



UNIVERSITY OF CALGARY

DEPARTMENT OF GEOSCIENCE COURSE OUTLINE WINTER 2016

1. **Course:** GOPH 547, Gravity and Magnetics

Lecture Sections:

L01: MoWeFr, 13:00 – 13:50, SA 106

For a listing of all lab sections corresponding with this course, please see the following link:

http://geoscience.ucalgary.ca/geoscience_info/courses/w16

Instructor: Dr. Brandon Karchewski, Office: ES 108, Ph. 403-220-6678, brandon.karchewski@ucalgary.ca
Office hours by appointment

Geoscience Department ES 118, 403-220-5841, geoscience.ucalgary.ca, geoscience@ucalgary.ca

2. **Prerequisites:** Geophysics 351 or 355 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)

3. **Description:**

The nature of the magnetic and gravitational fields of the earth. Theory and applications of the gravity and magnetic methods of geophysical exploration.

4. **Learning Objectives:**

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

- Explain** the nature of Earth's gravity and magnetic fields.
- Identify** the main points in the history of the development of our current models of these fields and **explain** the relevance of the scientists that contributed to this development.
- Apply** the mathematical theory of potential fields to **solve problems** relevant to geophysical surveying (e.g. determine the expected gravitational and/or magnetic field of bodies with simple and complex shapes).
- Calculate** typical corrections to survey data to **plot** and **interpret** a gravitational or magnetic anomaly map.
- Perform** the analysis in c) and d) using modern computational tools (e.g. Matlab, Excel).
- Communicate** the results of a gravitational or magnetic survey to peers in the geophysics/scientific community and **critically evaluate** the work of peers.

5. **Grading:** The University policy on grading and related matters is described in 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:

Grade Component	Weight	Notes
Lab Assignments/Reports	25%	See Lab schedule posted on D2L
iRAT/tRAT Quizzes	15%	See Lecture schedule posted on D2L
Midterm Exam	25%	During lab period week of Feb 22-26, room TBA
Final Exam*	35%	SCHEDULED BY THE REGISTRAR

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, rounded to the nearest integer percentage value. The conversion between course percentage and letter grade is given below.

Letter Grade	GPV	Percent	Letter Grade	GPV	Percent
A+	4.0	95-100	C+	2.3	65-69
A	4.0	90-94	C	2.0	62-64
A-	3.7	85-89	C-	1.7	60-61
B+	3.3	80-84	D+	1.3	55-59
B	3.0	75-79	D	1.0	50-54
B-	2.7	70-74	F	0.0	<50

6. **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.

7. **Course Materials:**

Suggested Course Text(s):

W.J. Hinze, R.R.B. von Frese, A.H. Saad. (2013). *Gravity and Magnetic Exploration: Principles, Practices and Applications*. Cambridge University Press, ISBN: 9780521871013.

W.M. Telford, L.P. Geldart, R.E. Sheriff. (1990). *Applied Geophysics, 2nd Edition*. Cambridge University Press, ISBN: 0521326931 (hardcover) or 0521339383 (paperback). [Note: This course will use Chapter 2, Chapter 3 and the Appendices only.]

Either of the above texts will provide a good reference for most of the course content. It is highly recommended, but not absolutely required to have at least one of these texts. You may already have Telford et al. (1990) from a previous geophysics course. Note that this text is over 15 years old, and the theory is still up-to-date, but the references to global geophysical models for the gravitational and magnetic fields may be out-of-date. Lecture videos supplementing the text reading assignments will be available on the instructor's channel (<https://www.youtube.com/channel/UCnW-eqMt-fOcvEXPtOnfc3w>). The instructor will also post supplemental notes or links to other sources on D2L (<https://d2l.ucalgary.ca/login.asp>).

For in-class quizzes and term tests, you will need a non-programmable scientific calculator such as the Casio FX-991 or one with similar functionality.

8. **Examination Policy:** Closed-book. Non-programmable scientific calculator and one 8.5"x11" double-sided crib sheet allowed. Students should also read the Calendar, [Section G](#), on Examinations.

9. **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.

10. **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) **Student Accommodations:** Students needing an Accommodation because of a Disability or medical condition should contact Student Accessibility Services in accordance with the Procedure for Accommodations for Students with Disabilities available at http://www.ucalgary.ca/policies/files/policies/procedure-for-accommodations-for-students-with-disabilities_0.pdf. Students needing an Accommodation in relation to their coursework or to fulfil requirements for a graduate degree, based on a Protected Ground other than Disability, should communicate this need, preferably in writing, to the Associate Head of Geoscience, Dr. E.S. Krebs by email krebs@ucalgary.ca or phone 403-220-5850.

(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: 403 220-3911 Email: suypaca@ucalgary.ca
SU Faculty Rep. Phone: 403 220-3913 Email: science1@su.ucalgary.ca, science2@su.ucalgary.ca and science3@su.ucalgary.ca;
Student Ombuds Office: 403-220-6420 Email: ombuds@ucalgary.ca; <http://ucalgary.ca/provost/students/ombuds>

- (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). Your responses make a difference – please participate in USRI Surveys.

Department Approval: ORIGINAL SIGNED

Date: December 21, 2015

Course Schedule for GOPH 547 – Winter 2016			
Week	Dates	Lecture Topic(s)	Text Sections[†]
1	Jan 11-15	Mathematical Fundamentals I <ul style="list-style-type: none"> ○ Vector analysis, vector products ○ Cylindrical and spherical coordinate systems ○ The vector operator ∇ ○ Divergence Theorem ○ Poisson's Equation for potential fields ○ Discrete spatial Fourier transforms 	TGS: A.3.1-A.3.4, A.4, A.9, 2.2.4 HVS: A.4, 3.7, 3.9
2	Jan 18-22	Gravity Theory I <ul style="list-style-type: none"> ○ History and applications of gravity theory ○ Newton's Law of Gravitation ○ Gravitational potential ○ Gravity effect and equivalent surface density 	TGS: 2.1, 2.2.1-2.2.3 HVS: 1.2, 2.1-2.5, 3.3-3.4
3	Jan 25-29	Gravity Theory II <ul style="list-style-type: none"> ○ Field equations for gravitational potential ○ Derivatives of the gravitational potential ○ Figure of the Earth, the geoid ○ Inertial forces (centrifugal, Coriolis) ○ Theoretical gravity vs. latitude formula 	TGS: 2.2.4-2.2.5, 2.3.1 HVS: 2.3, 3.9, 6.3.2-6.3.3
4	Feb 1-5	Gravity Surveying I <ul style="list-style-type: none"> ○ Survey types (land, marine, airborne, satellite) ○ Instrument types (absolute, relative) ○ Global gravity surveys (CHAMP, GRACE, GOCE) 	TGS: 2.4-2.5 HVS: 5.3-5.5
5	Feb 8-12	Gravity Surveying II <ul style="list-style-type: none"> ○ Corrections (drift-tide, latitude, free-air, Bouguer, terrain, underground, Eötvös) ○ Densities of rocks and minerals, determination from field measurements 	TGS: 2.3.2-2.3.4 HVS: 4.3-4.7, 6.3
6	Feb 15-19*	READING WEEK (NO CLASSES)	
7	Feb 22-26	Midterm Exam: During lab period this week, room TBA Math Fundamentals II <ul style="list-style-type: none"> ○ Spherical harmonics and solutions to Poisson's Equation using Legendre polynomials ○ Second vertical derivative and upward-downward continuation ○ Rotation of coordinates, Euler angles 	TGS: 2.6.7, 2.7.4 HVS: 3.6.6, 5.5.3, 6.5.3(E)
8	Feb 29-Mar 4	Gravity Interpretation <ul style="list-style-type: none"> ○ Gravity effect of simple bodies ○ Gravity effect of complex shapes ○ Fitting simple analytical models to gravity profiles ○ Excess mass, centre of mass, Smith's rules 	TGS: 2.7 HVS: 3.4, 3.8, 7.3-7.5
9	Mar 7-11	Magnetic Theory I <ul style="list-style-type: none"> ○ History and applications of magnetic theory ○ Magnetization, magnetic potential, scalar potential ○ Magnetic dipole theory ○ Poisson's relation between magnetic scalar potential and gravity effect ○ Derivatives of magnetic potential 	TGS: 3.1-3.2 HVS: 8.1-8.5, 9.1-9.7, 9.10
10	Mar 14-18	Magnetic Theory II <ul style="list-style-type: none"> ○ The geomagnetic field ○ Magnetic susceptibility of rocks and minerals, determination from field measurements ○ Magnetic remanence ○ Total field anomaly, vertical and horizontal anomalies 	TGS: 3.3 HVS: 8.3, 9.8, 10.2-10.8
11	Mar 21-25**	Magnetic Surveying <ul style="list-style-type: none"> ○ Survey types (land, marine, airborne, satellite, gradiometry) ○ Instrument types (flux gate, proton precession, optically pumped) ○ Global magnetic surveys (MAGSAT, Ørsted, CHAMP, SWARM) ○ Survey data corrections 	TGS: 3.4-3.5 HVS: 11.2-11.5, 12.3
12	Mar 28-Apr 1	Magnetic Interpretation <ul style="list-style-type: none"> ○ Magnetic anomalies of simple and complex bodies ○ Analytic signal method ○ Characteristic curves ○ Pseudo-gravity transformation, Smith's rules 	TGS: 3.6-3.7 HVS: 9.5-9.7, 13.3-13.5
13	Apr 4-8	Data Processing Techniques <ul style="list-style-type: none"> ○ Residual removal, gridding ○ Wavelength or wave number filtering ○ Werner/Euler deconvolution ○ Downward continuation by finite differences ○ Discrete linear inverse method 	TGS: 2.6-2.7, 3.7 HVS: A.4-A.5, 6.5, 7.4-7.5, 12.4, 13.4-13.5
14	Apr 11-13	Review	
	Apr 16-27	Final Exam (scheduled by Registrar)	

*No class Feb 15-19 (Reading Week)

**University closed (except libraries) on Mar. 25 (Good Friday)

† For text references, TGS = Telford et al. 1990, HVS = Hinze et al. 2013

Note: The course schedule is tentative and subject to changes