Course Approval Form

For instructions see:
http://registrar.gmu.edu/facultystaff/catalog-revisions/course/

Action Requested:

- [X] Create new course
- [ ] Inactivate existing course
- [ ] Reinstate inactive course
- [ ] Modify existing course (check all that apply)
  - [ ] Title
  - [ ] Credits
  - [ ] Repeat Status
  - [ ] Grade Type
  - [ ] Prereq/coreq
  - [ ] Schedule Type
  - [ ] Restrictions
  - [ ] Other:

Course Level:

- [ ] Undergraduate
- [X] Graduate

College/School: College of Science
Department: AOES
Submitted by: Dr. Rick Diecchio
Ext: 3-1642
Email: rmcbride@gmu.edu

Subject Code: GEOL
Number: 513
(Do not list multiple codes or numbers. Each course proposal must have a separate form.)

Effective Term:

- [ ] Fall
- [ ] Spring
- [X] Summer

Year 2015

Title:
Current
Banner (30 characters max w/ spaces)
New: Hydrogeology

Fulfills Mason Core Req? (undergrad only)

- [ ] Currently fulfills requirement
- [ ] Submission in progress

Credits: (check one)

- [3] Fixed
- [ ] Variable

or
to

Repeat Status: (check one)

- [X] Not Repeatable (NR)
- [ ] Repeatable within degree (RD)
- [ ] Repeatable within term (RT)

Maximum credits allowed:

Grade Mode: (check one)

- [X] Regular (A, B, C, etc.)
- [ ] Satisfactory/No Credit
- [ ] Special (A, B C, etc. +IP)

Schedule Type: (check one) LEC can include LAB or RCT

- [X] Lecture (LEC)
- [ ] Lab (LAB)
- [ ] Recitation (RCT)
- [ ] Internship (INT)
- [ ] Independent Study (IND)
- [ ] Seminar (SEM)
- [ ] Studio (STU)

Prerequisite(s):
Previous lab-science courses in each of the following: geology, calculus, and chemistry (12 credit hours); or permission of instructor.

Corequisite(s):

Instructional Mode:

- [X] 100% face-to-face
- [ ] Hybrid: ≤ 50% electronically delivered
- [ ] 100% electronically delivered

Restrictions Enforced by System: Major, College, Degree, Program, etc. Include Code.

Are there equivalent course(s)?

- [ ] Yes
- [X] No

If yes, please list

Catalog Copy for NEW Courses Only (Consult University Catalog for models)

Description (No more than 60 words, use verb phrases and present tense)	**Notes** (List additional information for the course)
Geological and hydrologic factors controlling occurrence, distribution, movement, quality, and development of groundwater.	

Indicate number of contact hours: Hours of Lecture or Seminar per week: 3 Hours of Lab or Studio: 0
When Offered: (check all that apply) [ ] Fall [ ] Summer [X] Spring

Approval Signatures

Department Approval Date

College/School Approval Date

If this course includes subject matter currently dealt with by any other units, the originating department must circulate this proposal for review by those units and obtain the necessary signatures prior to submission. Failure to do so will delay action on this proposal.

Unit Name	Unit Approval Name	Unit Approver's Signature	Date

For Graduate Courses Only

Graduate Council Member

Provost Office

Graduate Council Approval Date

For Registrar Office's Use Only: Banner_____Catalog_____

revised 10/16/14

Course Proposal Submitted to the Curriculum Committee of the College of Science

1. COURSE NUMBER AND TITLE: GEOL 513

Course Prerequisites: Previous lab-science courses in each of the following: geology, calculus, and chemistry (12 credit hours); or permission of instructor.

Catalog Description: Geological and hydrologic factors controlling occurrence, distribution, movement, quality, and development of groundwater.

2. COURSE JUSTIFICATION:

Course Objectives: This course will provide one of the core courses (Hydrosphere) for the Earth Systems Science MS.

Course Necessity: AOES currently does not provide any Hydrosphere core courses for MS in ESS degree.

Course Relationship to Existing Programs: Course is designed to fulfill core Hydrosphere requirement in support of the Earth Systems Science MS.

Course Relationship to Existing Courses: Course content is not covered in other graduate courses so it does not conflict with existing courses.

3. APPROVAL HISTORY: Approved by AOES faculty on 21 Nov 2014.

4. SCHEDULING AND PROPOSED INSTRUCTORS:

Semester of Initial Offering: Spring ‘15

Proposed Instructors: Dr. Jules Goldspiel

5. TENTATIVE SYLLABUS: See below.

GEOL 513 Hydrogeology

Course Syllabus
Dr. Jules Goldspiel

Description

Geological and hydrologic factors controlling the occurrence, distribution, movement, quality, and development of groundwater.

Anticipated Coursework & Grading Weights

- 20% Homework (every other week)
- 15% Project (e.g., model application or similar data analysis exercise)
- 5% Field Trip/Campus Grounds Tour Participation
- 15% Exam I
- 15% Exam II
- 30% Final Exam

Potential Textbooks

- *Applied Hydrogeology*, 4th Edition, 2001, C.W. Fetter
- *Groundwater*, 1979, A. R. Freeze and J. A. Cherry

Lecture Schedule Summary

Week	Lecture Topic
1	Overview of Hydrogeology
2	Groundwater Physical Environments
3	Groundwater Chemical Environments
4	Groundwater Connection to the Surface
5	Groundwater Connection to the Surface
6	*Preliminary Exam I*
7	*Field Trip or Campus Grounds Tour*
8	Groundwater Flow: Governing Equations & Approximations
9	Groundwater Flow: Numerical Modeling [with computers]
10	Groundwater Flow: Numerical Modeling [with computers]
11	Groundwater Flow: Numerical Modeling [with computers]
12	*Preliminary Exam II*
13	Aquifer Contamination
14	Hydrogeology in Unique or Special Environments
15	*Final Exam*

Week 1: Overview of Hydrogeology

- Groundwater Distribution
  - Water table definition
  - Aquifer definition
  - Confined vs. unconfined
- Groundwater Movement
  - Basics of flow
    - "Downhill" in hydrogeology
    - Intro to hydraulic conductivity
  - Flow boundaries/obstructions
- Groundwater Quality
  - Flow quality
  - Chemical quality
    - Salinity/Hardness
    - Acidity
    - Natural organic content
    - Contamination (Industrial, Municipal, Agricultural)
- Groundwater Development & Evolution
  - Natural sources/sinks
  - Engineered sources/sinks
- Surface Effects of Groundwater Flow
  - Constructive
  - Destructive
- Aquifer Identification and Distribution
  - Delineating aquifer boundaries
  - Major U.S. aquifers
  - Mid-Atlantic aquifers

<Flume/Tank/Table demonstration of basic concepts>

Week 2: Groundwater Physical Environments

- Rock/Soil Properties
  - Porosity
  - Fractures
  - Heterogeneity and anisotropy
- Water Properties
  - Temperature
  - Viscosity
- Aquifer Properties
  - Hydraulic head
  - Hydraulic gradients
  - Saturated vs. unsaturated
  - Specific Storage
  - Specific Yield
- Structural Controls
  - Surface topography
  - Subsurface structure
- Field Data Collection Methods
  - Well/borehole measurements

  - Subsurface survey measurements
  - Surface discharge measurements

Week 3: Groundwater Chemical Environments

- Chemical Composition Factors
  - Source water composition
  - Aquifer rock compositions
    - Upstream reactions
      - Dissolution and precipitation
      - Weathering
    - Local reactions
      - Dissolution and precipitation
      - Weathering
  - Injections and intrusions
  - pH & pH buffering
- Equilibrium vs. Kinetics
- Data Sources on the Web

Week 4: Groundwater Connection to the Surface

- Water Table
- Recharge/Infiltration
  - Precipitation
  - Surface water
- Discharge
  - Seeps
  - Springs
  - Wells
- Evapotranspiration
- Capillary Action
- Effects of Input/Output Variability

Week 5: Groundwater Connection to the Surface

- Erosion & Weathering
  - From groundwater
  - From groundwater & surface water
- Mineral Deposition
  - Direct precipitation
  - Source material for evaporites

Week 6: Preliminary Exam I

Week 7: Field Trip or Campus Grounds Tour

- Location and Details TBD
- *Since scheduled class time is in the evening when it will be dark, will attempt to shift the time for this specific class to the morning or afternoon. May have to offer an alternate date (such as the following Saturday) for students who cannot participate in a morning or afternoon trip/tour due to conflicts with other classes.*

Week 8: Groundwater Flow: Governing Equations & Approximations

- Darcy's Law

- Hydraulic Conductivity
  - Wide range of values
  - Relation to permeability
- 2D/3D Equations
  - Homogeneous & isotropic
  - Inhomogeneous & anisotropic
- Approximations
  - Analytical Methods and Applications
    - General assumptions
    - Dupuit equation (steady state seep, unconfined aquifer)
    - Thiem equation (steady state flow to pumping well, confined aquifer)
    - Theis equation (transient flow to pumping well, confined aquifer)
  - Graphical Methods
    - Flow Nets

Computers will be utilized for the next three classes.
Classes for these weeks will be held in the Computer Lab <Exploratory Hall, Room ??>

Week 9: Groundwater Flow: Numerical Modeling

- Numerical Methods Overview
- Introduction to MODFLOW

Week 10: Groundwater Flow: Numerical Modeling

- MODFLOW Applications, Simple Generic Cases
  - e.g., Effects of different K_{hy} values
- Analyzing Model Output
- Model Validation
  - Comparison to analytical solutions

Week 11: Groundwater Flow: Numerical Modeling

- MODFLOW Application, Specific Case
- Model Validation
  - Comparison to field data –or -
  - Comparison to laboratory/flume simulations

Week 12: Preliminary Exam II

Week 13: Aquifer Contamination

- Contamination Sources
  - Direct emplacement (dumping, leaking)
  - Leaching
- Transport
  - Volatilization
  - Diffusion-advection
    - Aqueous phase materials
  - Convection
    - Dense non-aqueous phase liquids
    - Light non-aqueous phase liquids
- Retardation
  - Adsorption

- Remediation
  - Volatilization-Vapor Phase Extraction
  - Dissolution
  - Adsorption
  - Degradation by microorganisms

<Flume/Tank/Table demonstration of contamination case>

Week 14: Hydrogeology in Unique or Special Environments

- Periglacial Regions
- Submarine Regions
- Mars
- Titan?

Week 15: Final Exam