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

1. **Course:** Geophysics 665, Theoretical Seismology

   Lecture Sections:
   L01: MoWe, 16:00-17.15, SA 125

   Instructor: Dr. E. S. Krebes, Office ES 230, Tel. No. 403-220-5028, e-mail address, krebes@ucalgary.ca,
   Office Hours: anytime instructor is in the office and the door is open.

   Desire 2 Learn (D2L) course name: W2015GOPH665L01
   Geoscience Department ES 118, 403-220-5841, geoscience.ucalgary.ca, geoscience@ucalgary.ca

2. **Prerequisites:** Geophysics 551 or consent of the Department. 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 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 (5)	60%	
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:** A set of printed course notes provided by the instructor.
   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 assignments will be a factor in the evaluation of those assignments. 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 (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: 220-3911 Email: suvpaca@ucagary.ca.
SU Faculty Rep. Phone: 220-3913 Email: 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). Your responses make a difference - please participate in USRI Surveys.

Department Approval: Original Signed Date: January 6, 2015

Geophysics 665: Main Topics Covered in Lectures

This is an advanced course in theoretical seismology. ***Ideally***, students should have a knowledge of basic reflection seismology (e.g., Geophysics 355), wave motion (e.g., Physics 321), multi-variable calculus (e.g., Mathematics 331), complex variables & linear systems analysis & Fourier transforms (e.g., Applied Mathematics 415), partial differential equations and boundary value problems (e.g., Applied Mathematics 413), basic tensor calculus, basic seismic wave theory (e.g., Geophysics 551: stress, strain, equation of motion, wave equation, plane waves, potentials, reflection-transmission, surface waves and normal modes, waves in layered media).

Topics covered will include all or most of the following:

1. ***First 3 weeks:*** Seismic ray theory: eikonal equation, Fermat's principle and Euler-Lagrange equations, equations for computing the ray path, ray coordinates, ray amplitudes in simple and not-so-simple structures using asymptotic ray theory, generalized rays.
2. ***Second 3 weeks:*** Discrete linear inverse theory: under- and over-determined systems, normal equations and the generalized inverse, singular value decomposition, resolution, numerical examples.
3. ***Third 3 weeks:*** Matrix methods in seismology: Thomson-Haskell method, propagator matrices, applications.
4. **Fourth 3 weeks:** Finite difference (FD) method for computing synthetic seismograms: FD derivative approximations, stability, velocity-stress method, non-reflecting boundary conditions, explicit and implicit FD schemes, grid dispersion.

Last week: Other topics that may be covered if time permits:

5. Point- and volume-source integral solutions to equation of motion and potential wave equations.
6. Exact solution of equation of motion for a directional point body force. Moment tensor.
7. Seismic ray theory: Hamiltonian approach, perturbation methods, paraxial and dynamic ray tracing methods, Gaussian beams.
8. Details of Cagniard – de Hoop method for obtaining the exact solution to Lamb's problem for 2D SH case (exact formulas for reflected, transmitted and head waves).
9. Details of other of full-wave methods for calculating the exact seismic wavefield.
10. Waves in weakly heterogeneous media – perturbation methods, etc.
11. Anisotropy and anelasticity (wave propagation review, reflection and transmission)

Geophysics 665: Assignments

About five sets of homework problems will be assigned in the above topics. The aim is to provide the student with background knowledge in theoretical seismology as well as analytical and computational skills in the subject, so that the student is better able to read and comprehend advanced literature in this field.