Global Geodynamics

GLY 6932 (*section 1234***) / GLY 4930 (***section 9988***)**

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Course location & hours: WM 210, *Tue & Thu* 10:40 am –12:35 pm (*periods 4 & 5)*
(15 minute break at 11:20 am)

Office Hours: by appointment

Course motivation and objectives:

This course will be concerned with the dynamics of the solid Earth system and how its different constituents (crust, lithosphere, mantle and core) interact with each other and evolve over geologic time. A particular focus will be on the dynamics of the Earth's interior and its impact on the global evolution of our planet. We will therefore study the most important process: namely thermal convection, which is effectively the internal "heat engine" of our planet. An understanding of how this internal engine works is essential to understanding the thermal and chemical evolution of the planet since it formed 4.5 billion years ago. A knowledge of thermal convection in the mantle is also critical to understanding the spatial and temporal changes of a multitude of geophysical and geological phenomena such as: continental drift, earthquakes, volcanism, gravitational field anomalies, changes in ocean bathymetry and continental topography, and corresponding long-term changes in sea level.

In the course lectures, I will develop the quantitative and physical basis necessary for understanding and interpreting the dynamics of Earth's interior. *Because the course adopts a quantitative approach, it is assumed each student has experience with basic mathematical tools, such as linear algebra, vector calculus, and differential equations in one and more spatial dimensions. Extra help and supplementary references can be provided to students who wish additional assistance*. Once the fundamental principles are established, the course will cover their application to mantle convection dynamics and the impact of this internal dynamics on surface processes (e.g. gravity field, plate motions, topography). Each student's progress in assimilating these core concepts of geodynamics will be determined in a number of problem assignments. Finally, the themes covered in the formal lectures are further explored through a selection of seminal journal articles that each student will choose from and present in written essays and classroom presentations.

Course grading scheme:

It is expected that each student will attend the lectures and class meetings, and actively participate (e.g. asking questions).

Evaluation of progress in this course will employ the following criteria:

- 5 problem assignments
- 2 written essays (~15 double-spaced pages + bibliography & figures) on topics selected from a list of papers that the instructor will supply
- 2 oral presentations: each written essay is accompanied by a presentation (20 minutes) that covers the key ideas, followed by a Q&A session (10 minutes)

Note: The written essays must include a final bibliography that clearly demonstrates the additional research carried out by each student in preparing the essay. It is also essential to remember that any

form of plagiarism (e.g. phrases and sentences directly copied from published papers) is subject to sanctions.

The final course grade will be calculated as follows:

- 5 problem assignments = 50%
- 2 written essays = 25%
- 2 oral presentations = 25%

Students: note that the following schedule is a guideline and there may be changes as the term progresses. Please refer to our Canvas page, and messages you will receive, for updates and adjustments that may be required.

Course topics and meeting dates:

Week 1 - Introduction; Tectonic Plate Motions:	*Jan 9 & 11*
Week 2 - Gravity and Topography Data:	*Jan 16 & 18*
Week 3 - Mantle Rheology from Surface Data:	*Jan 23 & 25*
Week 4 - Rheology Microphysics; Stress & Strain:	*Jan 30 & Feb 1*
Week 5 - Stress & Strain; Equation of Motion:	*Feb 6 & 8*
Week 6 - Energy Sources; Heat Flux:	*Feb 13 & 15*
Week 7: Presentations	*Feb 20 & Feb 22*
Week 8 - Energy Budget; Lithosphere Cooling:	*Feb 27 & 28*
Week 9 - Mantle Convection Modelling:	*Mar 12 & 14*
Week 10 - Simplified Model of Convection:	*Mar 19 & 21*
Week 11 - Adiabatic Mantle Geotherm:	*Mar 26 & 28*
Week 12 - Why the Mantle Matters:	*Apr 2 & 4*
Week 13 - Seismic Tomography and Mantle Flow:	*Apr 9 & 11*
Week 14 - Earth's Dynamic Topography:	*Apr 16 & 18*
Week 15: Presentations	*Apr 23 & 25*

Supplementary literature:

In this course, there is no required textbook and all necessary material will be provided in the lecture notes and directly by the instructor (e.g. handouts).

Students who desire more exposure to the topics covered in this course, will find the following references to be useful:

- G.F. Davies, « *Dynamic Earth: Plates, Plumes, Mantle Convection* », Cambridge University Press, 1999.
- F.D. Stacey & P.M. Davis « *Physics of the Earth* », fourth edition, Cambridge University Press, 2008.
- D.L. Turcotte & G. Schubert, « *Geodynamics* », second edition, Cambridge University Press, 2002.
- L.E. Malvern, *« Introduction to the Mechanics of a Continuous Medium »*, Prentice-Hall, Inc., 1969

For additional reading on the basic mathematical tools needed for this course, the following references can be helpful:

- H.M. Schey, *« Div, Grad, Curl, and All That: An Informal Text on Vector Calculus »*, third edition, W.W. Norton & Co., 1997.
- R. Wrede & M.R. Spiegel, *« Theory and Problems of Advanced Calculus »*, second edition, Schaum's Outline Series (McGraw-Hill), 2002.

- D. Bachman, *« Advanced Calculus Demystified »*, McGraw-Hill, 2007
- R. Snieder, *« A Guided Tour of Mathematical Physics »*, Samizdat Press (Colorado School of Mines), 1998. (Electronic copy is available from the instructor.)
- M.L. Boas, *« Mathematical Methods in the Physical Sciences»*, second edition, John Wiley & Sons, Inc., 1983.

Course website:
The course website is on Canvas through the UF e-learning website. Go to https://elearning.ufl.edu/ and click on the e-Learning button. The course site will have relevant announcements posted, downloadable materials as announced in class, etc. You are responsible for checking this site for announcements and to see that your grades are being correctly recorded.

Attendance Policy
Attendance and participation in all lectures and labs is expected. Notify one of the instructors ASAP if you have a known schedule conflict. If you miss a class due to illness, contact the instructor as soon as you are able to so to make arrangements for make-up work.

Grading Scale

Point Range (%)	Letter Grade	GPA equivalent
≥ 93.00	A	4.0
90.0 – 92.9	A-	3.67
87.0 – 89.9	B+	3.33
83.0 – 86.9	B	3.0
80.0 – 82.9	B-	2.67
77.0 – 79.9	C+	2.33
73.0 – 76.9	C	2.0
70.0 – 72.9	C-	1.67
67.0 – 69.9	D+	1.33
63.0 –66.9	D	1.0
60.0 – 62.9	D-	0.67
< 60.0	E	0

UF Counseling Services
Resources are available on-campus for students having personal problems or lacking clear career and academic goals. The resources include:
- UF Counseling & Wellness Center, 3190 Radio Rd, 392-1575, psychological and psychiatric services.
- Career Resource Center, Reitz Union, 392-1601, career and job search services.

Many students experience test anxiety and other stress related problems. “A Self Help Guide for Students” is available through the Counseling Center (301 Peabody Hall, 392-1575) and at their web site: http://www.counsel.ufl.edu/.

Honesty Policy
All students registered at the University of Florida have agreed to comply with the following statement: “I understand that the University of Florida expects its students to be

honest in all their academic work. I agree to adhere to this commitment to academic honesty and understand that my failure to comply with this commitment may result in disciplinary action up to and including expulsion from the University."

In addition, on all work submitted for credit the following pledge is either required or implied: "On my honor I have neither given nor received unauthorized aid in doing this assignment."

If you witness any instances of academic dishonesty in this class, please notify the instructor or contact the Student Honor Court (392-1631) or Cheating Hotline (392-6999). For additional information on Academic Honesty, please refer to the University of Florida Academic Honesty Guidelines at: http://www.dso.ufl.edu/judicial/procedures/academicguide.html.

Accommodation for Students with Disabilities

Students who will require a classroom accommodation for a disability must contact the Dean of Students Office of Disability Resources, in Peabody 202 (phone: 352-392-1261). Please see the University of Florida Disability Resources website for more information at: http://www.dso.ufl.edu/drp/services/.

It is the policy of the University of Florida that the student, not the instructor, is responsible for arranging accommodations when needed. Once notification is complete, the Dean of Students Office of Disability Resources will work with the instructor to accommodate the student.

Software Use

All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate.