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Department of Civil Engineering	
Ground Water (61541)	
Total Credits	**3**
major elective	
Prerequisites	P1 : Hydrology (61441)

Course Contents

Importance of groundwater, distribution of subsurface water, aquifer types, soil texture, general soil parameters, general aquifer parameters, and springs. The concept of hydraulic head. Darcys law. Determining the hydraulic conductivity. Storage in confined and unconfined aquifers. Heterogeneity and anisotropy. General equation of groundwater flow. Groundwater flow directions and flow nets. Steady state flow in confined and unconfined aquifers. Groundwater modeling. Components of pumping wells. Well hydraulics. General concepts of salt-water intrusion. Groundwater contamination. Soil water in the vadose zone. Groundwater recharge. Groundwater modeling and management using specialized software.

	Intended Learning Outcomes (ILO's)	Student Outcomes (SO's)	Contribution
1	Understand the general properties and characteristics of the aquifers.	A K	15 %
2	Comprehend the driving forces of groundwater movement and the general governing equations.	A C E	15 %
3	Understand the impact of pumping an aquifer and to be able to assess aquifer properties and well efficiency through pumping tests.	A B C E K	30 %
4	Gain an appreciation regarding groundwater modeling and management with emphasis on the use of MODFLOW.	A B C E G	15 %
5	Understand the salt-water intrusion phenomenon.	J	5 %
6	Comprehend the basic transport methods of contaminants in aquifers.	A B K	20 %

Textbook and/ or Refrences

1. Schwartz, F. and H. Zhang, 2004. Ground Water. John Wiley and Sons 2. Fetter, C. W., 1994. Applied hydrogeology. Prentice Hall, Upper Saddle River, New Jersey 3. Charbeneau, R. J., 2000. Groundwater hydraulics and pollutant transport. Prentice Hall, Upper Saddle River, New Jersey 4. Freeze, R. A. and J. A. Cherry, 1979. Groundwater. Prentice Hall, Upper Saddle River, New Jersey 5. Todd, D. K., 1980. Groundwater hydrology. John Wiley and Sons, New York 6. Domenico, P. A. and F. W. Schwartz, 1990. Physical and chemical hydrogeology. John Wiley and Sons, New York However, the class notes are the main source of information for this course and can be downloaded from the following website: http://sites.google.com/site/mohammadnablus/Home

Assessment Criteria	Percent (%)
First Exam	20 %
Second Exam	20 %
Projects	10 %
Final Exam	50 %

Course Plan

Week	Topic
1 &2	Course outline and introduction to groundwater
3, 4 &5	Groundwater movement

5	1st exam
6, 7, 8 &9	Well hydraulics
9	2nd exam
10 &11	Groundwater modeling
11	Seawater intrusion
12 &13	Groundwater contamination
14	Groundwater management
15	Group presentations of the project