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Spring 2-1-2022

### GEO 439.01: Geophysics

Hilary Martens

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# Geo 439: Geophysics

## Instructor information

Instructor: Dr. Hilary Martens | Office: CHCB 329/330  
 Email: hilary.martens@umontana.edu | Phone: 406.243.6855  
 Lecture hours: TR 3:30-4:50 PM | Office hours: TBD

## Course description:

We will explore a variety of fundamental topics in geophysics, including Earth formation, Earth structure, plate tectonics, gravity, seismology, heat flow and magnetics. The course will also cover modern geophysical surveying methods, including reflection seismology, refraction seismology, gravity surveying, and magnetic surveying. *Prerequisites:* PHSX207/PHSX217 and M162/M171, or consent of instructor. 3 credits.

## Learning Outcomes:

By the end of the course, students should be able to:

1. Explain the origin of the solar system and appreciate what we can learn about Earth from studying other planets
2. Describe the structure of Earth's interior and classify layers according to compositional and mechanical properties
3. Describe a gravitational potential field and explain dominant features of the geoid
4. Make appropriate corrections to gravity measurements and interpret data collected by a gravity survey
5. Distinguish between the different types of seismic waves and describe the properties that seismic velocities depend on
6. Interpret earthquake focal mechanisms
7. Analyze seismic reflection and refraction data to derive velocity structure and the locations of distinct layer interfaces
8. Interpret data collected by a magnetic survey

## Required textbooks:

Lowrie, W. & A. Fichtner (2020), *Fundamentals of Geophysics*, 3<sup>rd</sup> Ed., Cambridge University Press

## Course Calendar\*:

\* Subject to change: We will try to stick to the schedule as best as possible, but may need to adjust from time to time.

Dates	Topic	Reading	Assignment	Due Date
<b>Week 1</b>	<b>Welcome</b>			
18 January	Welcome   What is geophysics?			
20 January	Solar System I	1.1 – 1.3	Homework 1	Thursday, 01/27, 11 pm
<b>Week 2</b>	<b>Earth as a Planet I</b>			
25 January	Solar System II	1.4 – 1.6		
27 January	Dynamic Earth I	2.1 – 2.3	Homework 2	Thursday, 02/03, 11 pm
<b>Week 3</b>	<b>Earth as a Planet II</b>			
1 February	Dynamic Earth II	2.4 – 2.6; 2.9		
3 February	Gravitation Theory I	3.1 – 3.2	Homework 3	Thursday, 02/10, 11 pm
<b>Week 4</b>	<b>Gravity and Geodynamics I</b>			
8 February	Gravitation Theory II	3.3.1 – 3.3.2		
10 February	Earth's Figure and Gravity	3.4.1; 3.4.3 – 3.4.5	Homework 4	Thursday, 02/17, 11 pm
<b>Week 5</b>	<b>Gravity and Geodynamics II</b>			
15 February	Isostasy and Rheology	4.3		
17 February	Gravity Surveying I	4.1.1; 4.1.3	Homework 5	Thursday, 02/24, 11 pm
<b>Week 6</b>	<b>Gravity Surveying I</b>			
22 February	Gravity Surveying II	4.1.5		
24 February	Gravity Surveying III	4.2.1 – 4.2.2.2	Homework 6	Thursday, 03/03, 11 pm
<b>Week 7</b>	<b>Gravity Surveying II</b>			
1 March	Gravity Surveying IV	4.2.3		
3 March	Active Review		Midterm Study	
<b>Week 8</b>	<b>Midterm I / Elasticity</b>			

Dates	Topic	Reading	Assignment	Due Date
8 March	Midterm I			
10 March	Elasticity Theory	5.1	Homework 7	Thursday, 03/17, 11 pm
<b>Week 9</b>	<b>Seismology and Structure</b>			
15 March	Seismic Waves	6.1 – 6.2.2.2; 6.2.3		
17 March	Earthquake Seismology	7.1 – 7.2.4	Homework 8	Thursday, 03/31, 11 pm
<b>Week 10</b>	<b>Spring Break</b>			
22 March	No class			
24 March	No class			
<b>Week 11</b>	<b>Reflection Seismology</b>			
29 March	Reflection Seismology I	6.3.4		
31 March	Reflection Seismology II	6.3.5 – 6.3.5.2	Homework 9	Thursday, 04/07, 11 pm
<b>Week 12</b>	<b>Refraction Seismology</b>			
5 April	Refraction Seismology I	6.3.6 – 6.3.6.1		
7 April	Refraction Seismology II	6.3.6.2	Homework 10	Thursday, 04/14, 11 pm
<b>Week 13</b>	<b>Focal Mechanisms</b>			
12 April	Focal Mechanisms	7.2.5		
14 April	Active Review / Seismic Lab Tour		Midterm Study	
<b>Week 14</b>	<b>Midterm II / Magnetism</b>			
19 April	Midterm II			
21 April	Magnetism Theory I	11.1		
<b>Week 15</b>	<b>Geomagnetism</b>			
26 April	Magnetism Theory II	11.2.4.2	Homework 11	Thursday, 05/05, 11 pm
28 April	Geomagnetism	11.2 – 11.2.3		
<b>Week 16</b>	<b>Magnetic Surveying</b>			
3 May	Magnetic Surveying	11.4.1; 11.4.4		
5 May	Active Review / Wrap-Up / Evaluations		Final Study	
<b>Week 17</b>	<b>Final Exam</b>			
	Final Exam			

#### Required assignments and exams:

1. Homework 1: Planetary geophysics
2. Homework 2: Solar system
3. Homework 3: Plate tectonics
4. Homework 4: Gravity
5. Homework 5: Isostasy
6. Homework 6: Gravity anomalies
7. Homework 7: Elasticity
8. Homework 8: Earthquake seismology
9. Homework 9: Reflection seismology
10. Homework 10: Refraction seismology
11. Homework 11: Magnetism
12. **Midterm Exam 1:** Earth structure, tectonics, and gravity
13. **Midterm Exam 2:** Seismology
14. **Final Exam:** Comprehensive

#### Course guidelines and policies:

##### Student Conduct Code

All students are expected to abide by The University of Montana's Student Conduct Code:  
[https://www.umt.edu/vpsa/policies/student\\_conduct.php](https://www.umt.edu/vpsa/policies/student_conduct.php)

## **Attendance**

Regular participation in course exercises is expected. If you need to miss a class lecture or activity, please inform me in advance.

## **Course withdrawal**

Please refer to Institute policy on adding, dropping, and withdrawing from courses:  
<https://www.umt.edu/registrar/students/dropadd.php>

## **Disability modifications**

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and the [Office for Disability Equity \(ODE\)](#). If you think you may have a disability adversely affecting your academic performance, and you have not already registered with ODE, please contact ODE in Lommasson Center 154 or call 406.243.2243. I will work with you and the Office for Disability Equity to provide an appropriate modification.

## **Assignment expectations**

Assignments are expected to be completed thoughtfully and on-time.

Honor code: "No member of the community shall take unfair advantage of any other member of the community." [from Caltech]

**Plagiarism:** Reproducing the work of someone else, and representing the work as your own, without appropriate citation and attribution is forbidden. Plagiarism extends beyond tangible material to also include ideas. When in doubt, cite.

**Collaboration:** Collaboration on homework sets is encouraged, provided that all solutions that you submit represent your **own work**. In particular, homework solutions should be written up individually and reflect your own understanding of the material. As a general guideline, you should be able to reproduce solutions from your submitted homework sets without help from anyone else. You may consult external references (e.g., websites, textbooks, etc.), with citations and attributions included as appropriate.

More information on UM's academic policies and procedures:  
<https://catalog.umt.edu/academics/policies-procedures/>

## **Grading policy**

Homework: 50%  
Midterm Exam 1: 15%  
Midterm Exam 2: 15%  
Final Exam: 20%

For *graduate* students only: Homework: 45%. Graduate Increment: 5%.

**Late assignments, without written pre-approval, will incur a deduction of 20% off the maximum possible score per 24-hour period submitted late.** To accommodate unforeseen circumstances, your **lowest homework score will be dropped** at the end of the term. Under extenuating circumstances, full-credit extensions will be considered on a case-by-case basis by the instructor; normally, requests for extensions must be made in writing at least **48 hours in advance of the deadline**. Extensions are not guaranteed. It is always recommended that you begin homework assignments well in advance of the due date, so that you may have sufficient time to work through the problems and to avoid unexpected situations that might prevent you from finishing.

Problem sets will generally be due on Thursdays by 11 pm; please submit via Moodle. The extra time beyond our normal class period is provided as a courtesy window. Lectures are not intended for working on the sets or for asking last-minute questions right before the deadline. Assignments should be started well in advance of deadlines.

## **Additional information and resources**

### **Student Academic Resources**

Disability Services for Students (DSS): <http://www.umt.edu/dss/>  
The Writing Center: <http://www.umt.edu/writingcenter/>  
Office for Student Success: <http://www.umt.edu/oss/>  
Career Services: <http://www.umt.edu/career/>  
Mansfield Library: <http://www.lib.umt.edu>

### **Student Health and Wellbeing**

Curry Health Center (mental health, physical health, pharmacy, health promotion): <http://www.umt.edu/curry-health-center/>  
Campus Recreation: <http://www.umt.edu/crec/>  
DiverseU: <http://www.umt.edu/diverseu/>  
Student Activity Groups: [http://www.umt.edu/asum/student\\_groups/](http://www.umt.edu/asum/student_groups/)

### **Graduate increment**

The course is designated as UG, meaning that undergraduate and graduate students may enroll in the course simultaneously. Graduate students will have separate and higher expectations than undergraduate students. In particular, graduate students will be expected to undertake a small literature-based research project on an Earth-orbiting satellite or interplanetary space mission that studies planetary interiors, formation, and/or dynamics and evolution. If time allows, a brief presentation may be made to the class in the final week of term – as I like to say, science is meaningless unless it is shared.

### **COVID Information**

Expectations and important safety information from UM's Office of the Provost:

- Mask use is required in the classroom.
- If you feel sick and/or are exhibiting COVID symptoms, please don't come to class and contact the Curry Health Center at 406-243-4330.
- If you are required to isolate or quarantine, you will receive support in the class to ensure continued academic progress.
  - Assignments, handouts, and recorded lectures will be posted to Moodle.
  - Note: Recording quality is imperfect. We are not using sophisticated recording equipment. If recordings are unclear, please consult with classmates for lecture notes and updates.
- UM recommends students get the COVID vaccine and booster. Please direct your questions or concerns about vaccines to the Curry Health Center.
- Drinking liquids and eating food is discouraged within the classroom.
- Please note this class is being recorded.