NATIONAL EXAMS DECEMBER 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 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 cycle processes*, *surface runoff* and *ground water flow*.

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

(6) (a) Evapotranspiration and Transpiration

(6) (b) Surface runoff and Groundwater flow

(8) (ii) Briefly explain the main differences between infiltration and percolation as related to groundwater flow. In your explanation, consider how soil and subsurface conditions impact infiltration and percolation.

Problem 2

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

(8) (i) Briefly explain the use of a runoff model to convert rainfall volume into runoff volume. Provide an example in your explanation.

(6) (ii) If there is no data for the specific catchment to derive the *runoff hydrograph*, it is sometimes possible to construct a **synthetic** *runoff hydrograph*. Briefly explain the process of deriving a synthetic unit runoff hydrograph.

(6) (iii) Briefly explain how the *unit hydrograph* can be used to determine the direct *runoff hydrograph* for any rainfall amount with any time distribution. State two (2) main assumptions or approximations important to your explanation.

Problem 3

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

(7) (i) Briefly describe how the *Arithmetic Mean* and *Isohyetal Analysis* techniques are used to calculate areal precipitation.

(7) (ii) Briefly explain how *Stream Stage* and *Rating Curve* are related to each other through equations, figures and/or tables.

(iii) Identify two (2) main differences of the following:

(3) (a) Non-recording gauge and recording gauge

(3) (b) Calibration errors and electronic breakdown of equipment

Problem 4

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

(i) Contrast and compare the following terms related to the *basics of hydrologic modelling*:

(5) (a) Lumped versus distributed model parameters

(5) (b) Analytical versus numerical model implementations

(5) (ii) Briefly explain three (3) important steps used for reservoir or lake routing when applying the Muskingum or other applicable methods.

(5) (iii) Explain how the stage-storage curve used in reservoir routing may be developed.

Problem 5

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

(6) (i) Briefly explain the process of channel or river routing using the Method of Characteristics or other applicable method, provide an example of its use and give an advantage of the method.

(6) (ii) Briefly explain the use of the continuity and momentum equations in a river routing method and explain two (2) initial or boundary conditions that are necessary before a routing technique can be applied.

(8) (iii) Describe a methodology or flood model that can be used to predict the risk and potential downstream damage from the action of a flood wave. Identify four (4) important practical or theoretical considerations that need to be taken into account in the engineering analysis.

Problem 6

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

(8) (i) Compare and contrast the intensity-duration frequency (IDF) curve method of predicting the peak flows from rainfall events with the Rational Method.

(6) (ii) Provide a short example to show that one may determine the recurrence interval of an infrequent flood event in a river valley. Consider the data and statistical methods most appropriate and necessary in predicting flood events.

(6) (iii) Explain the justification for using frequency and probability distributions in characterizing and describing hydrologic events. Give an example that shows why such methods are appropriate.

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 50,000 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 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

(6) (ii) Give an outline of the use of the Energy and Water Budget equations in predicting a hydrological event associated with snow melt.

(6) (iii) Briefly explain three (3) important components of the Green-Ampt infiltration model used for infiltration modeling.

Marking Scheme

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