes.

Marking Scheme

1. (i) 6, (ii) 7, (iii) 7 marks, 20 marks total
2. (i) 7, (ii) 8, (iii) 5 marks, 20 marks total
3. (i) 8, (ii) 6, (iii) 6 marks, 20 marks total
4. (i) 8, (ii) 6, (iii) 6 marks, 20 marks total
5. (i) 7, (ii) 7, (iii) 6 marks, 20 marks total
6. (i) 7, (ii) 8, (iii) 5 marks, 20 marks total
7. (i) 6, (ii) 7, (iii) 7 marks, 20 marks total