EARTH 458
INFORMATION REGARDING FINAL EXAM
Friday December 2, 2016

TIME: Friday, December 2, 2016: 2:30 pm – 3:20 pm

LOCATION: B2 350

MATERIALS TO BRING: Pens, pencils and erasers
Straight edge for drawing
A calculator
Two (2) *Equation-Sheet*s 3" x 5" note cards with name on top left

STRUCTURE OF EXAM: A 50 min exam.
Types of questions will include:
- True/false
- Multiple choice
- Short answer
- Long answer

WHAT IT WILL COVER: Questions will be assigned from the following sources:
- All lecture materials presented in class with a strong emphasis on material after the midterm.
- The material covered in the 4 assignments.

EQUATIONS: No equations will be provided on the exam. You must know all of the equations covered in class and use your *Equation-Sheet* as reference.

SOME REVIEW IDEAS FOR THE FINAL EXAM
** NOTE: these are just some study ideas. Questions regarding these items may or may not be on the exam. Some questions on the exam may be related to other course material not included in this list.**

1. Introduction to Hydrology
1. Be able to explain why we study hydrogeology.
2. Be able to explain the importance of groundwater to humans and within the hydrologic cycle.

2. Fluid Potential and Hydraulic Head
1. Know the definition of fluid potential.
2. Know the equations for fluid potential and how it relates to hydraulic head.
3. Know the components of hydraulic head and be able to draw diagrams of elevation head, total head, and pressure head for various situations.
4. Be able to explain how piezometers are used to measure hydraulic head.
5. Understand how hydraulic head can be used to determine flow directions.
6. Know how to calculate hydraulic gradients.

3. Darcy's Law, Hydraulic Conductivities, and Porosity

1. Be able to write the equation for Darcy's Law and explain how it was derived and under what conditions it is applicable.
2. Know the different forms of Darcy's law.
3. Know the components and equations for hydraulic conductivity (K) and permeability (k) and be able to explain how they are different and what controls their values.
4. Be able to give representative values of K for different geological materials.
5. Be able to define, describe, and give examples of aquifer and aquitard units.
6. Know the difference between unconfined and confined aquifers and be able to draw examples of each.
7. Be able to provide representative values for porosities of different geologic materials.
8. Know the difference between porosity and effective porosity.

4. Average Linear Pore Water Velocity

1. Understand and be able to calculate average linear pore water velocities.
2. Understand the concept of a Representative Elemental Volume (REV).

5. Heterogeneity and Anisotropy

1. Be able to explain the difference between the terms homogeneous, heterogeneous, isotropic, and anisotropic.
2. Be able to list different geological causes of heterogeneity and anisotropy.
3. Know how to calculate effective K values for layered porous media.

6. Flow Nets

1. Be able to state the underlying assumptions necessary for creating flow nets.
2. Know the main rules for drawing flow nets.
3. Be able to construct and interpret basic flow nets.
4. Know how to calculate discharge through a flow net.
5. Know how geologic heterogeneities refract flow lines.

7. Compressibility, Effective Stress, and Storativity

1. Be able to explain the hydrogeologic and geologic importance of compressibility.
2. Be able to explain the relative extent to which the compressibility of water, solids and the solid-water matrix (porous medium) contribute to specific storage.
3. Understand effective stress and how it changes during pumping and other changes in pressure.
4. Know the definitions, equations for, and differences between, specific storage, specific yield, and storativity.
5. Be able to provide representative values of the storage coefficients (specific storage, specific yield) for different geologic materials.
6. Understand what causes land subsidence due to groundwater extraction.

8. Regional Groundwater Flow

1. Understand mass continuity equation for steady state flow.
2. Understand the Dupuit-Forchheimer assumptions and method.
3. Know the main components, boundaries and internal features of a regional groundwater flow system.
4. Understand how the water table topography and geologic heterogeneity affect flow in regional flow systems and how it controls zones of recharge and discharge.

5. Be able to discuss the relative ages of water in local, intermediate, and regional flow systems and where such features as stagnation points may occur.

9. Quantifying Groundwater Flow

1. Know how the Theim equation was derived and its underlying assumptions.
2. Be able to explain the components of the Theis equation and know the underlying assumptions.
3. Be able to calculate transmissivity (T), storativity (S), and drawdown using the Theis equation.
4. Be able to draw how different values of T, S, pumping rate, numbers of pumping wells and time effect drawdown.
5. Understand how the Cooper-Jacob approximation is related to the Theis equation and how to use the Cooper-Jacob method to estimate transmissivity (T), storativity (S) and drawdown.
6. Understand the influence of different boundary conditions on transient drawdown of a pumped aquifer.
7. Understand the concept of a capture zone.

10. The Unsaturated Zone

1. Know the definitions of the vadose zone, capillary fringe, water table, moisture content, saturation, interfacial tension and capillary pressure.
2. Understand the water content- pressure head-hydraulic conductivity relationships.
3. Understand how Darcy's Law is represented in the unsaturated zone.

11. Contaminant Transport in Groundwater Systems

1. Be able to give different examples of point, distributed, and other sources of contamination.
2. Be able to define advection, mechanical dispersion, dispersivity, hydrodynamic dispersion, effective diffusion coefficient, free solution diffusion coefficient, contaminant plume and retardation factor.
3. Know the underlying factors controlling dispersion.
4. Be able to list the major transport and attenuation processes and how they affect growth of a groundwater contaminant plume.
5. Understand the controls on solute breakthrough curves in a column.
6. Be able to identify and define all of the terms in the 1-D advection-dispersion equation.
7. Understand the process of sorption and how it differs from biodegradation processes relative to the movement of a groundwater contaminant.

Good luck studying!