NATIONAL EXAMS MAY 2019

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 *hydrologic cycle processes*, *groundwater flow* and *surface runoff*:

(7) (i) Select three (3) major hydrologic processes and briefly explain how they interact with each other. As part of your explanation, include a labelled schematic which shows the hydrologic cycle with the main processes identified.

(7) (ii) Briefly explain how Darcy's law can predict the flow of groundwater in a hydrological environment. As part of your explanation, state Darcy's law and two (2) assumptions the law makes.

(6) (iii) Briefly explain three (3) key watershed factors that influence surface runoff from a large developed watershed. In your explanation, prioritize the factors from most to least important with respect to their impact on the peak surface runoff generated.

Problem 2

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

(7) (i) Provide an explanation of how a runoff hydrograph is generated, provide a schematic of a typical runoff hydrograph with labels for three (3) important elements and give two (2) important limitations to consider when using the hydrograph method.

(7) (ii) Briefly explain what a unit hydrograph is for a given watershed and provide a labelled schematic identifying the lag time, time of concentration, recession curve and base flow.

(6) (iii) Briefly explain the method, strengths and best use of a conceptual runoff model. In your explanation, also provide a limitation in the application of such a model.

Problem 3

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

(7) (i) Briefly explain three (3) fundamental differences between a point and areal estimate of precipitation. In your explanation, name or give the basic equations of each type of precipitation estimation method.

(7) (ii) Briefly compare and contrast how the Stream Stage and Rating Curves are used to measure the stream flow following a storm event.

(6) (iii) Briefly explain two (2) challenges and two (2) approximations made with a conventional method of stream flow measurements in the field. As part of your explanation, briefly define the typical method of stream flow that you are considering.

Problem 4

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

(8) (i) Briefly explain three (3) key differences between a lumped and a distributed hydrologic model. As part of your explanation, also state under what field conditions each model is better suited in terms of improved accuracy.

(6) (ii) Briefly explain three (3) key steps in reservoir or lake Routing and provide a labelled storage versus time curve as part of your explanation.

(6) (iii) A reservoir acts to store water and release it through a control structure at a later time. Briefly explain how the maximum storage required for a reservoir may be calculated for a given watershed to control and reduce the outflow peaks from the reservoir. State clearly any assumptions made.

Problem 5

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

(6) (i) Flow routing in open channels is a technique for determining the propagation of flow from one point in the channel to another. Briefly explain three (3) key steps in the application of a method for channel or river routing and provide a brief example of *how* it would be used to determine the time for a flood to peak.

(7) (ii) Explain two (2) simplifying assumptions commonly made in channel or river routing methods. As part of your explanation, briefly explain the main difference between the hydraulic and hydrologic methods.

(7) (iii) Lumped flood wave routing is governed by the continuity equation and a storage-discharge functional relationship. Briefly explain how the continuity equation along with reservoir or level pool routing method can be used to model flood routing. State any assumptions made in the above procedure.

Problem 6

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

(6) (i) Briefly explain how an intensity-duration frequency (IDF) curve is generated and used to predict the peak runoff for a storm event. As part of your explanation, provide a clearly labelled schematic of a typical IDF-curve.

(6) (ii) Explain three (3) important elements of a statistical method that can be used in flood-frequency analysis to predict the peak discharge and peak time of an annual flood event.

(8) (iii) Provide the general equation that related probability of exceedance (P_X) with the return period (T_X). Briefly explain how this expression may be used to estimate the 25-year flood level return based on collected field data. State what data would be required and for what duration.

Problem 7

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

(10) (i) Briefly explain three (3) key design principles when using a storm detention pond to control the quantity of stormwater flow to prevent downstream flooding of an urban hyghway. As part of your eplanation, provide one limitation of the storm detention pond for flood prevention.

(5) (ii) Briefly explain two (2) key reasons for the use of perforated underdrains in the design of swales besides highway drainage structures.

(5) (iii) Briefly explain two (2) key reasons for the use of culverts below highways and highway structures where different grades are present in one side of the highway compared to the other.

Marking Scheme

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

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

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

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

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

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

7. (i) 10, (ii) 5, (iii) 5 marks, 20 marks total