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LIBERAL STUDIES

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Action Date: UWUCC App 12/19/00
Senate App 1/30/01

CURRICULUM PROPOSAL COVER SHEET
University-Wide Undergraduate Curriculum Committee

I. CONTACT

Contact Person Keith Putirka Phone x5627
Department Geoscience

II. PROPOSAL TYPE (Check All Appropriate Lines)

X **COURSE** Physical Geology
Suggested 20 character title

_____ New Course* _____
Course Number and Full Title

X Course Revision GEOS 121, Physical Geology
Course Number and Full Title

_____ Liberal Studies Approval for new or existing course _____
Course Number and Full Title

_____ Course Deletion _____
Course Number and Full Title

_____ Number and/or Title Change _____
Old Number and/or Full Old Title

_____
New Number and/or Full New Title

_____ Course or Catalog Description Change _____
Course Number and Full Title

_____ PROGRAM: _____ Major _____ Minor _Track

_____ New Program* _____
Program Name

_____ Program Revision _____
Program Name

_____ Program Deletion* _____
Program Name

_____ Title Change _____
Old Program Name

_____
New Program Name

III. Approvals (signatures and date)

Darlene Richard
Department Curriculum Committee

Darlene Richard
Department Chair

College Curriculum Committee

John D. Eck
College Dean

Mary E. Sadler 11-29-00
Director of Liberal Studies (where applicable)

_____
*Provost (where applicable)

Part II

1. Description of the Curriculum Change

A. Catalog Description

GEOS 121: Physical Geology

3 lecture hours
0 lab hours
3 credits
(3c-0l-3sh)

Prerequisites: None
Co-requisite: Enrollment in GEOS 122

A semi-quantitative introduction to the Earth sciences which will include topics regarding the physical properties of Earth's interior and crust, plate tectonics, surface processes, and the complex geologic interactions that shape and modify our planet. Designed to prepare students for upper-level course work in geology, physical geography and anthropology.

B. Course Objectives

1. Students will understand Earth's internal structure, the driving forces of plate tectonics and geophysical techniques for exploring Earth's interior.

2. Students will understand the origin and evolution of igneous, metamorphic and sedimentary rocks, and the rock cycle. Geochemical strategies for understanding the evolution of rocks and minerals will be emphasized.

3. Students will understand the role of geology in understanding environmental change, including sedimentary environments, geologic hazards and climate change.

4. Students will understand elementary quantitative techniques employed by scientists to test hypotheses and develop scientific models. Elementary algebra and the use of spreadsheets will be emphasized in order to prepare students for upper-level geology and environmental geoscience coursework.

C. Course Outline

1. **Introduction (4 hours)**

Earth's setting (Big Bang theory, nucleosynthesis, origin of the solar system)
Earth's interior (crust, lithosphere, mantle, core)
Plate tectonics
The rock cycle

Quantitative Exercises:
Scientific Notation (Compare sizes of Universe, Galaxy, solar system Earth-Sun separation, average human, cell, atom, electron...)
Gravity and inverse square laws (plot gravitational attraction with distance; compare gravitational attraction for planets, Sun)
Hubble diagram (advanced; determine Hubble constant from Hubble and Humanson's original data).

2. **Mineralogy (5 hours)**

Review of atomic structure, the Bohr model
Chemical bonding, Coulomb's law, introduction to Pauling's rules
Silicates: Polymerization of SiO_4 units
Element partitioning (Nernst distribution law)
Binary phase diagrams

Quantitative Exercises:
Coulomb's Law (calculate and plot forces of attraction for atom-atom pairs)
Compare electrostatic and gravitational forces
Nernst distribution coefficients (calculate equilibrium mineral/melt and mineral/fluid compositions)

3. **The Geologic Time Scale (3 hours)**

Relative time scale, stratigraphy (Steno's laws)
James Hutton, Charles Lyell & Uniformitarianism vs. Catastrophism
Radiometric dating techniques (Rb-Sr, Nd-Sm, U-Th-Pb, ^{14}C)

Quantitative Exercises:
Radioactive Decay (calculate and plot numbers of nuclides vs. time)
Age determinations (calculate age of Earth from graph of meteorite isotope data)

Exam (1 hour)

4. **Earth's Earliest History (3 hours)**

Overview of accretion and core formation
Early geothermal gradients, heat flow
Origin of the Moon; remaining problems
Evolution of Earth's oceans and atmosphere (mantle exhalation, dehydration, growth of oxygen)

Quantitative Exercises:
Energy of accretion (energy vs. impactor mass)
Plot and Compare geotherms from different tectonic environments

5. **Origin of Earth's Continental and Oceanic Crust (5 hours)**
Mantle convection and mantle melting (mantle adiabats; Rayleigh numbers)
Mantle plumes
Earth's first crust (basalt, komatiites; clues from trace elements)
Mid-ocean ridges (isotope and trace element characteristics, physics of melt transport)
Magma diversity (Bowen's reaction series)
Island arcs, origin of continents (origin of granite, role of water)

Quantitative Exercises:
Fractional crystallization (compare elemental concentrations vs. melt fraction)

6. **Weathering, Erosion and Sedimentary Processes (4 hours)**
Chemical and physical weathering (weathering rates).
Rivers; discharge, velocity, stream patterns and deposits
Ocean shorelines, tides and submarine deposits

Quantitative Exercises:
Introduction to exponentials and natural logarithms
Weathering rates (graph reaction progress vs. temperature)
Plot particle size vs. distance traveled, stream velocity (paleo-environment interpretation)

7. **Sedimentary Rocks and Environments (4 hours)**
Clastics: particle characteristics (interpretations of size, sorting, and textures)
Chemical and Biological sediments
Sedimentary structures - clues to paleo-environmental analysis
Sedimentary packages (turbidites/Bouma sequence, reefs, alluvial and deltaic sequences)

Quantitative Exercises:
Stokes' Law (calculate settling velocities, predict travel distances)
Sedimentation Rates

Exam (1 hour)

8. **Introduction to Geophysical Exploration (5 hours)**
Earth's magnetic field, paleomagnetism
Gravity and Isostasy
Earthquakes and seismology

Quantitative Exercises:
Gravity (gravitational acceleration as a function of latitude; calculate isostatically-balanced crustal sections)
Seismic waves (P- and S-wave arrivals, seismic velocity)

9. **Structural Geology (4 hours)**
Brittle & ductile deformation
Stress & strain
Faults and fractures
Strength profile of the lithosphere

Quantitative Exercises:
Fold wavelength (calculate tectonic forces from measured fold wavelengths)
Graph a strength profile, with brittle-ductile transition

10. **Glaciation & Climate Change (3 hours)**
Factors that determine a planet's surface temperature
The carbonate-silicate cycle
Ice ages, oxygen isotopes
Astronomical influences

Quantitative Exercises:
Oxygen isotopes as a record of temperature change

D. Evaluation Methods

The final grade for this course will be determined as follows:

30% Quizzes
40% Exams (Two exams during the term, and a final exam, each equally weighted)
23% Homework
7% Book review

Grading Scale: A = 90-100%; B = 80-89%; C = 70-79%; D = 60-69%; F = 0-59%.

E. Required Textbooks, Supplemental Books and Readings

Text:

Press, F. and Siever, R., 1998, Earth, Fourth Edition: New York, NY, 656 p.

Non-text—will vary with instructor, but may include:

Bolles, E. B., 1999, The Ice Finders: Counterpoint, Washington, D.C., 257 p.

McPhee, J., 1989, The Control of Nature: Farrar, Strauss and Giroux, New York, NY, 272 p.

McPhee, J., 1990, Basin and Range: Farrar, Strauss and Giroux, New York, NY, 216 p.

McPhee, J., 1993, Assembling California: Farrar, Strauss and Giroux, New York, NY, 304 p.

Scholz, C., 1997, Fieldwork: A geologists memoir of the Kalahari: Princeton University Press, , Princeton, N.J., 190 p.

F. Special Resource Requirements

None.

G. Bibliography

Allen, J. R. L., 1970, Physical Processes of Sedimentation: George Allen and Unwin Ltd., London, UK, 248 p.

Bates, R. L., and Jackson, J. A., 1984, Dictionary of geological terms: AGI, Doubleday, New York, NY, 571 p.

Coch, N. K., and Ludman, A., 1991, Physical Geology: McMillan, New York, NY, 678 p.

Fowler, C, M. R., 1992, The Solid Earth: Cambridge University Press, Cambridge, UK, 472 p.

Hamblin, W. K., and Christiansen, E. H., 1998, Earth's Dynamic Systems: Prentice Hall, Inc., Upper Saddle River, NJ, 740 p.

Kump, L. R., Kasting, J. F., and Crane, R. G., 1999, The Earth System: Prentice Hall, Upper Saddle River, NJ, 351 p.

Lunine, J. I., 1999, Earth: evolution of a habitable world: Cambridge University Press, Cambridge, UK, 319 p.

McKinney, M. L., and Tolliver, R. L., 1994, Current issues in geology: selected readings: West Publishing Co., New York, NY. 254 p.

Plummer, C. C., and McGeary, D., 1993, Physical Geology, 6th ed.: William Brown Publishers, Dubuque, IA, 537 p.

Press, F., and Siever, R., 2001, Understanding Earth, 3rd ed.: W. H. Freeman and Co., New York, NY, 573 p.

Skinner, B. J., and Porter, S. C., 1995, The Dynamic Earth: an introduction to physical geology, 3rd ed.: John Wiley and Sons, New York, NY, 567 p.

Zelink, M., 1997, Astronomy: the evolving universe, 8th ed.: John Wiley and Sons, New York, NY, 525 p.

2. Summary of Proposed Revisions

A. Comparison of Catalog Descriptions

Current Catalog Description:

GEOS 121: Physical Geology

3 lecture hours
0 lab hours
3 credits
(3c-0l-3sh)

Prerequisites: Geoscience majors/minors, any Science or Science Education majors/minors; Anthropology, Geography/Regional Planning majors, or permission of instructor

Co-requisite: Enrollment in GEOS122

Introduction to the science of the earth, including physical properties of its interior and crust; its tectonic and surface processes; and the complex geologic interactions which shape and modify our planet. Designed to prepare students for upper-level geology classes..

Proposed Catalog Description:

GEOS 121: Physical Geology

3 lecture hours
0 lab hours
3 credits
(3c-0l-3sh)

Prerequisites: None
Co-requisite: Enrollment in GEOS 122

A semi-quantitative introduction to the Earth sciences, which will include the physical properties of Earth's interior and crust, plate tectonics, surface processes, and the complex geologic interactions that shape and modify our planet. Designed to prepare students for upper-level course work in geology, physical geography and anthropology.

B. Summary of revisions

The enrollment restriction has been deleted and, with additional re-wording, the new course description notes the semi-quantitative nature of the course.

3. Justification for Revision:

By deletion of the enrollment restriction, non-majors who prefer a rigorous introduction to the Earth sciences can sign up for the course.

The most significant change involves the addition of a quantitative component to each major section of the course (and the course description has been modified, so students will be aware of the nature of this course). The addition of quantitative material is crucial for several reasons. First, it is necessary that GEOS 121 keep pace with the increasingly quantitative nature of the geological sciences. Secondly, by introducing elementary quantitative material at the beginning of the program, students will be better prepared for additional quantitative work in upper division courses, and within their professional career. Finally, students will better appreciate the central role that mathematics plays in the sciences, and will perhaps be encouraged to explore additional offerings within the Mathematics department.

This is an introductory course, recommended by some anthropology and geography programs, and required by all geoscience majors; these students usually enroll in GEOS 121 during their freshman year. For this reason mathematical aspects will be treated at an elementary level, involving no more than high school-level arithmetic/algebra. In GEOS 121 students will review and utilize high school-level algebra, and will be required to create and interpret graphs in the context of their geologic studies. Students will also learn to use spreadsheets for creating and interpreting their graphs. Through additional course revisions, the elementary mathematical skills introduced in GEOS 121 will be augmented and enhanced in upper division GEOS coursework. We anticipate that this early introduction of mathematics within the geoscience curriculum will result in increased student motivation and performance in mathematics courses, as well as a heightened comfort level with computers and quantitative techniques. Most importantly, this course revision addresses the changing nature of geology and emphasizes the skills students will need for their professional careers and post-baccalaureate education.

4. Old Syllabus of record

Part III - Letters of Support (in appendix)

Geography and Regional Planning (9/25/00):

The geography department supports the proposed changes made to GEOS 121. We look forward to continuing to recommend the Geoscience lab sequence to our students.

Dr. Robert Sechrist, Chair
Dept. of Geography & Planning
Indiana University of Pennsylvania
Indiana Pa, 15705
(724)357-2251 | rpsecrst@grove.iup.edu

Letter from Anthropology is forthcoming

PART II DESCRIPTION OF CURRICULUM CHANGE

1. New Syllabi of Record:

GS 121 Physical Geology

I. Catalog Description:

GS 121 Physical Geology — 3 credits, 3 lecture hours (3c-0l-3sh)

Pre-reqs: Geoscience Major/Minor or Anthropology / Geography / Regional Planning Major or Permission of instructor

Introduction to the science of the earth, including physical properties of its interior and crust; its tectonic and surface processes; and the complex geologic interactions which shape and modify our planet. Designed to prepare students for upper-level geology classes.

II. Course Objectives

1. Students will learn about the earth's structure, tectonic activity and geophysics.
2. Students will study the origin of rocks and the rock cycle
3. Students will examine the role that geologic hazards play in everyday life.
4. Students will gain enough knowlege and understanding of earth processes to prepare them for upper-level geology and environmental geoscience course-work.

III. Course Outline

A. Introduction to Physical Geology (4 hours)
- Origin of the Earth
- Plate tectonics: theory
- Plate tectonics: modern examples
- The rock cycle

42 hours

B. Igneous rocks and minerals (5 hours)
- Minerals made from molten rock
- Plutons and volcanoes
- Igneous rocks of the ocean floor
- Igneous rocks from island arcs
- Igneous rocks on continents

C. Sedimentary rocks and minerals (5 hours)
- Minerals made by weathering
- Sediments and sedimentation processes
- Sedimentary rocks on land
- Sedimentary rocks along the shore
- Sedimentary rocks in the sea

D. Metamorphic rocks and minerals (4 hours)
- Minerals made by heat & pressure
- Regional metamorphism
- Other types of metamorphism
- Metamorphism and plate tectonics

E. Time and rock deformation (4 hours)
- Stratigraphy: the science of layered rocks
- Geologic time and ways to tell it
- Folds and ductile strain
- Faults and brittle strain

F. The Earth's hydrosphere (5 hours)
- The hydrologic cycle and the origin of water
- Groundwater flow and chemistry
- Caves and karst development
- Rivers: erosional and depositional agents
- The sea around us

G. Climates and landscape (5 hours)
- Deserts: wind, sand dunes and pavements
- Glaciers and the effects of glaciation
- Ice Ages, past and present
- Mass wasting and natural hazards
- Landscape development

H. The Earth's internal processes (5 hours)
- Earthquakes: processes and natural hazards
- Geophysics: heat flow, magnetism and gravity
- Plate tectonics revisited
- Evidence for plate tectonics
- Mountain building events

I. The Earth's future (5 hours)
- Energy resources: fossil fuels
- Energy resources: renewable sources of energy
- Mineral resources
- Climate change, past and future
- The earth's changing environment

IV. Evaluation Methods

Your grade in this course will be calculated from four non-cumulative exams (worth 100 points each) and one written book report (worth 50 points). Exams will consist of short answer and essay questions. Exam scores will be adjusted to a mean of 75% so that 90-100%=A; 80-89%=B; 70-79%=C; 60-69%=D; and below 60%=F.

V. Required Textbook, Supplemental Book and Readings

Text: Press, F. and Siever, R., EARTH (4th Ed.). New York: W.H. Freeman and Company, 656 p.

Non-text: May vary with instructor, but will include choices such as:

David Brin EARTH
Paul Preuss CORE
John McPhee THE CONTROL OF NATURE
John McPhee BASIN AND RANGE

VI. Special Resource Requirements: None

VII. Bibliography:

Bates, R.L. and Jackson, J.A., 1984, DICTIONARY OF GEOLOGICAL TERMS. New York: Doubleday, 571 p.

Coch, N.K. and Ludman, A., 1991, PHYSICAL GEOLOGY. New York: McMillan Publishing Company, 678 p.

McKinney, M.L. and Tolliver, R.L., 1994, CURRENT ISSUES IN GEOLOGY: SELECTED READINGS. New York: West Publishing Company, 254 p.

Plummer, C.C. and McGeary, D., 1993, PHYSICAL GEOLOGY (6th ed). Dubuque, Wm. Brown Publishers, 537 p.

Skinner, B.J. and Porter, S.C., 1989, THE DYNAMIC EARTH. New York: John Wiley & Sons, 541 p.

Skinner, B.J. and Porter, S.C., 1995, THE BLUE PLANET: AN INTRODUCTION TO EARTH SYSTEM SCIENCE. New York: John Wiley and Sons, 493 p.

Liberal Studies Office
110 Gordon Hall Ext. 7-5715

Dr. Mary E. Sadler
email: msadler

Date: December 8, 2000

To: Dr. Keith Putirka

From: Dr. Mary E. Sadler

Subject: Liberal Studies approvals

At the November 16, 200 meeting of the Liberal Studies Committee the following proposals were reviewed and approved:

GEOS 121Physical Geology – catalog description and prerequisite change approved,

GEOS 122 Physical Geology Lab - catalog description and prerequisite change approved.

A copy of this memo is forwarded to the UWUCC so it is available as they review these proposals. Please don't hesitate to ask if you have any questions about the review process.

CC: Dr. Darlene Richardson, Chair
Dr. John Eck, Dean
UWUCC