

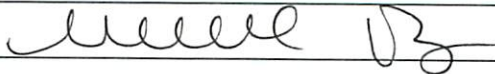
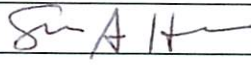
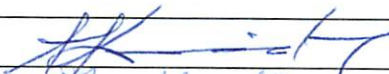

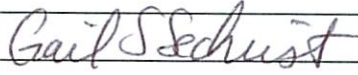
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LSC Use Only No:	LSC Action-Date:	UWUCC USE Only No.	UWUCC Action-Date:	Senate Action Date:
		07-4300	App-10/14/08	App-2/24/09

**Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee**

Contact Person Karen Rose Cercone	Email Address kcercone@iup.edu
Proposing Department/Unit Geosciences - Natural Sciences and Mathematics	Phone 724-357-7650

Check all appropriate lines and complete information as requested. Use a separate cover sheet for each course proposal and for each program proposal.

<b>1. Course Proposals (check all that apply)</b> <input type="checkbox"/> New Course <input type="checkbox"/> Course Prefix Change <input type="checkbox"/> Course Deletion <input checked="" type="checkbox"/> Course Revision <input checked="" type="checkbox"/> Course Number and/or Title Change <input checked="" type="checkbox"/> Catalog Description Change	
GEOS 331 Hydrogeology  <i>Current Course prefix, number and full title</i>	GEOS 312 Hydrogeology  <i>Proposed course prefix, number and full title, if changing</i>
<b>2. Additional Course Designations: check if appropriate</b> <input type="checkbox"/> This course is also proposed as a Liberal Studies Course. <input type="checkbox"/> Other: (e.g., Women's Studies, Pan-African) <input type="checkbox"/> This course is also proposed as an Honors College Course.	
<b>3. Program Proposals</b> <input type="checkbox"/> New Degree Program <input type="checkbox"/> Program Title Change <input type="checkbox"/> Other <input type="checkbox"/> New Minor Program <input type="checkbox"/> New Track <input type="checkbox"/> Catalog Description Change <input type="checkbox"/> Program Revision	
<i>Current program name</i>	<i>Proposed program name, if changing</i>
<b>4. Approvals</b>	
Department Curriculum Committee Chair(s)	Date
	2/4/08
Department Chair(s)	
	2/4/08
College Curriculum Committee Chair	
	2-11-08
College Dean	
	2-11-08
Director of Liberal Studies *	
Director of Honors College *	
Provost *	
Additional signatures as appropriate: (include title)	
UWUCC Co-Chairs	
	10/14/08

\* where applicable

Received

SEP 25 2008

Liberal Studies

Received

FEB 14 2008

Liberal Studies

## **Part II. Description of Curricular Change**

### **1. SYLLABUS OF RECORD**

#### **I. Catalog Description**

##### **GEOS 312 Hydrogeology**

3c-01-3cr

**Prerequisite:** Grade of C or better in GEOS 201 and GEOS 202; MATH 121 or MATH 125 or instructor permission

An overview of groundwater geology, including flow equations, graphical solutions to flow problems, and computer modeling of flow systems, as well as the geotechnical and social implications of groundwater utilization. Field trips may occur on weekends.

#### **II. Course Objectives**

At the end of this course, students will be able to:

1. summarize the fundamental principles that govern the flow of water in porous media such as rocks and soils, and will understand how groundwater flow is controlled by geology, topography and fluid characteristics.
2. model and predict groundwater flow in porous media using mathematical, graphical and computer-based techniques.
3. evaluate how to extract groundwater through well pumping, and measure the impact of pumping on groundwater systems.
4. evaluate how vulnerable groundwater systems are to pollution, and identify appropriate remediation methods for various groundwater contaminants.

#### **III. Course Outline**

##### **1. Introduction (3 academic hours)**

The Hydrologic Cycle

Recharge, Discharge & Surface Water Flow

Groundwater Zones

##### **2. Fundamentals of Flow (4 academic hours)**

Aquifer Properties

Darcy's Law

Fluid Potential and Hydraulic Head

##### **3. Graphic Depictions of Groundwater Flow (6 academic hours)**

Flow Nets in Unconfined Aquifers

Flow Nets in Confined Aquifers

Heterogeneous Flow Nets

Anisotropic Flow Nets

Flow Tube Analysis

FLOWNET-D computer modeling

##### **Exam #1 (1 academic hour)**

##### **4. Flow to Pumping Wells (4 academic hours)**

Radial Flow Equations

Analytical Flow Models & Image Wells

Predicting Well Flow in Confined Aquifers

Predicting Well Flow in Unconfined Aquifers

##### **5. Aquifer Tests (6 academic hours)**

- Single Well Tests
- Multiple Well Tests
- Pump Test Analysis
- Pump Tests in the Field
- AQTESOLV computer modeling
- 6. Computer Modeling of Groundwater Flow (3 academic hours)
  - Steady State & Transient Flow
  - Numerical Models
  - MODFLOW computer modeling
  - Regional Flow Systems
- Exam #2 (1 academic hour)
- 7. Groundwater Remediation (6 academic hours)
  - Aqueous Pollutants
  - Non-aqueous Pollutants
  - Monitoring Wells
  - Remediation methods
  - Wellhead Protection
  - QUICKFLOW computer modeling
- 8. Groundwater Law and Protection (4 academic hours)
  - The Pennsylvania Land Recycling Act (Act 4)
  - The safe landfill program
  - The Superfund program
  - Preliminary Site Assessments
- 9. Applied Topics in Groundwater (3 academic hours)
  - Well Drilling & Field Methods
  - Salt-water intrusion
  - Hydrothermal fields
- Exam #3 (1 academic hour)

Cumulative Final or Term Paper during Exam Week

#### IV. Evaluation Methods

Each component of the course will contribute to final grade as follows:

Exam 1	15%
Exam 2	15%
Exam 3	15%
Problem Sets	15%
Computer Models	15%
Final Exam or Paper	<u>25%</u>
Total	100%

#### V. Example Grading Scale

The final grade for this course will be determined using the following schedule:

A=90-100%; B=80-89%, C=70-79%, D=60-69%, F=<60%

#### VI. Attendance Policy

The attendance policy will conform to IUP's undergraduate course attendance policy.

#### VII. Required textbooks, supplemental books and readings

Fetter, C.W. *Applied Hydrogeology 4th Edition (with CD-ROM)*. New York: Prentice Hall, 1999.

Bair, S. W. *Practical Problems in Groundwater Hydrology (with CD-ROM)*. New York: Prentice Hall. 2006.

### **VIII. Special resource requirements**

There are no special resource requirements for this course.

### **IX. Bibliography**

In addition to the required textbook and supplemental readings from current literature, the following will be used to develop the course curriculum:

- Anderson, Mary P. (2005) Heat as a Ground Water Tracer: *Ground Water* v. 43, n.6 p. 951
- Boulding, Russell (2004) *Practical handbook of soil, vadose zone, and ground-water contamination : assessment, prevention, and remediation (2<sup>nd</sup> Edition)*: Boca Raton : Lewis Publishers, 948 pp.
- Bredehoeft, J.D. (2002) The water budget myth revisited: why hydrogeologists model: *Ground Water*. 2002 Jul-Aug;40(4):340-5.
- Deming, David. (2002) *Introduction to Hydrogeology*. Boston: McGraw-Hill, pp. 468.
- Fitts, Charles R (2006) Exact solution for two-dimensional flow to a well in an anisotropic domain: *Ground Water*, v. 44 i. 1, p. 99
- Hiscock, K.M. (2005) *Hydrogeology, Principles and Practice*: Malden MA: Blackwell, pp. 389.
- Reilly, Thomas E., (2004) *A Brief History of Contributions to Ground Water Hydrology by the U.S. Geological Survey*: *Groundwater*: v. 42, i. 4 p.625.
- Rubin, Yoram (2003) *Applied Stochastic Hydrogeology*: Oxford, New York: Oxford University Press, 391 pp.
- Soliman, MM; LaMoreaux, PE; Memon, BA; Assad, FA; LaMoreaux, JW (1998) *Environmental Hydrogeology*. Boca Raton FL: CRC PRESS, 400 pp.
- Theis, T.L., O'Carroll, D.M., Vogel, D. C., Lane, A.B., & Collins, K. (2003) *Systems Analysis of Pump-and-Treat Groundwater Remediation: Pract. Periodical of Hazardous, Toxic, and Radioactive Waste Management*, v. 7, i. 3, p. 177-181.
- Voss, Clifford I. (2005) The future of hydrogeology: *Hydrogeology Journal*, v. 13, n. 1, p. 1-6.
- Zheng, Li, Guo, Jian-Qing and Lei, Yuping (2005) An Improved Straight-Line Fitting Method for Analyzing Pumping Test Recovery Data: *Ground Water*, v. 43 p. 939.

### **2. SUMMARY OF PROPOSED REVISIONS**

**Major change:** The format of this class is being changed from 2 lecture hours and 3 lab hours (3 credits) to 3 lecture hours and 0 lab hours (3 credits). See justification for this change below.

**Minor changes:** The course number was modified from GEOS 331 to GEOS 312 to conform to the new numbering system proposed by the Geoscience Department. The course prerequisites were altered to conform to the new curriculum (GEOS 121/131 replaced by GEOS 201) and to allow students more flexibility in scheduling this alternate year course (MATH 121-122 reduced to MATH 121 or MATH 125 only).

### **3. JUSTIFICATION/RATIONALE**

The three-hour lecture-only format is used in other science departments on campus, particularly in biology for subjects that are more conceptual than technical in nature. Other geology classes have not fit this format previously, but field of hydrogeology is going through immense changes

due to recent technological innovations, particularly in the area of groundwater remediation or cleanup. It is no longer economically feasible or technically possible for IUP to offer a truly hands-on laboratory to accompany this course. In fact, only major groundwater research centers such as Ohio State and Waterloo can still generate the complex data needed to create up-to-date hydrogeology lab exercises.

Fortunately, Dr. Scott Bair of Ohio State has recently created a new kind of teaching tool designed to solve this problem: a manual of problems based on real groundwater pollution sites where all of the original data is provided in Excel format on an accompanying CD-ROM. This tool was piloted in Spring 2004 and was found to work exceedingly well. Given this new teaching strategy, a formal lab period is no longer required for this class.

Hydrogeology or the study of groundwater flow requires students to be familiar with the central ideas of calculus as covered in MATH 121 or MATH 125 (limits, derivatives and integrals). However, the field of hydrogeology has changed over the last decade to incorporate much more sophisticated computer modeling of groundwater flow, based on three-dimensional application of differential flow equations of the type covered in MATH 122. These computer models are widely used in industry and academia, and they do a much better and more accurate job of predicting groundwater flow than the old method of hand-calculating flow from differential equations. This change in technology has eliminated the need for working hydrogeologists to use and manipulate differential equations as part of their daily work. Of course, it is still important that any working geologist have a theoretical understanding of how differential equations function and we expect all of our majors to eventually complete both calculus courses. However, there is no longer a need to limit Hydrogeology as a class only to those students who have finished the entire sequence of calculus.

#### **4. OLD SYLLABUS OF RECORD**

There is no available syllabus of record for this course.

#### **Part III. Letters of Support or Acknowledgment**

No other departments or programs are affected by these revisions.