



UNIVERSITY OF CALGARY  
FACULTY OF SCIENCE  
DEPARTMENT OF GEOSCIENCE  
COURSE OUTLINE  
WINTER 2015

1. **Course:** Geophysics 547, Gravity and Magnetism

Lecture Sections:

L01: MoWeFr, 13:00-13:50, MLT 118

Laboratory Sections:

B01: Thurs, 08:00-10:50, ES 924. B02: Thurs, 11:00-13:50, ES 924.

Instructor: Dr. E. S. Krebs, Office ES 230, Tel. No. 403-220-5028, e-mail address, [krebs@ucalgary.ca](mailto:krebs@ucalgary.ca),

Office Hours: anytime instructor is in the office and the door is open.

Desire 2 Learn (D2L) course name: W2015GOPH547L01

Geoscience Department ES 118, 403-220-5841, [geoscience.ucalgary.ca](http://geoscience.ucalgary.ca), [geoscience@ucalgary.ca](mailto:geoscience@ucalgary.ca)

2. **Prerequisites:** Geophysics 355; 351 or 359; Mathematics 331 and Applied Mathematics 415. See section 3.5.C in the Faculty of Science section of the online Calendar ([www.ucalgary.ca/pubs/calendar/current/sc-3-5.html](http://www.ucalgary.ca/pubs/calendar/current/sc-3-5.html))

3. **Grading:** The University policy on grading and related matters is described sections F.1 and F.2 of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Lab Assignments (10)	30%
Midterm exam	30% (2 hours, February 26, in lab room)
Final Examination	40% (2 hours, Registrar-scheduled)

Each piece of work, e.g., assignment or exam(s), submitted by the student will be assigned a percentage score. The score for the exam(s) and the average score for the assignments will be combined with the weights indicated above to produce an overall percentage for the course, which will be used to determine the course letter grade. The conversion between course percentage and letter grade is given below.

Letter Grade	GPV	Percent	Letter Grade	GPV	Percent
A+	4.0	90-100	C+	2.3	60-65
A	4.0	85-90	C	2.0	55-60
A-	3.7	80-85	C-	1.7	50-55
B+	3.3	75-80	D+	1.3	45-50
B	3.0	70-75	D	1.0	40-45
B-	2.7	65-70	F	0.0	00-40

Scores within 0.5% of the upper boundary of a Percent range (e.g., 79.5%) may or may not be rounded up at the discretion of the instructor (a decision will be made based on the student's performance in the course). For percent grades on a boundary, the higher grade will be chosen (e.g., 70% is a B, not a B-).

4. **Missed Components of Term Work:** The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in [Section 3.6](#). It is the student's responsibility to familiarize himself/herself with these regulations. See also [Section E.6](#) of the University Calendar

5. **Course Materials:** *"Applied Geophysics", 2<sup>nd</sup> Edition, by Telford, Geldart & Sheriff. Cambridge U.P.*  
*Other materials: documents posted on D2L.*

6. **Examination Policy:** Closed-book. No calculators or any other electronic devices. Formulas will be provided. Students should also read the Calendar, [Section G](#), on Examinations.

7. **Writing across the curriculum statement:** In this course, the quality of the student's writing in laboratory reports will be a factor in the evaluation of those reports. See also [Section E.2](#) of the University Calendar.

8. **Human studies statement:** in this course, students are not expected to participate as subjects or researchers in any way. See also [Section E.5](#) of the University Calendar.

## 9. OTHER IMPORTANT INFORMATION FOR STUDENTS:

- (a) **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under [Section K. Student Misconduct](#) to inform yourself of definitions, processes and penalties.
- (b) **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on [assembly points](#).
- (c) **Academic Accommodation Policy:** Students with documentable disabilities are referred to the following links: Students with Disabilities: <http://www.ucalgary.ca/pubs/calendar/current/b-1.html> **B.1** and Student Accessibility Services: <http://www.ucalgary.ca/access/>.
- (d) **Safewalk:** Campus Security will escort individuals day or night (<http://www.ucalgary.ca/security/safewalk/>). Call 220-5333 for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.
- (e) **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPPA). As one consequence, students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information see also <http://www.ucalgary.ca/secretariat/privacy>.
- (f) **Student Union Information:** VP Academic Phone: 220-3911 Email: [suvpaca@ucalgary.ca](mailto:suvpaca@ucalgary.ca).  
SU Faculty Rep. Phone: 220-3913 Email: [sciencerep@su.ucalgary.ca](mailto:sciencerep@su.ucalgary.ca); [Student Ombudsman](#)
- (g) **Internet and Electronic Device Information:** You can assume that in all classes that you attend, your cell phone should be turned off unless instructed otherwise. Also, communication with other individuals, via laptop computers, Blackberries or other devices connectable to the Internet is not allowed in class time unless specifically permitted by the instructor. If you violate this policy you may be asked to leave the classroom. Repeated abuse may result in a charge of misconduct.
- (h) **U.S.R.I.:** At the University of Calgary, feedback provided by students through the Universal Student Ratings of Instruction (USRI) survey provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses ([www.ucalgary.ca/usri](http://www.ucalgary.ca/usri)). Your responses make a difference – please participate in USRI Surveys.

Department Approval: Original Signed

Date: January 6, 2015

**Geophysics 547: Main Topics Covered in Lectures**  
**Text: Telford et al., Applied Geophysics, Chapters 2 and 3**

**GRAVITY ( ~ first seven weeks)**

1. Discrete spatial Fourier transforms.
2. Newton's law of gravitation, gravitational potential.
3. Cylindrical and spherical coordinate systems.
4. Concept of gravity effect  $g_z$ .
5. Logarithmic (2D) potential.
6. Example: gravity effect of a cylinder (using both  $g_z$  and potential formulas).
7. Examples: gravity effect of infinite slab, infinite cylinder.
8. Examples: gravity effect of infinite and finite-length rod.
9. Field equations for gravitational acceleration.
10. Gauss's Law. Poisson's equation for potential.
11. Equivalent surface density.
12. Derivatives of the potential.
13. Spatial Fourier transform.
14. Figure of the Earth, geoid, solution to Poisson's equation using Legendre polynomials.
15. Basics of spherical harmonics.
16. Derivation of gravity vs. latitude formula.
17. Inertial forces (centrifugal and Coriolis forces).
18. Equation of motion in a rotating and moving reference frame.
19. Gravity surveys and corrections (drift-tide, latitude, free-air, Bouguer).
20. Terrain correction using gravity effect of a sector of a cylinder. Correction Tables.
21. Underground corrections. Density determination.
22. Eotvos correction (including derivation). Isostatic correction.
23. Gravity instruments. Details of zero-length spring in Lacoste-Romberg instrument.
24. Gravity data processing: residual removal, gridding, second vertical derivative.
25. Gravity data processing: wavelength or wavenumber filtering.
26. Gravity data processing: theory of upward-downward continuation.
27. Gravity data processing: downward continuation by finite differences.
28. Gravity data interpretation: gravity effect of sphere, cylinder, thin dipping (& horizontal/vertical) sheet.
29. Gravity data interpretation: fitting simple analytical models to gravity profiles.
30. Gravity data interpretation: gravity effects of complex shapes from simple ones.
31. Gravity data interpretation: discrete linear inverse method.
32. Gravity data interpretation: excess mass, center of mass, Smith's rules.

**MAGNETICS ( ~ last six weeks)**

1. Basic theory of magnetic field, magnetization, etc. Magnetic potentials, scalar potential.
2. Magnetic dipole theory and application to Earth.
3. Formulas for general magnetic anomaly (scalar potential).
4. Poisson's relation for getting magnetic scalar potential from gravity effect.
5. Examples of Poisson's relation: sphere, slab, cylinder.
6. Earth's magnetism, magnetic susceptibility.
7. Magnetic field instruments (flux-gate and proton precession magnetometers).
8. Field operations in magnetic surveys. Data corrections.
9. Magnetic effects of bodies: isolated pole, dipole (vertical and horizontal).
10. Magnetic effect of infinitely-long line of poles.
11. Total field anomaly, vertical and horizontal anomalies.
12. Derivation of magnetic effect of dipping sheet (and vertical and horizontal sheets).
13. Rotation of coordinates and how B-formulas changes. Euler angles.
14. Magnetic effect of thick sheets.
15. Processing and interpretation of magnetic data: second vertical derivative, upward and downward continuation, characteristic curves (master curves), Werner deconvolution, Euler deconvolution, analytic signal method, pseudo-gravity transformation, Smith's rules.

**Geophysics 547: Lab Exercises**

1. 10 labs (theoretical and computer exercises) covering some of the main lecture topics (computing gravity effects, Fourier transforms, data corrections, downward continuation, magnetic effects, etc.).
2. No lab on February 19 (Reading Week) or April 9 (last lab day).
3. Mid-term exam during lab periods on February 26.