

**AGRICULTURAL AND FOOD ENGINEERING DEPARTMENT**  
**INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR**

**Mid-Autumn Semester Examination 2010-2011**

**Program: M.Tech. (LWRE) + M.Tech. (WM)**

**Full Marks: 30**

**Subject: Advanced Groundwater Hydrology (AG60044)**

**Time: 2 hours**

**Date of Examination: 17 September 2010 (AN)**

**No. of Students: 24**

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**Instructions:** *Answer all the questions. Make reasonable assumptions wherever needed.  
Answer different parts of a question at one place.*

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1. (a) What are the important issues of groundwater management in India? (2)
- (b) Write improved terminologies for the terms 'groundwater hydrology', 'surface water hydrology' and 'hydrologic cycle'. What are the three conditions triggered by urbanization, which have detrimental impacts on groundwater? (3)
2. (a) The average thickness and storage coefficient of a confined aquifer are 30 m and 0.0005, respectively and the aquifer extends over an area of 800 km<sup>2</sup>. From field investigation, it was found that the average piezometric level fluctuates annually from 19 m to 9 m above the top of the aquifer, and that the total porosity of the aquifer material is 20%. Calculate the following: (2+2)
- (i) Average annual groundwater storage in the confined aquifer.
- (ii) If the compressibility of the aquifer material is  $10^{-8}$  m<sup>2</sup>/N, compute the percentage of water released by the aquifer due to the compression of the aquifer material as well as due to the expansion of water when the aquifer will be pumped.
- (b) An aquifer system consists of sand having a median grain diameter of 0.05 cm and a hydraulic conductivity of 10 m/day. If the dynamic viscosity of water at 15 °C is  $1.14 \times 10^{-2}$  g/s-cm and the density of water is  $0.999 \times 10^3$  kg/m<sup>3</sup>, what is the greatest velocity of groundwater for which Darcy law will be valid? Also, estimate the intrinsic permeability of the aquifer material. (2+2)
3. (a) A municipal waste disposal facility is situated in a sand and gravel pit with a ground elevation of 152 m MSL. The leachate (pollutant) caused by the waste is in contact with local water table and is directly contaminating the underlying unconfined aquifer of thickness 12 m. The hydraulic conductivity of the aquifer is  $5 \times 10^{-4}$  m/s, effective porosity 0.25, and the depth to water table at the waste disposal site is 5 m from the ground surface and the depth to water table at the site close to a river located at 250 m downstream of the waste disposal facility is 3 m from the ground surface (elevation = 148 m MSL). Assuming that the pollutant is unreactive and moves at the same rate as the steady and uniform groundwater flow, calculate the time taken by the pollutant to reach the river. (4)
- (b) Fill in the following blanks: (4)
- (i) Unconfined aquifers are also known as ----- aquifers or ----- aquifers.
- (ii) Most confined aquifers are unconfined at their exposed edge, which is called -----.
- (iii) Magmatic water available at a shallow depth is termed -----, but it is termed ----- if available at a deeper depth.
- (iv) Good aquifers are characterized by relatively large values of -----, -----, and -----.

4. (a) State whether the following statements are 'true' or 'false' (*Marks will be deducted for every wrong answer*): (5)

- (i) Depression spring and contact spring are the examples of gravitational springs.
- (ii) The value of kinematic porosity of an aquifer system is always smaller than its total porosity.
- (iii) The bank storage is created when a perennial river is under losing or gaining stream conditions.
- (iv) Changes in the atmospheric pressure usually produce significant fluctuations in the wells penetrating confined aquifers.
- (v) Unconsolidated formations serve as aquifers due to the presence of secondary porosity.
- (vi) 'Fluid potential' of groundwater denotes mechanical energy per unit weight of the water, whereas the 'hydraulic head' denotes mechanical energy per unit mass of the water.
- (vii) Tritium is used for estimating groundwater residence times of up to five hundred years.
- (viii) In a river basin, gaining-stream conditions exist because of groundwater flow to the stream.
- (ix) A 50% reduction in the dynamic viscosity of groundwater will increase the aquifer hydraulic conductivity by two times.
- (x) The terms 'leaky confining layer' and 'aquitard' denote the same type of subsurface formation.

4. (b) Define the following terms: (4)

- (i) Specific Storage, (ii) Effective Porosity, (iii) Leakage, and (iv) Perched Aquifer.

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