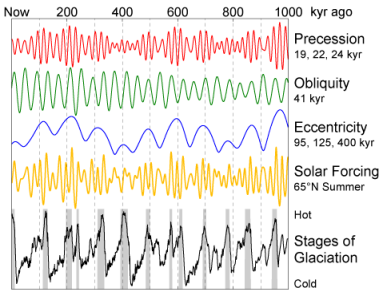
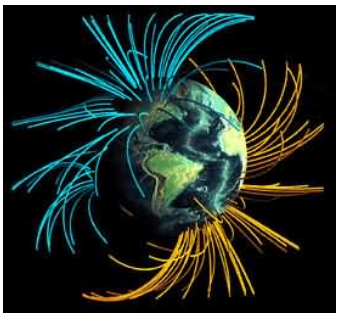
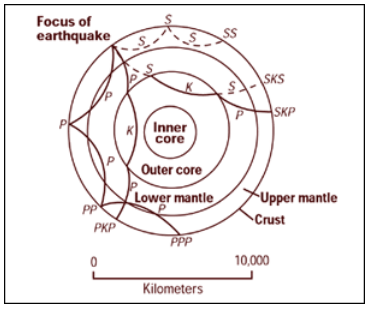
Fall 2018 **GPH 455/655 Geophysics and Geodynamics** **Syllabus**

Tues. & Thurs. 16:30 – 17:45 Location LME 415 4 Credits







Course Description:
Geophysics is the use of physical principals and associated mathematical methods applied to the study of the Earth. The course will explore the structure, composition and evolution of the planet earth, using mathematical description to study global properties of gravity, rotation and figure, seismicity, seismic wave propagation and interior structure, internal heat and the Earth's tectonic engine, the magnetic dynamo, and resulting magnetic field. Context for Earth as an individual among the pantheon of planets will be provided.

Recommended Prereqs: GPH 333 (Plate Tectonics) and MATH 285 (Diff Equations)

Instructors: Wendy Calvin, wcalvin@unr.edu, Office: LME 427, 784-1785
Bill Hammond, whammond@unr.edu, Office: SEM 315, 784-6436

Calvin Office Hours: In LME 427 by appointment only
Hammond Office Hours: TBD

Course Textbook and other References:
(Required) Lowrie, W., **Fundamentals of Geophysics, 2nd Ed.**, Cambridge Univ. Press. 2007.

On Reserve at De La Mare.
Fowler, C.M.R., **The Solid Earth, An Introduction to Global Geophysics**, 2nd Ed., Cambridge Univ. Press. 2005.

Student Learning Outcomes:
Demonstrate critical thinking and reasoning.
Demonstrate competence in oral and written communication.
Develop the ability to read and critically evaluate relevant geoscience literature.

Specific Content Goals:
- Understand how Earth's rotation affects its shape and the resulting gravitational torques.
- Derive common solutions for the equations for global gravity, magnetic fields and propagating seismic waves.

- Understand how rock elastic parameters contribute to seismic wave propagation and lithospheric flexure.
- Learn how seismic waves contribute to our understanding of Earth's interior structure and processes.
- Learn the geochemical starting point for Earth as inferred from meteorites.
- Learn how interior processes drive plate tectonics and the geodynamo.

Grading - 455

~Weekly Homework	25%
Lab Activities & Exercises	25%
Two Exams (Midterm and Final)	25%
Final Paper and Presentation	20%
Attendance and Participation	5%

Requirements for Graduate (655) Credit:
Graduate level work will consist of reading selected articles from the peer-reviewed literature (~ 1/week). Written synthesis and summary reports will constitute a fraction of the grade as outlined below.

Grading - 655

~Weekly Homework	20%
Lab Activities & Exercises	20%
Two Exams (Midterm and Final)	20%
Journal selection summaries	15%
Final Paper and Presentation	20%
Attendance and Participation	5%

Please note these important dates:

The Mid-term Exam is scheduled for Thursday, October 11th during class time.

The Final Exam is schedule for Thursday, December 12, 4:50 to 6:50pm

Final grades will be curved separately for graduate and undergraduate students, and plus or minus grades may be assigned.

Most years, the letter grade is determined from a scale such as this:
A (93-100); A- (89-92); B+ (86-88); B (82-85); B- (79-81); C+ (76-78); C (72-75); C- (69-71); D+ (66-68); D (62-65); D- (59-61); F ($\leq$ 58)

EXPECTATIONS
The lectures, and activities are intended to be a positive learning experience and cannot be replicated outside of class. Occasional emergencies may occur; if for some reason you are unable to attend class you must notify the instructor before class begins that you will not be there. If you don't speak to the instructor in person, you can leave a voice mail or email message with your name and the reason you won't be attending class that day. You are responsible for finding out what you missed in class. Each unexcused absence, and absences in excess of 5 (whether excused or not), deducts 1% from your final grade.

HOMEWORK
Late work is not accepted. If illness or other accident prevents you from turning in your homework on the assigned day and time you must notify the instructor before the due date of the reasons for your failure to complete the work on time and to arrange an alternate day and time to turn in the assignment. Failure to arrange a late deadline before an assignment is due will result in a zero for the assignment.

SCIENTIFIC COMPUTING
This class will have many homework exercises that involve calculations. There are many tools that students may use to solve these problems (hand calculator, Excel, Matlab, Python, R). Ability to use such tools is a strong factor in job placement and future success.

Both instructors for this course use advanced software for most of their scientific computing. Students have free access to many licensed software packages through the Dataworks Lab of the UNR Learning Center, located in DeLaMare Library. Alternatively, students may purchase a Student version of many of these software packages. Another alternative is to download the free software GNU OCTAVE, which is the same as Matlab for most purposes.

To access Matlab, Python, R etc. remotely, see the instructions on the IT web page: https://guides.library.unr.edu/computers-labs-software/remote Call the Computing Help Desk (775) 682-5000 if you encounter any difficulties.

Basic calculations and plots using most of these software packages are very simple to learn. The Matlab website (or a Google search) will identify several introductory guides. One that we like (at least the introductory sections) is prepared by faculty at the University of British Columbia (http://ubcmatlabguide.github.io/, last accessed May 14, 2018). Students who take the time to learn some of the basics of Matlab are likely to find it advantageous for several of the assignments and crucial for future employment. Simple command structure, plotting, and analysis routines will be included in the instruction of this course.

Academic Dishonesty
Students are expected to adhere to the ethical code as described in the UNR Student Handbook. Academic dishonesty is defined as cheating, plagiarism or otherwise obtaining grades under false pretenses, and is unacceptable in any form. Disciplinary procedures for incidents of academic dishonesty may involve both academic action and administrative action for behavior against the campus regulations for student conduct. The procedures involve the determination by the faculty member pursuing concerns over cheating or plagiarism as to whether administrative action is

warranted, in addition to making a determination as to any academic consequence. Academic action may include: (1) cancelling the student's enrollment in the class without a grade; (2) filing a final grade of "F"; (3) awarding a failing mark on the assignment in question; (4) requiring the student to retake the test or resubmit the assignment.

Students with Disabilities
Students with disabilities or who require special accommodations should notify the instructor at the beginning of the semester so that suitable arrangements may be made.

Academic Success Services:
Your student fees cover usage of the Math Center (784-4433 or www.unr.edu/mathcenter/ <http://www.unr.edu/mathcenter/>), Tutoring Center (784-6801 or www.unr.edu/tutoring/ <http://www.unr.edu/tutoring/>), and University Writing Center (784-6030 or www.unr.edu/writing_center <http://www.unr.edu/writing_center>). These centers support your classroom learning; it is your responsibility to take advantage of their services. Keep in mind that seeking help outside of class is the sign of a responsible and successful student.

Statement on Audio and Video Recording:
Surreptitious or covert video-taping of class or unauthorized audio recording of class is prohibited by law and by Board of Regents policy. This class may be videotaped or audio recorded only with the written permission of the instructor. In order to accommodate students with disabilities, some students may be given permission to record class lectures and discussions. Therefore, students should understand that their comments during class may be recorded.

Topical Outline / Associated Reading: Detailed Weekly Schedule in a Separate Document

1) **Earth Formation** (**Lowrie-1.1**)
   a) Review of Earth as a planet, chemical composition in our solar system.
   b) Planet formation and evolution.
   c) Meteorites and the chemical building blocks of Earth

2) **Dynamic Earth** (**Lowrie**- 1.2)
   a) Earth's plate tectonics
   b) Triple junctions and relative plate motions, spherical geometry and Euler poles.

3) **Gravity, Rotation, Tides** (**Lowrie-2.1-2.7:** Fowler Ch. 5)
   a) Gravitational potential and the geoid, moment of inertia.
   b) Rotation and polar flattening of the Earth's figure, precession, nutation, wobble and tides
   c) Gravity anomalies, isostasy and crustal compensation

4) **Stress, Strain, Elasticity and Flexure** (**Lowrie-2.8, 3.2:** Fowler Section 5.7, Appx 2)
   a) Stress, strain, displacements
   b) Elasticity, Shear and Flexure

5) **Geodesy and Lithospheric Dynamics**
   a) Lithospheric deformation

6) **Seismic waves, propagation and the internal structure of the Earth**
   (**Lowrie-3.1, 3.3, 3.6, 3.7:** Fowler-Ch. 4, Appx 3)
   a) Wave equation and solutions
   b) Seismic waves, body, surface, compression, shear
   c) Seismic reflection, refraction and earth models

7) **Earthquake Mechanics** (**Lowrie-3.4, 3.5:** Fowler Ch. 4)
   a) Fault plane solutions, focal mechanisms (first motions)
   b) Earthquake magnitude, intensity and frequency

8) **Radioactivity and Geochronology** (**Lowrie-1.1, 4.1:** Fowler-Ch. 6)
   a) Radioactive elements and principles of radiometric dating, isochrons, age of materials in the solar system

9) **Heat transfer, Conduction, Convection** (**Lowrie-4.2:** Fowler- Ch. 7, 8)
   a) Thermodynamics, adiabatic temperature gradient
   b) Radioactive heat budget vs accreted heat energy
   c) Conduction and heat flow, geothermal gradient
   d) Convection and the earth's heat engines

10) **Geomagnetism and Paleomagnetism** (**Lowrie-5.1-5.4, 5.6, 5.7:** Fowler-Ch. 3)
   a) The main field **--** Generation of the field and secular variation
   b) Rock Magnetism, magnetic reversals, and past plate motions