GEOS701

Advanced Geophysical Theory

S1 Day 2017

Dept of Earth and Planetary Sciences

Contents

General Information

Unit convenor and teaching staff Juan Carlos Afonso juan.afonso@mq.edu.au
Credit points 4
Prerequisites Admission to MRes
Corequisites
Co-badged status
Unit description This unit will focus on advanced topics relevant to research in Solid Earth and exploration geophysics. Topics include, but are not limited to, inverse theory, numerical methods in geophysics, global seismology, and geodynamics. Practicals will include working with different scientific computing lagnuages currently used in geophysics research. Delivery of both lectures and workshops/labs are designed to engage and encourage students to become independent and critical thinkers, as well as proficient in solving quantitative problems in geoscience.

Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at https://www.mq.edu.au/study/calendar-of-dates

Learning Outcomes

On successful completion of this unit, you will be able to:

1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems
3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
4. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.

5. Capability to present scientific ideas clearly with supporting evidence.

General Assessment Information

If you apply for Disruption to Study for your final examination, you must make yourself available for the week of July 24 – 28, 2017. If you are not available at that time, there is no guarantee an additional examination time will be offered. Specific examination dates and times will be determined at a later date.

Assessment Tasks

Name	Weighting	Hurdle	Due
Exam	25%	No	June
Assignments I	25%	No	The end of March
Assignments II	25%	No	Mid May
Assignments III	25%	No	Early June

Exam

Due: **June**
Weighting: **25%**

This Assessment Task relates to the following Learning Outcomes:

1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
2. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
3. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
4. capacity to present scientific ideas clearly with supporting evidence

On successful completion you will be able to:

- 1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
- 3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
- 5. Capability to present scientific ideas clearly with supporting evidence.

Assignments I

Due: **The end of March**
Weighting: **25%**

Matlab exercises about numerical methods used in scientific research. This assignment will consist of 3 or 4 individual parts that will be evaluated separately. All three parts must be completed to approve the assignment.

This Assessment Task relates to the following Learning Outcomes:

1. Understanding of the fundamental principles and concepts of numerical methods.
2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems
3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
4. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
5. capacity to present scientific ideas clearly with supporting evidence

On successful completion you will be able to:

- 1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
- 2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems
- 3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
- 4. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
- 5. Capability to present scientific ideas clearly with supporting evidence.

Assignments II

Due: **Mid May**
Weighting: **25%**

This assignment will consist of a short review paper for ambient noise tomography following papers published in *Journal of Geophysics Research-solid earth.* The review paper is expected to cover the introduction, the physical principle of ambient noise tomography, current application of ambient noise, discussion on other possible applications, and so on.

This Assessment Task relates to the following Learning Outcomes:

1. Understanding of the fundamental principles and concepts of seismic tomography,
2. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
3. capacity to present scientific ideas clearly with supporting evidence

On successful completion you will be able to:

- 1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
- 2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems
- 3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
- 4. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
- 5. Capability to present scientific ideas clearly with supporting evidence.

Assignments III

Due: **Early June**
Weighting: **25%**

Problems in Mantle convection. Use of matlab and convection codes to simulate convection in the Earth's mantle. This assignment will consist of 2 or 3 individual parts that will be evaluated separately. All three parts must be completed to approve the assignment.

This Assessment Task relates to the following Learning Outcomes:

1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems
3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.

On successful completion you will be able to:

- 1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
- 2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems

- 3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
- 4. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
- 5. Capability to present scientific ideas clearly with supporting evidence.

Delivery and Resources

3 hours weekly, consisting of lectures and practicals

Unit Schedule

Week	Lecturer	Topic
Week 1	Juan Carlos Afonso	Review of Matlab and basics of Math
Week 2	Juan Carlos Afonso	Numerical methods 1: how to solve partial differential equations
Week 3	Juan Carlos Afonso	Numerical methods 2: how to solve integral equations
Week 4	Juan Carlos Afonso	Inverse theory 1: matrix-based methods
Week 5	Juan Carlos Afonso	Inverse theory 2: matrix-free methods
Week 6	Yingjie Yang	Introduction to Seismic interferometry
Week 7	Yingjie Yang	Data processing and dispersion measurements of ambient noise
	Mid-term Recess	
Week 8	Yingjie Yang	Applications of ambient noise tomography in imaging subsurface structures
Week 9	Yingjie Yang	Applications of interferometry in temporal monitoring and exploration geophysics
Week 10	Craig O'Neill	Continuum mechanics 1
Week 11 26 May	Craig O'Neill	Continuum mechanics 2
Week 12	Craig O'Neill	Mantle convection 1

Week 13	Craig O'Neill	Mantle convection 2

Policies and Procedures

Macquarie University policies and procedures are accessible from Policy Central. Students should be aware of the following policies in particular with regard to Learning and Teaching:

Academic Honesty Policy http://mq.edu.au/policy/docs/academic_honesty/policy.html

Assessment Policy http://mq.edu.au/policy/docs/assessment/policy_2016.html

Grade Appeal Policy http://mq.edu.au/policy/docs/gradeappeal/policy.html

Complaint Management Procedure for Students and Members of the Public http://www.mq.edu.au/policy/docs/complaint_management/procedure.html

Disruption to Studies Policy (in effect until Dec 4th, 2017): http://www.mq.edu.au/policy/docs/disruption_studies/policy.html

Special Consideration Policy (in effect from Dec 4th, 2017): https://staff.mq.edu.au/work/strategy-planning-and-governance/university-policies-and-procedures/policies/special-consideration

In addition, a number of other policies can be found in the Learning and Teaching Category of Policy Central.

Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: https://students.mq.edu.au/support/student_conduct/

Results

Results shown in *iLearn*, or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in eStudent. For more information visit ask.mq.edu.au.

Student Support

Macquarie University provides a range of support services for students. For details, visit http://students.mq.edu.au/support/

Learning Skills

Learning Skills (mq.edu.au/learningskills) provides academic writing resources and study strategies to improve your marks and take control of your study.

- Workshops
- StudyWise
- Academic Integrity Module for Students
- Ask a Learning Adviser

Student Services and Support

Students with a disability are encouraged to contact the Disability Service who can provide appropriate help with any issues that arise during their studies.

Student Enquiries

For all student enquiries, visit Student Connect at ask.mq.edu.au

IT Help

For help with University computer systems and technology, visit http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/.

When using the University's IT, you must adhere to the Acceptable Use of IT Resources Policy. The policy applies to all who connect to the MQ network including students.

Graduate Capabilities

PG - Capable of Professional and Personal Judgment and Initiative

Our postgraduates will demonstrate a high standard of discernment and common sense in their professional and personal judgment. They will have the ability to make informed choices and decisions that reflect both the nature of their professional work and their personal perspectives.

This graduate capability is supported by:

Learning outcomes

- 1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
- 3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
- 4. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
- 5. Capability to present scientific ideas clearly with supporting evidence.

Assessment tasks

- Exam
- Assignments I
- Assignments II
- Assignments III

PG - Discipline Knowledge and Skills

Our postgraduates will be able to demonstrate a significantly enhanced depth and breadth of

knowledge, scholarly understanding, and specific subject content knowledge in their chosen fields.

This graduate capability is supported by:

Learning outcomes

- 1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
- 2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems

Assessment tasks

- Exam
- Assignments II
- Assignments III

PG - Critical, Analytical and Integrative Thinking

Our postgraduates will be capable of utilising and reflecting on prior knowledge and experience, of applying higher level critical thinking skills, and of integrating and synthesising learning and knowledge from a range of sources and environments. A characteristic of this form of thinking is the generation of new, professionally oriented knowledge through personal or group-based critique of practice and theory.

This graduate capability is supported by:

Learning outcomes

- 1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
- 2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems
- 3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
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Assessment tasks

- Assignments I
- Assignments II
- Assignments III

PG - Research and Problem Solving Capability

Our postgraduates will be capable of systematic enquiry; able to use research skills to create new knowledge that can be applied to real world issues, or contribute to a field of study or practice to enhance society. They will be capable of creative questioning, problem finding and problem solving.

This graduate capability is supported by:

Learning outcomes

- 1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
- 2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems
- 3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
- 4. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
- 5. Capability to present scientific ideas clearly with supporting evidence.

Assessment tasks

- Assignments I
- Assignments II
- Assignments III

PG - Effective Communication

Our postgraduates will be able to communicate effectively and convey their views to different social, cultural, and professional audiences. They will be able to use a variety of technologically supported media to communicate with empathy using a range of written, spoken or visual formats.

This graduate capability is supported by:

Learning outcomes

- 2. Understanding of computer programming (MATLAB) for solving differential equations, linear systems, and tensorial algebra relevant to Geophysics problems
- 3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
- 4. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
- 5. Capability to present scientific ideas clearly with supporting evidence.

Assessment tasks

- Exam
- Assignments I
- Assignments II
- Assignments III

PG - Engaged and Responsible, Active and Ethical Citizens

Our postgraduates will be ethically aware and capable of confident transformative action in relation to their professional responsibilities and the wider community. They will have a sense of connectedness with others and country and have a sense of mutual obligation. They will be able to appreciate the impact of their professional roles for social justice and inclusion related to national and global issues

This graduate capability is supported by:

Learning outcomes

- 1. Understanding of the fundamental principles and concepts of seismic tomography, gravity potential and numerical methods.
- 3. Capability to apply acquired knowledge to solving problems and evaluating ideas and information.
- 4. Capability to summarize relevant information for specific problems and formulating adequate solutions for them.
- 5. Capability to present scientific ideas clearly with supporting evidence.

Assessment tasks

- Assignments I
- Assignments II
- Assignments III