08-7W

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		~~07-43a~~	App-10/14/08	App-2/24/09

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

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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.

1. Course Proposals (check all that apply)

____New Course _____Course Prefix Change _____Course Deletion

__X__Course Revision __X__Course Number and/or Title Change __X__Catalog Description Change

GEOS 331 Hydrogeology	GEOS 312 Hydrogeology
Current Course prefix, number and full title	*Proposed course prefix, number and full title, if changing*

2. Additional Course Designations: check if appropriate

_____ This course is also proposed as a Liberal Studies Course.

_____ This course is also proposed as an Honors College Course.

_______ Other: (e.g., Women's Studies, Pan-African)

3. Program Proposals

____New Degree Program ______Catalog Description Change _____Program Revision

____New Minor Program ______Program Title Change _____Other

______New Track

Current program name	*Proposed program name, if changing*

4. Approvals

		Date
Department Curriculum Committee Chair(s)	[signature]	2/4/08
Department Chair(s)	[signature]	2/4/08
College Curriculum Committee Chair	[signature]	2-11-08
College Dean	[signature]	2-11-08
Director of Liberal Studies *		
Director of Honors College *		
Provost *		
Additional signatures as appropriate: (include title)		
UWUCC Co-Chairs	Gail S Sechrist	10/14/08

* where applicable

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	25%
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 (2nd 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 Managementt, 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.