NATIONAL EXAMS MAY 2013

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 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.

Problem 1

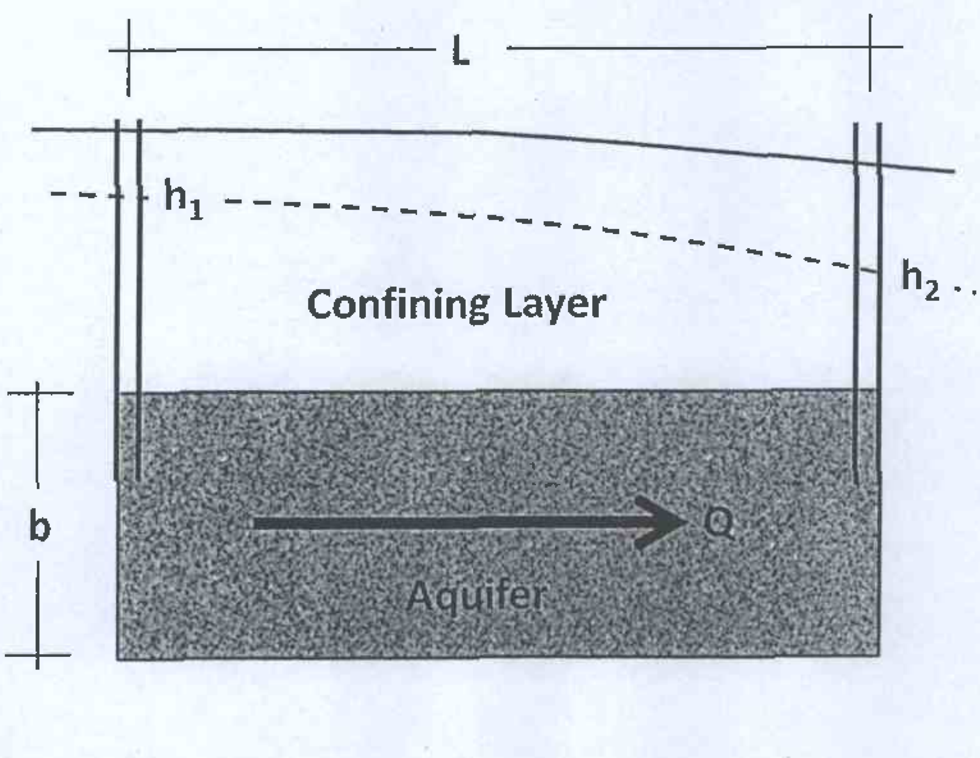
Provide answers to the following questions related to *hydrologic cycle processes*, *surface runoff* and *ground water flow*:

(7) (i) Briefly explain how the hydrologic cycle works and explain three (3) essential processes that engineers need to consider in the design of a hydraulic collection or conveyance system (e.g., culverts conveying surface runoff under a highway). Consider using figures and/or diagrams for your explanation.

(7) (ii) The effective rainfall is the portion of the rainfall which causes direct surface runoff. Consider an undeveloped watershed and develop a symbolic equation, that includes three (3) key processes, to determine the effective rainfall.

(6) (iii) Recall that the ground water flow (Q) is given by the expression below. With reference to the figure below and assuming that the hydraulic conductivity is 1 m/d, h_1 is 100 m, h_2 is 90 m, length of the aquifer is 1000 m, width of aquifer is 7000 m and depth of aquifer is 33 m, compute the daily water flow through the aquifer Q in m^3/d and briefly explain the physical basis of hydraulic conductivity within an aquifer.

$$Q = K \cdot b \cdot \frac{\Delta H}{\Delta L} \cdot w$$



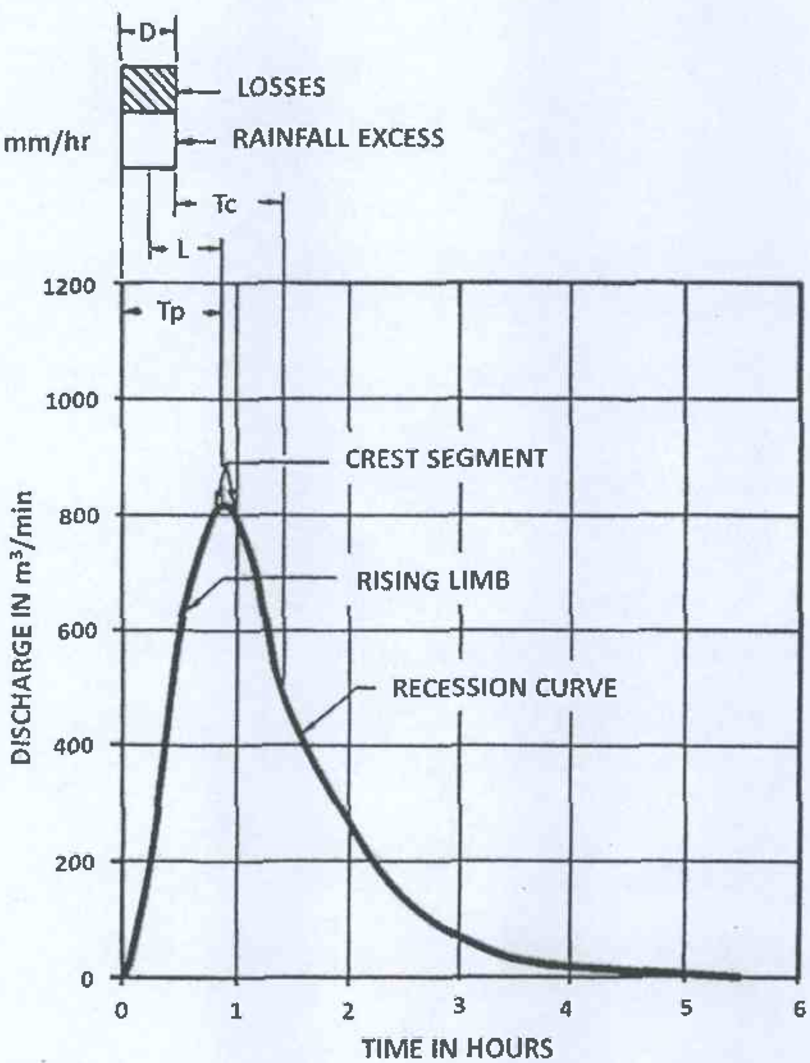
Problem 2

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

(6) (i) Compare and contrast a conceptual model with a numerical model as applied to an engineered hydrology system. As part of your comparison provide a short example where a numerical model is preferred over a conceptual model.

(7) (ii) Define what is meant by a unit hydrograph and explain three (3) important rules to consider when developing a unit hydrograph for a particular watershed.

(7) (iii) With reference to the hyetograph and runoff hydrograph diagram below, explain the the significance of any three (3) important aspects of the hydrograph curve for the design of a stormwater collection system or flow control structure.



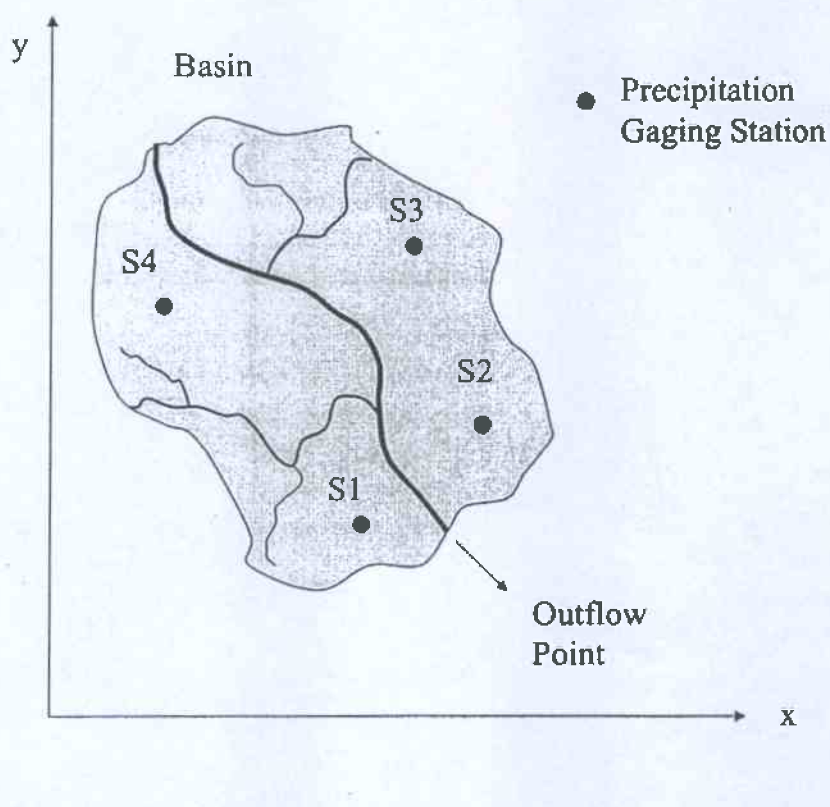
Problem 3

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

(5) (i) Briefly define Stream Stage and Rating Curve. In your answer, explain how each term is related to the other and provide one (1) common environmental phenomena that may impact the accuracy of the Rating Curve.

(5) (ii) Point precipitation is traditionally measured using various types of rain gages such as the non-recording cylindrical container type or the recording weighing type, float type and tipping-bucket type. Give two (2) reasons why a single point precipitation measurement is typically not representative of the volume of precipitation falling over a given catchment area.

(10) (iii) Briefly describe **any two (2)** methods from the following list of methods used to approximate areal precipitation: 1) Arithmetic Average, 2) Theissen Polygons, 3) Isohyetal Method and 4) Grid Method. Use the figure below in your description.



Problem 4

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

(10) (i) Stream flow routing is based on a few basic concepts that allow us to calculate the amount of water transported through a channel or river. Describe four (4) important concepts or steps in applying the Storage-Release Concept, Storage-Budget Concept or the Flood-Wave Concept (only one (1) concept applied to either channel or river routing; **not both)**.

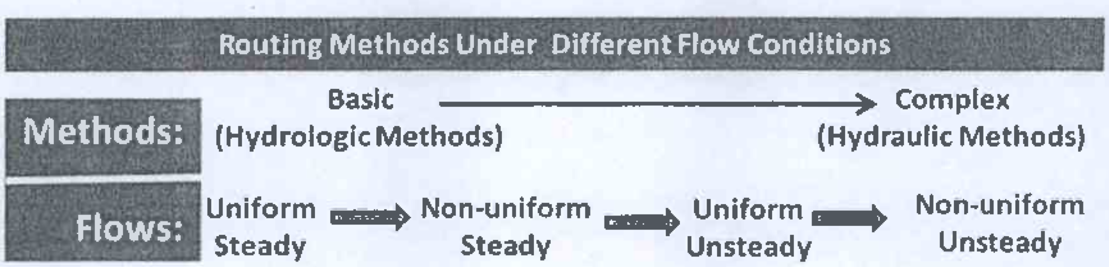
(10) (ii) Consider a flood wave propagating in a river due to a sudden Spring thaw causing a large volume of snow melt. Describe how you would define and solve this problem in principle to predict the resulting flow, velocity and wave height downstream along the river channel.

Problem 5

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

(10) (i) Explain the method of calibrating a historical hydrologic model that is to be applied to predict the runoff hydrograph in a different watershed then what the original model was derived from.

(10) (ii) Explain the process of applying the Muskingum Crest Segment Routing method or similar method, used for reservoir or lake routing. **Select One (1) method applied to one (1) routing type only**. You may consider the conceptual diagram below to assist you in your explanation.



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 may be used in the hydrologic design by scaling short term precipitation data.

(6) (ii) Explain why frequency and probability distributions are used to characterize hydrologic events. Identify two (2) important hydrologic variables used in these distributions to characterize hydrologic events.

(8) (iii) Briefly explain the use of an extreme value distribution to predict floods and/or peak flow events. In addition explain how hydrologic analysis is used to further predict the period and characteristics of future floods.

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 10,000 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 500 m^3/s. Justify any assumptions you make and you may use the basic equation of hydrology (BEH) (below):

$$P - R - G - ET = \Delta S$$

where P, R, G, ET and Δ S refer to precipitation, surface runoff, groundwater flow, evaporation and evapotrasnpirationation and change in storage, respectively.

(6) (ii) Provide an example to show how the Energy budget equation (in conjunction with other information) may be used to predict surface water infiltration associated with snow melt.

(6) (iii) Briefly explain how the Green-Ampt or similar infiltration model is used to simulate infiltration.

Marking Scheme

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