



UNIVERSITY OF CALGARY

DEPARTMENT OF GEOSCIENCE COURSE OUTLINE WINTER 2016

1. **Course:** GOPH 657, Geophysical Interpretation

Lecture Sections:

L01: TuTh, 12:30 - 15:15, SA 249

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. K.A. Innanen, Office ES 212, Tel. No. 403-210-6837, e-mail address, kinnanen@ucalgary.ca,
Office Hours: Appointments Upon Request

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

2. **Prerequisites:** 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. **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:

Assignments (3)	25%
Quizzes (3)	25%
Final Project	
Write up	20%
Presentation	30%

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.

Grading Scheme

A+	95 – 100%
A	86 – 94%
A-	80 – 85%
B+	77 – 79%
B	73 – 76%
B-	70 – 72%
C+	67 – 69%
C	63 – 66%
C-	60 – 62%
D+	55 – 59%
D	50 – 54%
F	<50%

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:**
Course Notes are supplied.

6. 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 (FOIPP). 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: suvpaca@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: January 8, 2016

Associate Dean's Approval for
Alternate final examination arrangements: ORIGINAL SIGNED

Date: January 12, 2016

GOPH 657 Seismic Signal Analysis

"5 Lectures on Deterministic Seismic Processing Methods"

Instructor: K. Innanen

Winter 2016 SYLLABUS

1.0 Preliminaries

- 1.1 Introduction: deterministic vs. statistical signal models
- 1.2 Seismic reflection data and the classification of events
- 1.3 The "predictability" of multiple reflections
- 1.4 Math-physics review
 - 1.4.1 *Complex analysis and contour integration*
 - 1.4.2 *Inhomogeneous scalar wave equation*
 - 1.4.3 *An exact scalar Green's function in free space*
 - 1.4.4 *2D and 3D scalar Green's functions in free space*
 - 1.4.5 *A Green's function in the presence of a free surface*

2.0 Free surface multiples (FSMs) and their removal

- 2.1 A brief history of multiples
- 2.2 A mysterious numerical example
- 2.3 FSM prediction and removal: a primer
 - 2.3.1 *A general scalar 1D view*
 - 2.3.2 *An analytic example*
- 2.4 Two models of reflection seismic data with FSMs
 - 2.4.1 *The Delft feedback model*
 - 2.4.2 *The scattering model*
- 2.5 Two approaches to FSM prediction
 - 2.5.1 *"Surface-related multiple elimination": the Delft approach*
 - 2.5.2 *"Free-surface multiple elimination": the scattering approach*
- 2.6 Adaptive subtraction

3.0 Internal multiples (IMs) and their removal

- 3.1 FSMs in terms of subevents & the addition of traveltimes
- 3.2 IMs in terms of addition and subtraction of traveltimes
- 3.3 A candidate algorithm in terms of convolution and correlation
- 3.4 Internal multiple prediction in 1D
 - 3.4.1 *Choosing events that obey a lower-higher-lower relationship*
 - 3.4.2 *An analytic example*
 - 3.4.3 *IM prediction and data search*
- 3.5 Issues in multidimensional IM prediction
 - 3.5.1 *Looking for IMs that will fool the algorithm*
 - 3.5.2 *Pseudo-depth and vertical traveltimes*

4.0 Seismic interferometry

- 4.1 Seismic data reconstruction and some words about interferometry
- 4.2 A basis for interferometry in Green's theorem
- 4.3 Causality
 - 4.3.1 *The Hilbert transform*
 - 4.3.2 *Wave field causality*
- 4.4 Interferometry in 1D: "acoustic daylight imaging"
 - 4.4.1 *Green's theorem in 1D*
 - 4.4.2 *Reduction to a correlation*
- 4.5 An analytic example
 - 4.5.1 *A subevent interpretation of the equations of interferometry*
 - 4.5.2 *Hidden infinite series*

5.0 Attenuation (Q) modeling and compensation

- 5.1 The distinction of past and future
- 5.2 Extrinsic vs. intrinsic wave attenuation
 - 5.2.1 *Mechanisms for increasing the disorder of a wave field*
 - 5.2.2 *An extrinsic/intrinsic threshold*
- 5.3 Complex, frequency dependent seismic velocities
 - 5.3.1 *Relaxation*
 - 5.3.2 *Complex moduli*
 - 5.3.3 *Q defined*
- 5.4 Viscoelastic models
- 5.5 Macroscopic models
 - 5.5.1 *Linearity*
 - 5.5.2 *Constant vs. nearly-constant Q*
 - 5.5.3 *Causality: the Hilbert transform again*
- 5.6 Influence of Q on seismic data
 - 5.6.1 *Propagation and resolution loss*
 - 5.6.2 *Reflection strength and some contemporary research avenues*
- 5.7 Deterministic Q Compensation
 - 5.7.1 *A review of FK migration*
 - 5.7.2 *The Hargreaves-Calvert algorithm*