NATIONAL EXAMS DECEMBER 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

Compare and contrast, using an example, the following pairs of terms related to *hydrologic cycle processes*, *ground water flow* and *surface runoff*.

(5) (i) Evapotranspiration and evaporation

(5) (ii) Surface runoff and groundwater flow

(5) (iii) Infiltration and depression storage

(5) (iv) Porosity and permeability.

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* may be used and how it incorporates three (3) important catchment properties.

(6) (ii) Explain how the *unit hydrograph* method may be used to predict the runoff from a very large (> 1000 ha) watershed, provide its theoretical basis and explain two (2) limitations in its use.

(8) (iii) Compare and contrast the use of a *conceptual model* with a *physical model* as applied to hydrology.

Problem 3

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

(6) (i) Using an example explain three (3) main differences or similarities between point and areal estimates of precipitation.

(6) (ii) Briefly explain how a *Rating Curve* is derived for a stream and how it may be used to predict the expected *stream flow* following a storm event. What is the accuracy of the your prediction based on?

(8) (iii) Explain how a V-notched weir may be used to measure stream flow in a natural stream. In your explanation, provide two (2) important construction considerations to ensure accuracy and precision of the flow measurements.

Problem 4

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

(i) Compare and contrast the following terms as they relate to hydrologic modelling:

(4) (a) Lumped and distributed models

(4) (b) Deterministic and stochastic parameters

(4) (c) Event and continuous watershed-runoff models

(8) (ii) Explain the process of reservoir and/or lake routing over a spillway with a broad crested weir. In your answer, explain how the continuity equation and weir equations, below, may be used in combination to predict the outflow over the weir during storm events.

$$\bar{I} - \bar{O} = \frac{\Delta S}{\Delta t}$$

$$\bar{O} = C \cdot L \cdot H^{\frac{3}{2}}$$

Problem 5

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

(4) (i) Briefly explain two (2) main differences between hydraulic and hydrologic channel or river routing techniques.

(6) (ii) Briefly explain the use of the Muskingum method in channel or river routing. What are two (2) important assumptions of the method.

(5) (iii) Explain how the 1-dimensional (1-D) Saint Venant equations, may be used to simulate a flood wave propagation with respect to distance along the channel.

(5) (iv) Explain two (2) important assumptions when using the 1-D Saint Venant equations that lead to the steady non-uniform flow form of the equations. Provide the steady non-uniform flow form of the equation.

Problem 6

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

(6) (i) Explain how intensity-duration frequency (IDF) curves are generated and give an example of their use.

(5) (ii) Explain how the Method(s) of Plotting Positions may be used to determine the probability of exceeding a design storm depth and how the return period can then be determined.

(4) (iii) Briefly explain why the Gumbel distribution is a preferred distribution for flood frequency analysis.

(5) (iv) Explain how the rational formula may be used to predict the peak flow rate from a catchment area. Provide two (2) underlying assumptions that limit the application of rational formula.

Problem 7

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

(8) (i) Estimate the amount of evapotranspiration (ET) for the year (*mm*) from a watershed with a 5,000 km^2 surface area. Consider the drainage area receives 100 *mm* of rain over the year and the river draining the area has an annual flowrate of 100 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

(6) (ii) Provide an example of the energy budget equation as it relates to the hydrologic cycle and explain its importance in an engineering application.

(6) (iii) Explain the Green-Ampt or Horton's method of infiltration estimation. Explain why these methods of infiltration estimation are generally preferred over Darcy's law approach.

Marking Scheme

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

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

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

4. (i) (a) 4, (b) 4, (c) 4, (ii) 8 marks, 20 marks total

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

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

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