LSC Use Only Proposal No: LSC Action-Date:	UWUCC Use Only Proposal No: 14-976 UWUCC Action-Date: App 10/28/14 Senate Action Date: App 12/2/14

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person(s)	Email Address
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Proposing Department/Unit	Phone
Geoscience	724-357- 7650

Check all appropriate lines and complete all information. Use a separate cover sheet for each course proposal and/or 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

Current course prefix, number and full title: **GEOS 301 Mineralogy** & Petrology

Proposed course prefix, number and full title, if changing: GEOS 301 Mineralogy

2. Liberal Studies Course Designations, as appropriate

_____ This course is also proposed as a Liberal Studies Course (please mark the appropriate categories below)

_____ Learning Skills _____ Knowledge Area _____ Global and Multicultural Awareness _____ Writing Intensive (include W cover sheet)

_____ Liberal Studies Elective (please mark the designation(s) that applies – must meet at least one)

_____ Global Citizenship _____ Information Literacy _____ Oral Communication

_____ Quantitative Reasoning _____ Scientific Literacy _____ Technological Literacy

3. Other Designations, as appropriate

_____ Honors College Course _____ Other: (e.g. Women's Studies, Pan African)

4. Program Proposals

_____ Catalog Description Change _____ Program Revision _____ Program Title Change _____ New Track

_____ New Degree Program _____ New Minor Program _____ Liberal Studies Requirement Changes _____ Other

Current program name:

Proposed program name, if changing:

5. Approvals	Signature	Date
Department Curriculum Committee Chair(s)	Kenneth S. Coles	3/31/2014
Department Chairperson(s)		4/24/14
College Curriculum Committee Chair		10/17/14
College Dean		10/20/14
Director of Liberal Studies (as needed)		
Director of Honors College (as needed)		
Provost (as needed)		
Additional signature (with title) as appropriate		
UWUCC Co-Chairs	Gail S Sechrist	10/28/14

Part II. Description of Curricular Change

1. SYLLABUS OF RECORD

I. Catalog Description

GEOS 301 Mineralogy (3c-3l-4cr)
Prerequisite: Grade of C or better in GEOS 201 and 202; CHEM 111 or 113

Introduces students to crystallography, crystal chemistry, physical properties, optical properties and phase equilibria of minerals pertinent to geology and economic resources. Laboratory exercises focus on mineral identification and interpretation as well as analytical techniques such as x-ray diffractometry and optical microscopy.

II. Course Objectives
At the end of this course, students will be able to:
1) Explain the fundamentals of crystallography and chemical bonding in minerals.
2) Explain crystal nucleation, growth and imperfections.
3) Utilize physical properties such as color, luster, cleavage, and hardness to recognize common rock-building minerals in hand sample specimens.
4) Explain mineral phase diagrams and crystallization sequences.
5) Describe and characterize common silicate structures.
6) Use the petrographic microscope to identify common minerals in thin section using optical properties.

III. Course Outline

Lecture Schedule

A. *Atoms, bonding of elements and minerals, symmetry, crystal systems, Miller indices*	(6 hours)
B. *Crystallization, introduction to thermodynamics, crystal growth and imperfections*	(4 hours)
D. *Structural classification of silicates: single, double, and ring tetrahedral structures*	(6 hours)
C. Exam 1	(1 hour)
D. *Structural classification of silicates: chain, sheet and framework tetrahedral structures*	(8 hours)
E. Exam 2	(1 hour)
F. *Properties of light passing through minerals*	(8 hours)
G. *Optical Mineralogy- optical properties of minerals*	(8 hours)
I. Final exam	(2 hours during final exam period)

Lab Schedule

Week 1	Physical properties of minerals
Week 2	Crystal systems, symmetry and Miller indices

Week 3	Silicates 1: Isolated and double tetrahedra, ring structures
Week 4	Silicates 2: Single and double chain tetrahedral structures
Week 5	Silicates 3: Sheet tetrahedral structures
Week 6	Silicates 4: Framework tetrahedral structures
Week 7	**Lab Exam 1;** Non-silicate minerals
Week 8	Optical properties of minerals 1: plane polarized light, pleochroism, relief
Week 9	Optical properties of minerals 2: cross-polarized light, birefringence, retardation
Week 10	Optical properties of minerals 3: uniaxial minerals
Week 11	Optical properties of minerals 4: biaxial minerals
Week 12	Mineral Identification: Real rocks in thin section
Week 13	Powder X-ray diffraction and rock analysis
Week 14	**Lab Exam 2**

IV. Evaluation Methods
The final class grade will be determined from the following assessments:

Lecture Exam 1	15 %
Lecture Exam 2	15 %
Final Lecture Exam	15 %
Lecture assignments and quizzes	10 %
Lab assignments	15 %
Lab Exam 1	15 %
Lab Exam 2	15 %
Total	100 %

V. Example Grading Scale
The final grade will be assigned based on the semester average using the scale: 90-100%=A; 80-89%=B; 70-79%=C; 60-69%=D and below 60%=F.

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

VII. Required Textbook(s), Supplemental Books and Readings.
Nesse, Introduction to Mineralogy 2nd ed., 2012

VIII. Special Resource Requirements.
Students must purchase a 10X hand lens for lab exercises. These typically run $5-20 depending on quality.

IX. Bibliography
The following resources will be used to develop the course curriculum:

Dohaney, Jacqueline, Erik Brogt, and Ben Kennedy (2012) "Successful Curriculum Development and Evaluation of Group Work in an Introductory Mineralogy Laboratory." Journal of Geoscience Education v. 60: 21-33.

Farndon, John (2012) The Illustrated Guide to Rocks & Minerals: Anness, 256 pp.

Ghiorso, M. S. (2011) "PhasePlot: A Software Program for Visualizing Phase Relations Computed Using Thermochemical Models and Databases." AGU Fall Meeting Abstracts. Vol. 1.

Hoisch, Thomas D., Barbara A. Austin, Shawn L. Newell, and Mark F. Manone (2010) "Application of Tablet PCs to Lecture Demonstrations on Optical Mineralogy." Journal of Geoscience Education: v. 58, pp. 221-231.

Hollabaugh, Curtis L. (2012) "Teaching Undergraduate Mineralogy With Experiential Learning: From The Field To The Lab To Geological Society Of America Meetings." 2012 GSA Annual Meeting in Charlotte. Abstracts with Programs

Lalonde, Andre E. (2012) "The Importance Of Polarized Light Microscopy And Optical Mineralogy In The Undergraduate Geology Curriculum At The University Of Ottawa." 2012 GSA Annual Meeting in Charlotte Abstracts with Programs.

Mogk, D. W., et al. (2011) "Teaching Mineralogy, Petrology and Geochemistry in the 21st Century: Instructional Resources for Geoscience Faculty." AGU Fall Meeting Abstracts. Vol. 1.

Nesse, William (2011) Introduction to Mineralogy (2nd Ed). Oxford University Press, 496 pp.

Nord, Julia A. (2012) "Mineralogy Labs: An Integrated Approach." 2012 GSA Annual Meeting in Charlotte Abstracts with Programs.

Perkins, Dexter (2010) Mineralogy (3rd Ed). Prentice-Hall, 453 pp.

Perkins, Dexter and Kevin R. Henke (2003) Minerals in Thin Section (2nd Ed). Prentice-Hall, 176 pp.

Swope, R. Jeffrey and Reto Giere (2004) "Teaching an effective undergraduate mineralogy course." Journal of Geoscience Education: v. 52, p. 15-22.

2. SUMMARY OF PROPOSED REVISIONS

1) Course content of current GEOS 301 Mineralogy and Petrology will be split back into two semester-long courses: GEOS 301 Mineralogy and GEOS 345 Igneous and Metamorphic Petrology (addressed with a separate new course proposal). This will return the sequence to its original IUP format and make it equivalent to the way most other undergraduate programs teach mineralogy and hard-rock petrography for geology degree programs.

2) One semester of chemistry (CHEM 111 or CHEM 113) has been added as a pre-requisite.

3. JUSTIFICATION/RATIONALE FOR THE REVISION

Rock and mineral interpretation is one of the key student learning outcomes identified by our strategic plan and mission. These are critical professional skills both for students entering the geologic workforce (IE, mud-logging and energy exploration) as well as those continuing on to graduate study. Since the Geoscience Department was first formed in 1968, Mineralogy was taught as a stand-alone class taken by geology majors during their sophomore year while Igneous and Metamorphic Petrology was either an upper-level requirement or controlled elective, depending on degree track.

During our last curriculum update (2008-2009), the department experimented with combining these two subjects into a single-semester course in an attempt to reduce the number of required classes and improve 4-year graduation rates. While other parts of the 2008-2009 curriculum reform were successful, faculty analysis of student learning outcomes during our department planning retreats has consistently identified rock and mineral identification and interpretation as a weak area for recent geoscience graduates. Analysis of the current curriculum pointed to two problems: 1) the merger of Mineralogy and Petrology, and 2) the lack of background knowledge when students enrolled in Mineralogy prior to learning fundamental chemical concepts.

We want to close the loop in our assessment process by returning to a two-course sequence: GEOS 301 Mineralogy (the topic of this course revision) and GEOS 345 Igneous and Metamorphic Petrology (the topic of an associated new course proposal, since the original Igneous and Metamorphic Petrology class was deleted). GEOS 301 Mineralogy will now require CHEM 111 (or 113) in order to ensure students have the fundamental background knowledge of chemical bonding and reactions. It will form part of the common geologic core for all degree tracks, while GEOS 345 Igneous and Metamorphic Petrology will be required for Geology Track majors and optional for Environmental / Energy Resources Track majors.

We plan to implement this change in conjunction with a program revision of all three B.S. in geology tracks that reduces non-geology requirements for all tracks and maintains flexibility in course scheduling through the use of optional choices for most program requirements and a broad slate of controlled electives. The division of Mineralogy and Petrology into two courses does not increase the degree credit requirements, as outlined in the accompanying program revisions. The addition of a CHEM 111 pre-requisite for Mineralogy and the addition of GEOS 345 Igneous and Metamorphic Petrology as a separate course should therefore not impact our time-to-degree and four-year graduation rates. Over the next five years we will monitor this closely as part of our strategic assessment plan for program review.

The planned changes to GEOS 301 Mineralogy will not only improve our student learning outcomes, it will also bring our degree programs into compliance with the way that most other geology programs across the country teach this subject. This will result in IUP geoscience

graduates being better prepared and more able to compete effectively against students from other institutions, both for jobs in the geologic workforce and for graduate fellowships.

4. PREVIOUS SYLLABUS OF RECORD

1. SYLLABUS OF RECORD

I. Catalog Description — 3 class hours
GEOS 301 Mineralogy and Petrology — 3 lab hours
4 credit hours

Prerequisite: Grade of C or better in GEOS 201 and GEOS 202 (3c-3l-4cr)
Introduces students to crystallography, crystal chemistry, optical properties and phase equilibria of minerals pertinent to geology, Earth resources and technology. Introduces the origins of igneous and metamorphic rocks based on a plate tectonic framework emphasizing melting and crystallization processes as well as metamorphic reactions. Laboratory exercises will focus on mineral and rock identification and interpretation as well as quantitative techniques such as x-ray diffractometry and optical microscopy.

II. Course Objectives
At the end of this course students will be able to:

1) Explain the fundamentals of crystallography and chemical bonding.
2) Demonstrate knowledge of approximately 100 minerals commonly encountered in geology, earth resources and technology, their chemistry, identification, occurrence and geologic relevance.
3) Use the petrographic microscope to identify common minerals in thin section using optical properties.
4) Relate common minerals with igneous, metamorphic and sedimentary rocks and the tectonic setting in which these rocks form.
5) Classify approximately forty igneous and metamorphic rocks commonly encountered in geology as well as demonstrate knowledge of their chemistry, phase relations, occurrence and geologic relevance.
6) Use the optical microscope to classify common igneous and metamorphic rocks in thin section on the basis of their mineralogy, and interpret textures within those rocks.
7) Evaluate the tectonic history of a region based on the occurrence and distribution of igneous and metamorphic rocks.

III. Course Outline

Lecture

Part A (10 academic hours): Foundations of Mineralogy

1. Symmetry and Crystallography
2. Atoms, Elements and Chemical Bonding
3. Physical Properties of Minerals
4. Conceptually Building Minerals
5. Chemical Classes of Minerals

Exam 1 (1 academic hour)

Part B (10 academic hours): Systematic Mineralogy

1. Non-Silicate Minerals
2. Silicate Minerals
3. Phyllosilicate Minerals

Exam 2 (1 academic hour)

Part C (10 academic hours): Igneous Rocks

1. Melting Mechanisms and Plate Tectonics
2. Felsic Igneous Rock Associations and Phase Relations
3. Intermediate Igneous Rock Associations and Phase Relations
4. Mafic Igneous Rock Associations and Phase Relations

4. Tectonic Interpretations of Igneous Rocks

Exam 3 (1 academic hour)

Part D (9 academic hours): Metamorphic Rocks

1. Agents of Metmorphism
2. Types of Metamorphism and Metamorphic Rocks
3. Metamorphic Textures and their Origins
4. Metamorphic Facies, Reactions and Pressure-Temperature-Time Paths
5. Tectonic Interpretations of Metamorphic Rocks

Final exam during final exam period.

Laboratory Exercises (3 academic hours each)

Week 1:	Geologic Interpretation Exercise
Week 2:	Symmetry and Crystallography
Week 3:	Physical Properties of Minerals
Week 4:	Systematic Mineralogy
Week 5:	Systematic Mineralogy
Week 6:	Systematic Mineralogy
Week 7:	Laboratory Exam 1
Week 8:	Felsic Igneous Rocks
Week 9:	Intermediate Igneous Rocks
Week 10:	Mafic Igneous Rocks
Week 11:	Metamorphic Rocks
Week 12:	Metamorphic Rocks
Week 13:	Tectonic Interpretation Exercise
Week 14:	Laboratory Final Exam

IV. Evaluation Methods

Each component of the course will contribute to final grade according to:

Exam 1	15%
Exam 2	15%
Exam 3	15%
Final Exam	30%
Laboratory Exam 1	10%
Laboratory Final Exam	10%
Laboratory Exercises	5%
Total	100%

Possible points earned are distributed between lecture and lab according to the credit hour allocation for the course (3 credits for the lecture, 1 credit for the lab).

V. 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

Sen, G. *Earth's Materials: Minerals and Rocks*. Upper Saddle River, N.J.: Prentice Hall, 2001.

Approximately five scientific papers will be used periodically throughout the course to supplement textbook readings.

VIII. Special resource requirements

There are no special resource requirements for this course.

IX. Bibliography

In addition to the required textbooks and supplemental readings from science journals, the following will be used to develop the course curriculum:

Winter, J.D. (2001) An Introduction to Igneous and Metamorphic Petrology: Prentice Hall, Upper Saddle River, NJ, 697p.

Klein, C. (2002) The 22nd Edition of the Manual of Mineral Science: John Wiley and Sons, New York, 641p.

Klein, C. (1994) Minerals and Rocks: Exercises in Crystallography, Mineralogy and Hand Specimen Petrology: John Wiley and Sons, New York, 405p.

Chang, L.L.Y. (2002) Industrial Mineralogy: Materials, Processes and Uses: Prentice Hall, Upper Saddle River, NJ, 472p.

Putnis, A. (2001) Introduction to Mineral Sciences: Cambridge University Press, Cambridge, UK, 457p.

Perkins, D. (2002) Mineralogy, 2nd ed.: Prentice Hall, Upper Saddle River, NJ, 483p.

Nesse, W.D. (2000) Introduction to Mineralogy: Oxford University Press, New York, 442p.

Spear, F.S. (1993) Metamorphic Phase Equilibria and Pressure-Temperature-Time Paths: Mineralogical Society of America, Washington, DC, 799p.

Nesse, W.D. (2004) Introduction to Optical Mineralogy: Oxford University Press, New York, 348p.

Philpotts, A.R. (1990) Principles of Igneous and Metamorphic Petrology: Prentice Hall, Upper Saddle River, NJ, 498p.

Perkins, D. and Henke, K.R. (2000) Minerals in Thin Section: Prentice Hall, Upper Saddle River, NJ, 125p.

Part III. Letters of Support or Acknowledgment

No other departments or programs are affected by these revisions. CHEM 111/113 is already a degree requirement for all tracks in the Geology major; it is simply added as a pre-requisite for this course.