NATIONAL EXAMS MAY 2012

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. However, candidates are allowed to bring **ONE** aid sheet 8.5" x 11" hand-written on both sides containing notes and formulae.

3. A Casio or Sharp approved calculator is permitted. 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) marks for a total of a possible one-hundred (100) marks for a complete paper.

Problem 1

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

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

(4) (a) Surface runoff

(4) (b) Groundwater flow

(4) (c) Evapotranspiration

(8) (ii) Briefly explain the main differences between confined and unconfined aquifers. What do the terms porosity and storativity have to do with the water release and storage capacity of an aquifer?

Problem 2

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

(6) (i) Briefly explain what a *runoff hydrograph* is and give two (2) main properties of a watershed that influence a runoff hydrograph significantly.

(6) (ii) Describe the use of the *unit hydrograph* in an engineering application and provide two (2) limitations or considerations .

(8) (iii) Compare and contrast a *conceptual model* with a *physical model* as applied to an engineered hydrological system. As part of your comparison, provide an example where a physical model is preferred over a conceptual 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 the two (2) main differences between the *Arithmetic Mean* and *Isohyetal Analysis* techniques used to calculate areal precipitation.

(6) (ii) Briefly define *Stream Stage* and *Rating Curve*. In your answer, explain how each term may vary over time due to hydrological events in the watershed.

(iii) Compare and contrast the following terms:

(4) (a) Statistically derived and measured runoff data

(4) (b) Drainage area and watershed length

Problem 4

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

(i) Explain how the following model and equation may be applied:

(4) (a) Hydrologic transport model

(4) (b) Nonlinear outflow-storage equation

(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 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 behavior*.

(6) (i) Briefly explain the Convolution method or similar method useful for channel or river routing and provide an example of its use.

(6) (ii) Briefly explain the basics of the Muskingum method of flow routing and in your explanation provide two (2) limitations of the method.

(8) (iii) Consider a flood wave propagating in a river due to a land slide. Describe how you would solve this problem in principle to predict the wave effect downstream along the river (i.e., resulting flow, velocity, wave height).

Problem 6

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

(4) (i) Briefly explain how an intensity-duration frequency (IDF) curve may be derived and give an example of its use.

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

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

(4) (iv) Briefly explain the use of gaging stations 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 20,000 km^2 surface area. Consider that the drainage area receives 60 *mm* of rain over the year and the river draining the area has an annual flowrate of 300 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 information) may be used to predict runoff associated with snow melt.

(5) (iii) Brieflly explain the fundamentals of the Green-Ampt or SCS-CN infiltration model and how one of these models is used to simulate infiltration.

Marking Scheme

1. (i) (a) 4, (b) 4, (c) 4, (ii) 8 marks, 20 marks total
2. (i) 6, (ii) 6, (iii) 8 marks, 20 marks total
3. (i) 6, (ii) 6, (iii) (a) 4 (b) 4 marks, 20 marks total
4. (i) (a) 4, (b) 4, (ii) 6, (iii) 6 marks, 20 marks total
5. (i) 6, (ii) 6, (iii) 8 marks, 20 marks total
6. (i) 4, (ii) 6, (iii) 6, (iv) 4 marks, 20 marks total
7. (i) 10, (ii) 5, (iii) 5 marks, 20 marks total