LSC Use Only Proposal No: LSC Action-Date:	*UWUCC Use Only* Proposal No: 14-97g 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
Karen Rose Cercone	**kcercone@iup.edu**
Proposing Department/Unit **Geoscience**	Phone **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 _____ Course Number and/or Title Change __X__ Catalog Description Change

Current course prefix, number and full title: **GEOS 362 Plate Tectonics**

Proposed course prefix, number and full title, if changing:

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	4/17/2014
Department Chairperson(s)	[signature]	4/24/14
College Curriculum Committee Chair	Anne Kondo	10/17/14
College Dean	Deanne Snavely	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 Sechrist	10/28/14

Received

OCT 23 2014

Part II. Description of Curricular Change

1. SYLLABUS OF RECORD

I. Catalog Description

GEOS 362 Plate Tectonics (3c-3l-4cr)
Prerequisite: Grade of C or better in GEOS 201

Introduction to formal theory of plate tectonics. Topics include magnetic anomalies, first motion studies, thermal structures of the plates, kinematics, crustal generation, sea floor spreading, collision, and subduction deformation.

II. Course Objectives

1. Students will quantify constraints on lithospheric plate architecture and motion using paleomagnetic, seismic and geochronologic data.
2. Students will describe and understand modern and past plate motions using spherical geometry.
3. Students will relate rock lithologies and rock associations to unique plate tectonic settings.
4. Students will identify gaps in scientific knowledge through reading primary scientific literature on a plate tectonics topic of their choice, and craft a National Science Foundation-style research proposal to address the gaps in knowledge.

III. Course Outline

Lecture Schedule

A. Basis of a scientific revolution (4 hours)
Continental drift versus plate tectonics. Introduction to the rock record in the context of plate tectonic theory.

B. Divergent plate boundaries (4 hours)
Introduction to paleomagnetism. Velocity of plates as determined from the seafloor record. Formation of oceanic lithosphere. Introduction to ophiolites.

C. Convergent plate boundaries (3 hours)
Architecture and geometry of oceanic trenches and island arcs. Velocity of plates at convergent boundaries. Partitioning of plate motion.

D. Transform plate boundaries (3 hours)
The morphology of strike-slip fault zone (e.g., San Andreas fault). Angular versus linear velocity of plates.

E. Exam 1 (1 hour)

F. Where three plate boundaries meet; i.e., triple junctions (4 hours)
Stability of triple junctions. Migration of triple junctions and implications for the rock record.

G. Plate interactions in velocity space (6 hours)
Velocity space diagrams. Methods for exploring spherical geometry.

H. Seismologic constraints on plate motion (4 hours)
Earthquake first-motion studies. Earthquake focal mechanisms and their relation to tectonic setting. The relation between fault kinematics and tectonic setting.

I. Exam 2 (1 hour)

J. Research proposal development (6 hours)
In-class roundtable discussions and "chalk talk" presentations on research proposals.

K. Direct measurements of plate motion (2 hours)
Modern methods of geodesy. Introduction to the geodetic expression of recoverable versus permanent strain in the crust.

L. Expression of plate tectonics in the shallow crust (2 hours)
Tectonic geomorphology. Neotectonic processes and rock records over $10^4 - 10^6$ years.

M. Geodynamics (2 hours)
Introduction to the driving forces for plate motion. Tomographic constraints on whole Earth behavior.

N. Final exam during final exam period (2 hours)

Lab Schedule

Week 1	Introduction to plate boundaries; the rock record
Week 2	Seafloor spreading; magnetic records, ridge jumping, velocity calculations
Week 3	Linear plate kinematics I
Week 4	Linear plate kinematics II
Week 5	Velocity triangles; 3-plate problems
Week 6	Spherical geometry problems I; plotting poles on lower and upper hemisphere projections
Week 7	Spherical geometry problems II; plotting planes and plate motions on lower and upper hemisphere projections
Week 8	Triple junction stability
Week 9	Student research proposal presentations based on primary literature of their choosing
Week 10	Earthquake first motions and fault kinematics at convergent boundaries
Week 11	Angular velocity calculations
Week 12	Coordinate transformations; plane and vectors in local coordinates
Week 13	Tectonic geomorphology; geochronology applied to active faults
Week 14	Active tectonics; using earthquake focal mechanism solutions to understand active plate boundaries; instantaneous velocity calculations

IV. Evaluation Methods

The final class grade will be determined from the following assessments:

Lecture exam 1	15%
Lecture exam 2	15%
In-class writing	5%
Research proposal	30%
Lab/Hands-on activities	20%
Lecture final exam	15%
Total	100 %

V. Example Grading Scale

The final grade will be assigned using a scale no stricter than 90-100%=A; 80-89.9%=B; 70-79.9%=C; 60-69.9%=D and below 60%=F.

VI. Attendance Policy

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

VII. Required Textbooks

Plate Tectonics – How it Works, 1st edition, by Allan Cox & Robert Brian Hart (1986, Blackwell Scientific, Palo Alto)

Tectonics, 1st edition, by Eldridge M. Moores & Robert J. Twiss (2006, W.H. Freeman & Company, New York)

Note: Cox and Hart is a classic but superb presentation of quantitative methods, while Moores and Twiss covers the geology aspects of tectonics much better than other available books.

VIII. Special Resource Requirements

Students must have a hand lens, sleeping bag, field boots and waterproof field notebook. Approximately $30 will be required for meals and camping during the 3-day field trip.

IX. Bibliography

In addition to the required textbook and supplemental readings from current literature, the following will be used to develop the course curriculum:

Burbank, Douglas W. and Anderson, Robert J., Tectonic Geomorphology (2nd edition), 2011, Wiley-Blackwell.

Dragert, H., Wang, K., and James, T. S., 2001, A Silent Slip Event on the Deeper Cascadia Subduction Interface: Science, v. 292, p. 1525-1528.

Fisch, Wolfgang; Meschede, Martin and Blakey, Ronald C., Plate Tectonics: Continental Drift and Mountain Building, 2011, Springer.

Fitch, T. J., 1972, Plate Convergence, Transcurrent Faults, and Internal Deformation Adjacent to Southeast Asia and the Western Pacific: Journal of Geophysical Research, v. 77, no. 23, p. 4432-4460.

Gillis, K. M., Snow, J. E., Klaus, A., Abe, N., Adriao, A. B., Akizawa, N., Ceuleneer, G., Cheadle, M. J., Faak, K., Falloon, T. J., Friedman, S. A., Godard, M., Guerin, G., Harigane, Y., Horst, A. J., Hoshide, T., Ildefonse, B., Jean, M. M., John, B. E., Koepke, J., Machi, S., Maeda, J., Marks, N. E., McCaig, A. M., Meyer, R., Morris, A., Nozaka, T., Python, M., Saha, A., and Wintsch, R. P., 2014, Primitive layered gabbros from fast-spreading lower oceanic crust: Nature, v. 505, no. 7482, p. 204-207.

Ito, Y., Asano, Y., and Obara, K., 2009, Very-low-frequency earthquakes indicate a transpressional stress regime in the Nankai accretionary prism: Geophysical Research Letters, v. 36.

Jackson, J., 2002, Strength of the continental lithosphere; time to abandon the jelly sandwich?: GSA Today, v. 12, no. 9, p. 4-10.

Jagoutz, O., and Behn, M. D., 2013, Foundering of lower island-arc crust as an explanation for the origin of the continental Moho: Nature, v. 504, no. 7478, p. 131-134.

Kearey, Philip; Klepeis, Keith A. and Vine, Frederick J. Global Tectonics (3rd edition), 2009, Wiley-Blackwell.

Obara, K., 2002, Nonvolcanic deep tremor associated with subduction in southwest Japan: Science, v. 296, p. 1679-1681.Oreskes, N., 2013, Earth science: How plate tectonics clicked: Nature-Comment, v. 501, no. 7465, p. 27-29.

Sigloch, K., and Mihalynuk, M. G., 2013, Intra-oceanic subduction shaped the assembly of Cordilleran North America: Nature, v. 496, no. 7443, p. 50-56.

Turcotte, Donald L. and Schubert, Gerald, Geodynamics (2nd edition), 2002, Cambridge.

2. SUMMARY OF PROPOSED REVISIONS

Plate Tectonics is currently taught in a 2c-3l-3cr format. Material is presented in both lecture and laboratory formats. This proposed revision would add an additional lecture hour to promote better student learning outcomes primarily for department SLO goals II, III and IV (plate tectonic theory, spatial data analysis and map interpretation; computer spreadsheet analysis, statistics or mathematical modeling, and effective scientific communication skills). The new format for the class would then be 3c-3l-4cr, allowing for more classroom time for students to discuss and present their research proposal ideas. This change makes the class format similar to most other upper-level majors classes in the Geoscience Department.

3. JUSTIFICATION/RATIONALE FOR THE REVISION

This course revision addresses shortcomings that have been identified, in part, through our departmental Student Learning Outcomes committee. These shortcomings are addressed in the overarching curriculum proposal of which this revision is a part. The specific professional skills that this course revision aims to address are underlined below:

I. Students will develop the tools needed to analyze and solve problems in earth science.

II. Students will master three foundational content areas in geoscience: plate tectonic theory, organic evolution and environmental change.

III. Students will develop professional skills needed for field and lab research: rock & mineral identification and interpretation; spatial data analysis and map interpretation; computer spreadsheet analysis, statistics or mathematical modeling.

IV. Students will develop effective scientific communication skills in both written and oral formats.

The theory of plate tectonics provides a profoundly unifying lens through which Earth processes and Earth history are examined and understood. Because it touches nearly all facets of the Geosciences plate tectonics provides an ideal format for employing writing as a means of content delivery. Since 2008 this class has been taught as writing intensive using in-class writing, essay exam questions, and the development of a National Science Foundation-style proposal. The latter work entails reading primary literature and identifying a gap in our understanding. The current course format (2c-3l-3cr) does not provide adequate classroom time for students to flesh out their research proposals through roundtable discussions and/or "chalk talk" presentations.

Note on time to degree:

The addition of this extra credit hour will not impact any student's time to graduation or required total credits for their major. Under our proposed new curriculum (included elsewhere in this revision package), all upper level Geoscience courses will be incorporated as options rather than as required courses for our degree tracks. Each optional category requires two of the four courses to be taken, and in these categories, most of the courses already carry four credits. Because of this, we have adjusted the overall program requirements so that the total major credits have actually decreased from 59 to 58 and free electives have therefore increased from 15 to 16. These changes were made to reduce curriculum 'bottle-necks,' shorten time to degree, and allow more flexibility for transfer students and students switching between our degree tracks.

Note on faculty work-load requirements

The Geoscience Department is aware that that the changes requested here will require additional faculty work-load to cover the added class time. Financially, this change will be covered by the additional credit load payments by students for the class as well as by our on-going commitment to teach very large lecture sections of Liberal Studies classes such as GEOS 101, GEOS 103 and GEOS 105 in order to cover the curricular costs of our smaller majors' courses. Operationally, the department will absorb this increase in work-load hours mainly by decreasing the number of workload-intensive non-major lab sections (GEOS 102, GEOS 104 and GEOS 106) that we teach each term, a change which synchronizes well with the recent change in Liberal Studies science requirements from 8 to 7 with its concomitant decrease in demand for laboratory science sections. Under our proposed new curriculum, we will also be able to schedule upper-level majors classes more judiciously so as not to spread our student load over too many options in each semester. Currently required courses such as GEOS 324 Geology of Oil & Gas or GEOS 352 Stratigraphy must be taught once every two years to allow students to graduate on time. With the optional menu of courses that is built into our new program, we can offer those courses at longer intervals if needed to accommodate the increased workload of other courses. Although not optimal, we believe these changes are worth making in order to achieve our student learning outcome goals.

PREVIOUS SYLLABUS OF RECORD

A. Catalog description

GEOS 362 Plate Tectonics

2 lecture hours
3 lab hours
3 credits
(2c-3l-3cr)

Prerequisites: GEOS 131 and a minimum of 16sh of GEOS coursework

The impact of plate tectonic processes on different disciplines within the field of geology. Emphasis is placed on the relationship of plate tectonics relates to the global environment.

B. Course Objectives

Upon successful completion of the course, students will be able to

1. Understand the Earth's internal structure, the driving forces of plate tectonics and various techniques for exploring Earth's interior.

2. Explain, using examples, the interrelationships between plate tectonics and the evolution igneous, metamorphic and sedimentary rocks.

3. Demonstrate the role of plate tectonics in regards to the evolution of global climate.

C. Course Outline

1. Introduction. Sources of data: (3 hours)
2. Composition and formation of Earth (1 hour)
3. Internal structure of the Earth (1 hour)
4. The Earth's Crust (2)
5. Mantle and Core (3 hours)
6. Continents drifting (2 hours)
7. Seafloor spreading (2 hours)
8. Framework of Plate Tectonic Theory (3 hours)
9. Driving mechanisms (3 hours)

Mid Term Exam and exam review (2 hours)

10. Oceanic Ridges & Hydrothermal Vents (2 hours)
11. Convergent margins and subduction zones (3 hours)
12. Collisions and mountain growth (1 hour)
13. Convergent margins and subduction zones (2 hours)
14. Collisions and mountain growth (2 hours)
15. Global tectonic history: A brief walk through time (2 hours)
16. Paleozoic tectonic history (2)
18. Mesozoic and Cenozoic tectonics of North America (2)
17. Tectonics and Global Change (4 hours)

Final exam during final exam period

D. Evaluation Methods

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

Midterm Exam	30%
Final Exam	30%
Research Paper	30%
Oral Presentations	10%

Research paper and presentation:

Students will prepare an enlightening but brief oral presentation (12-15 minutes) on three different topics relevant to plate tectonics. In addition, students will select one of these topics to develop into a written term project consisting of 6-10 typed pages. Students will have a chance to revise papers after peer and professor reviews.
Grading Scale: A = 90-100%; B = 80-89%; C = 70-79%; D = 60-69%; F = 0-59%.

E. Required Textbooks, Supplemental Books and Readings

Condie, K. C., *Plate Tectonics and crustal evolution, Fourth Edition,* Pergamon Press, New York, NY, 476 p., 1998.

F. Special Resource Requirements: None.

G. Bibliography

Aki, K., and Koyanagi, R., Deep volcanic tremor and magma ascent mechanism under Kilauea, Hawaii, *J. Geophys. Res.*, v. 86, p. 7095-7109, 1981.

Bijwaard, H., and W. Spakman, Tomographic evidence for a narrow whole mantle plume below Iceland, *Earth Planet. Sci. Lett.,* 166, 121-126, 1999.

Blichert-Toft, J., F. A. Frey, and F. Albarede, Hf isotope evidence for pelagic sediments in the source of Hawaiian basalts, *Science*, 285, 879-882, 1999.

Creager, K.C., and T. H. Jordan, Slab penetration into the lower mantle, *J. Geophys. Res.*, 89, 3031-3049, 1984.

Faure, G., *Principles of isotope geology*, 2nd ed., John Wiley and Sons, New York, NY, 589 p., 1986.

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

Kellogg, L. H., B. H. Hager, and R. D. van der Hilst, Compositional stratification in the deep mantle, *Science*, 283, 881-884, 1999.

Kinzler, R.J., and T.L. Grove, Primary magmas of mid-ocean ridge basalts 1. Experiments and methods, *J. Geophys. Res.*, 97, 6885-6906, 1992.

Klein, E. M., and C. H. Langmuir, Global correlations of ocean ridge basalt chemistry with axial depth and crustal thickness, *J. Geophys. Res.*, 92, 8089-8115, 1987.

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

Langmuir, C.H., E.M. Klein, and T. Plank, Petrological systematics of mid-ocean ridge basalts: Constraints on melt generation beneath ocean ridges, in *Mantle Flow and Melt Generation at Mid-Ocean Ridges*, *Geophys. Monogr., Ser.*, vol. 71, edited by J.P. Morgan, D.K. Blackman, and J.M. Sinton, pp. 183-280, AGU, Washington, D.C., 1992.

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

McKenzie, D., and M.J. Bickle, The volume and composition of melt generated by extension of the lithosphere, *J. Petrol.*, 29, 625-679, 1988.

Morgan, J. P., Isotope topology of individual hotspot basalt arrays: mixing curves or melt extraction trajectories?, *Geochem., Geophys. Geosyst.*, 1, 1999GC000004, 1999.

Oxburgh, E.R., and D.L. Turcotte, Mid-ocean ridges and geotherm distribution during mantle convection, *J. Geophys. Res.*, 73, 2643-2661, 1968.

Plank, T., and C.H. Langmuir, Effects of the melting regime on the composition of the oceanic crust, *J. Geophys. Res.*, 97, 19749—19770, 1992.

Putirka, K. Melting depths and mantle heterogeneity beneath Hawaii and the East Pacific Rise: Constraints from Na/Ti and rare earth element ratios, *J. Geophys. Res.*, 104, 2817-2829, 1999.

Spear, F. S., Metamorphic phase equilibria and pressure-temperature-time paths, *Mineralogical Society of America Monograph*, Washington D. C., 799 p., 1993.

Takahashi, E., E. Ito E, Mineralogy of mantle peridotite along a model geotherm up to 700 km depth, in *High Pressure Research in Mineral Physics*, edited by M.H. Manghnani, and Y. Syono, *AGU*, pp 427-437, 1987.

van der Hilst, R. D., and H. Karason, Compositional heterogeneity in the bottom 1000 kilometers of Earth's mantle: toward a hybrid convection model, *Science*, 283, 885-888, 1999.

Williams, Q., J. Revenaugh, and E. Garnero, A correlation between ultra-low basal velocities in the mantle and hot spots, *Science*, 281, 546-549, 1998.

Zindler, A. and S. Hart, Chemical geodynamics, *Ann. Rev. Earth Planet. Sci.*, 14, 493- 571, 1986.