UNIVERSITY OF CALGARY

DEPARTMENT OF GEOSCIENCE
COURSE OUTLINE
WINTER 2016

1. **Course:** GOPH 659, Practical Seismic Modeling Migration & Inversion

   Lecture Sections:

   L01: January 4-8, 2016, 9:00-3:00, ENA 233
   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. J. Bancroft, Office ES 150, Tel. No. 403-614-2262, e-mail address, bancroft@ucalgary.ca,
   Office Hours: All day

   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)

   Note: Some familiarity with seismic data and computer programming is assumed.

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:

Attendance	30%
Quizzes	15%
Laboratory experiments (5)	35%
Term paper	20%

   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	**Percent**
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:**
   A set of notes available from D2L.

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. Krebes by email krebes@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: December 16, 2015

Associate Dean's Approval for
Alternate final examination arrangements: ORIGINAL SIGNED Date: December 16, 2015

Course Schedule GOPH 659 Jan. 2016

The lectures are based on course notes that have been continually updated since 1982. The current version contains over 1,100 pages. The schedule below follows these course notes over five days.

Day 1

Chapter 1 Introduction

1.0 Introduction
1.1 Recording and Processing
1.2 Zero Offset Migration
1.3 Prestack Migration
1.4 Three main post stack migration methods

Chapter 2 Modelling with Zero Offset

2.0 Introduction
2.1 Ray Tracing with Compass
2.2 Modelling with Diffractions
2.3 Fourier Transform Modelling
2.4 Ray tracing Modelling with Constant Int. Velocities
2.5 Exploding Reflector Model
2.6 Huygens Method of Wave Front Modelling
2.7 Eikonal Method of Modelling
2.8 Modelling 3-D Data

Chapter 3 Bits and Pieces

3.1 Circles Ellipses and Hyperbolas
3.2 Velocities (Instantaneous, Interval, Average, RMS, Stacking, Migration, and DMO)
3.3 The Fourier Transform
3.4 Aliasing in One and Two Dimensions
3.5 Frequency, Dip, Velocity, and Trace Spacing
3.6 Trace Interpolation to Reduce Aliasing
3.7 The Wave Equation(s)
3.8 Derivatives and the Wave Equation
3.9 Time and Depth Migration

Day 2

Chapter 4 Post-stack Migration

4.0 Introduction
4.1 Migration by Compass and Ray Tracing
4.2 Hagedoorn Migration
4.3 Kirchhoff Migration
4.4 FK Direct Fourier Transform Migration
4.5 Downward Continuation Migration
4.6 Various Algorithms for Downward Continuation
4.7 Migration of 3-D Data
4.8 Testing migration

Chapter 5 Examples of Migration

5.1 Dip models - constant velocity
5.2 Practice examples
5.3 Assorted migrations of real data
5.4 Assorted migrations of ray-trace model
5.5 Migration velocities varying from 80% to 150 %
5.7 Comparison of 2D and 3D migrations
5.8 Migration tests with model and single trace

5.9 Migration test of velocity profile
5.10 Time to depth conversion of diffractions

Day 3

Chapter 6 Special Topics on Migration

6.1 Moving Window Migration
6.2 Side-swipe
6.3 Oblique Reflectors
6.4 Overlapping Reflections
6.5 Fresnel Zones
6.6 Aliasing in Time it Depth Conversions
6.7 Frequency Changes due to Migration
6.8 Recording Time and Migration Aperture
6.9 Dip Limitations with Depth
6.10 Cascade Migration
6.11 Surface Elevation, Datums, and Migration
6.12 Example Problem

Chapter 7 Prestack Modelling

7.0 Introduction of Prestack Data
7.1 Modelling of Source Records
7.2 Constant Offset Sections
7.3 Prestack Eikonal Equation Modelling
7.4 Source Modelling and Constant Offset Sections
7.5 The Marmousi Model
7.6 Prestack Modelling of 3-D Data

Day 4

Chapter 8 2-D Dip Moveout (DMO)

8.0 Introduction
8.1 Single Trace Prestack Processing
8.2 Prestack Processing of Constant Offset Sections
8.3 Prestack Processing of Source Gathers
8.4 Introduction of Dip Moveout (DMO) and Prestack Partial Migration
8.5 DMO Algorithms
8.6 Processing Sequences for DMO
8.7 DMO Examples on Modelled Data
8.8 Why does DMO not Improve Many Sections
8.9 When Should DMO be Used

Chapter 9 Prestack Migrations

9.0 Comparison of DMO and Full Prestack Migration
9.1 Prestack Migration Methods
9.2 Source Geophone Method
9.3 Prestack Migration of Source Records
9.4 Prestack Inversion of Source Records
9.5 Prestack Migration of Constant Offset Sections
9.6 Stolt Prestack 2-D Migration Using 3-D Transforms
9.7 DMO and PSM of 3-D Data Volumes
9.8 3-D DMO
9.9 Cross Dip, Down Dip, and Azimuth in Acquisition

Day 5

Chapter 10 Examples of Prestack Migrations

10.1 Comparison of DMO and PSM ellipse
10.2 Examples of DMO testing