APPLICATION FOR NEW COURSE

1. Submitted by the **College of Arts and Sciences** Date **January 29, 2002**

   Department/Division offering course: **Geological Sciences**

2. Proposed designation and Bulletin description of this course:

   (a) Prefix and Number **GLY 560** (b) Title* **Geophysical Field Methods**
   *NOTE: If the title is longer than 24 characters (including spaces), write a sensible title (not exceeding 24 characters) for use in transcripts: **Geophysics-Field Methods**

   (c) Lecture/Discussion hours per week **3.0** (d) Laboratory hours per week **3.0**

   (e) Studio hours per week **n/a** (f) Credits **4.0**

   (g) Course description:

   **An introduction to the principles and applications of geophysics in the field. The course will present the geophysical methods used to assess the configuration and physical properties of the Earth's subsurface, as well as to explore for natural resources. Designed for geology students (upper-division or first-year graduate) and other science or engineering students without prior formal instruction in geophysics. To understand the discussions and exercises, the student should be familiar with first-year calculus and physics.**

   (h) Prerequisites (if any): **MA 113, 114; PHY 211, 213 or PHY 231, 232 or consent of instructor. MA 114, PHY 213 or PHY 232 may be taken concurrently.**

   (i) May be repeated to a maximum of **n/a** (if applicable)

4. To be cross-listed as: **n/a**
   Prefix & No. Signature, Chairman, cross-listing department

5. Effective Date: **Spring, 2003** (semester and year)

6. Course to be offered (a) Fall (b) **Spring** (c) Summer

7. Will the course be offered each year? (a) **Yes** (b) No
   (Explain if not annually):

8. Why is this course needed:

   **Standard geophysics is a field-based discipline that requires use of equipment in the field to characterize and understand the earth's subsurface. We have just brought on board two new geophysicists, who can contribute the field expertise and also new field equipment. Understanding how this equipment works and having some experience in using it is critical to student training in our newly reinvigorated geophysics program.**

9. (a) By whom will the course be taught? **Dr. Ed Woolery and/or Dr. Shelley Kenner**

   (b) Are facilities for teaching the course now available? (a) **Yes** (b) No
   If not, what plans have been made for providing them?

10. What enrollment may be reasonably anticipated? 15

11. Will this course serve students in the Department primarily? (a) **Yes** (b) No

Will it be of service to a significant number of students outside the Department? (a) **Yes** (b) No
If so, explain
**A non-invasive exploration science that has broad applications outside the Geological Sciences (i.e., Agronomy, Forestry, Anthropology, Archaeology, Civil Engineering, Agriculture, Engineering, Mining Engineering)**

Will the course serve as a University Studies Program course? (a) Yes (b) **No**
If yes, under what Area?

12. Check the category most applicable to this course:

____**X**_ traditional; offered in corresponding departments elsewhere;

_____ relatively new, now being widely established

_____ not yet to be found in many (or any) other universities

13. Is this course part of a proposed new program? (a) Yes (b) **No**
If yes, which?

14. Will adding this course change the degree requirements in one or more programs?* (a) Yes (b) **No**
If yes, explain the change(s) below:

15. Attach a list of the major teaching objectives of the proposed course, outline and/or reference list to be used.

16. If the course is a 100-200 level course, please submit evidence (e.g., correspondence) that the Community College System has been consulted.

17. Within the Department, who should be contacted for further information about the proposed course?
Name/e-mail: **Edward Woolery** Phone Extension: **257-3016**

*NOTE: Approval of this course will constitute approval of the program change unless other program modifications are proposed.

**Signatures of Approval:**

| | |
|---|---|
| Frank R. Etemadi<br>Department Chair | 18 Feb, 2002<br>Date |
| Philip Harding<br>Dean of the College | MAR 19 2002<br>Date |
| | MAR 11 2002<br>Date of Notice to the Faculty |
| *Undergraduate Council | Date |
| *University Studies | Date |
| *Graduate Council | Date |
| *Academic Council for the Medical Center | Date |
| *Senate Council | Date of Notice to Univ. Senate |

*If applicable, as provided by the Rules of the University Senate

ACTION OTHER THAN APPROVAL:

**Student Outcomes**:

Upon completion of the course, a student should be able to:

- Exhibit a balanced knowledge of modern geophysical procedures, instruments, data processing methods, and key aspects of interpretation
- Describe all primary geophysical survey types
- Explain fundamental principles for each survey type
- Apply these principles to practical problems
- Demonstrate expanded/improved problem-solving skills

# GLY 560: Geophysical Field Methods

Department of Geological Sciences, University of Kentucky
4 Credit Hours

## Course Proposal

**Course Description**: An introduction to the principles and applications of geophysics. The course will present the geophysical methods used to assess the configuration and physical properties of the Earth's subsurface, as well as, to explore for natural resources. Designed for geology students (upper-division or first-year graduate) and other science or engineering students without prior formal instruction in geophysics. To understand the discussions and exercises, the student should be familiar with first year calculus and physics.

**Course Need**: Geophysics is a traditional part of most geological science curricula. It has arisen from the fact that geologists and engineers make critical decisions regarding natural resources exploitation, engineering design/construction, and natural hazard mitigation based on the configuration and physical properties of the Earth's subsurface. As energy demands strive to keep pace with an expanding economy and population, and as the nation's infrastructure begins to age, forcing new construction into less desirable locations, geophysical exploration will continue to increase in importance for the professional geologist and engineer.

**Major Teaching Objectives**:

- Provide the student with a balanced knowledge of modern geophysical procedures, instruments, data processing methods, and key aspects of interpretation
- Discuss all primary geophysical survey types
- Develop fundamental principles for each survey type
- Illustrate principles with practical examples
- Offer exercises/situations that will allow the student to expand/improve problem-solving skills, and that emphasize functionality in a "real world" environment where theory may or may not work and equipment sometimes malfunctions.

**Proposed Course Outline**:

**Topic**

**1. Seismic Methods**

- Seismic Waves
  - *Elasticity*
  - *Body Waves*
  - *Surface Wave*
- Seismic Refraction*
  - *The Single-Layer Problem*
  - *Multi-layered Structure*
  - *Dipping Layers*
  - *Refraction Discontinuities*
  - *Processing and Interpretation*

- *Limitations*
- Seismic Reflection*
  - *The Single Horizontal Surface*
  - *Multi-layered Structure*
  - *Dipping Surfaces*
  - *Multiples and Diffractions*
  - *Processing and Interpretation*
  - *Limitations*
- Seismic Surveying*
  - *Geophones*
  - *Digital Recording Systems*
  - *Impulsive and Vibratory Sources*
  - *Field Operations*

**2. Potential Field: Gravity and Magnetic Methods**

- Earth's Gravity
  - *Nature of Gravity*
  - *Measuring Gravity*
  - *Normal Gravity*
- Gravity Surveys
  - *Terrestrial Gravity Surveying*
  - *Gravity Reductions*
- Bouguer Gravity
  - *Bouguer Features*
  - *Local Anomaly Patterns*
  - *Gravitational Attraction of Various Shapes*
  - *Search and Discovery*
- Earth's Magnetism
  - *Nature of Magnetism*
  - *Measuring Magnetism*
  - *Main Magnetic Field*
- Surveying the Magnetic Field Anomalies
  - *Terrestrial Surveys*
  - *Aeromagnetic Surveys*
  - *Data Reductions*
- Magnetic Anomalies and Their Geologic Sources
  - Rock Magnetism
  - Modeling Anomalies
  - Magnetic Anomaly Interpretation

**3. Potential Field: Geo-Electrical Methods**

- Electrical Resistivity Surveys*
  - *Ohm's Law and Resistivity*
  - *Current Flow*
  - *Measuring Resistivity*
  - *Survey Procedures*
  - *Analysis of Measurements*
- Electromagnetic Surveys

  - *EM Principles I*
  - *Survey Procedures*
    - *Parallel Line*
    - *Horizontal Loop*
  - *Analysis of Measurements*
- Ground Penetrating Radar*
  - *EM Principles II*
  - *Physical Properties*
  - *GPR Survey Design*
  - *GPR Instrumentation*
  - *Processing and Interpretation*

**4. Geophysical Well Logging**

- Well Drilling
  - *Rotary*
  - *Percussion*
  - *Casing*
- Formation Evaluation
  - *Lithology and Bed Thickness*
  - *Porosity*
  - *Permeability*
- Electric Logging
  - *Ohm's Law (Special Forms)*
  - *Induction*
  - *Spontaneous Potential*
  - *Combinations*
- Radioactive Logging
  - *Natural Gamma*
  - *Gamma Density*
  - *Neutron-Gamma*
- Sonic, Downhole, and Crosshole Logging*

**5. Geodesy**

- GPS (Global Positioning System)*
  - *GPS Principles*
  - *Point Positioning*
  - *Differential GPS*
  - *Kinematic GPS*
  - *Data Processing and Interpretation*
- InSAR (Interferometric Synthetic Aperature Radar)
  - *InSAR Principles*
  - *Data Processing and Interpretation*
  - *Monitoring Crustal Motion*
  - *Other Remote Sensing Applications*

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*** Topics with field exercise**

**Proposed Grading Distribution:**

*Undergraduate Credit*

The grade for the course will be computed from the following components and their respective weights:

| | |
|---|---|
| Laboratory | 40 % |
| Lecture Homework/Quizzes | 20 % |
| Midterm | 20 % |
| Final Exam | 20 % |

Letter grades will be assigned based on the final computed grade as follows:

| | |
|---|---|
| $\geq 90\%$ | A |
| $\geq 80\%$ and $< 90\%$ | B |
| $\geq 70\%$ and $< 80\%$ | C |
| $\geq 60\%$ and $< 70\%$ | D |
| $< 60\%$ | E |

*Graduate Credit*

The grade for the course will be computed from the following components and their respective weights:

| | |
|---|---|
| Laboratory | 20 % |
| Lecture Homework/Quizzes | 20 % |
| Midterm | 20 % |
| Final Exam | 20 % |
| Final Project* | 20% |

Letter grades will be assigned based on the final computed grade as follows:

| | |
|---|---|
| $\geq 90\%$ | A |
| $\geq 80\%$ and $< 90\%$ | B |
| $\geq 70\%$ and $< 80\%$ | C |
| $\geq 60\%$ and $< 70\%$ | D |
| $< 60\%$ | E |

* Final project will include an oral and written report of an assigned geophysical site characterization. The field exercise may include subsurface imaging and/or derivation geophysical earth properties.

**Possible References and/or Course Texts:**


- Burger, H.R., 1992, *Exploration Geophysics of the Shallow Subsurface*, Englewood Cliffs, N.J.: Prentice Hall, Inc., 489 pp.
- Hofmann-Wellenhof, B., H. Lichtenegger, and J. Collins, 1994, *GPS: Theory and Practice – 3rd Edition*, New York, Springer-Verlag Wein, 355 pp.
- Robinson, E.S., and C. Coruth, 1988, *Basic Exploration Geophysics*, New York: John Wiley and Sons, 562 pp.
- Reynolds, J.M., 1997, *An Introduction to Applied and Environmental Geophysics*, New York: John Wiley and Sons, 806 pp.
- Milson, J., 1996, *Field Geophysics–2nd Edition*, New York: John Wiley and Sons, 198 pp.
- Rosen, P.A., S. Hensley, I. Joughin, F. Li, S. Madsen, E. Rodriguez, and R. Goldstein, 2000, *Synthetic Aperture Radar Interferometry*, Proceedings of the IEEE, vol. 88, p. 333-382.