UNSW Course Outline

# ZPEM3311 Mathematical Methods for Differential Equations - 2024

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## General Course Information

**Course Code :** ZPEM3311
**Year :** 2024
**Term :** Semester 1
**Teaching Period :** Z1
**Is a multi-term course? :** No
**Faculty :** UNSW Canberra
**Academic Unit :** UC Science
**Delivery Mode :** In Person
**Delivery Format :** Standard
**Delivery Location :** UNSW Canberra at ADFA
**Campus :** UNSW Canberra
**Study Level :** Undergraduate
**Units of Credit :** 6

**Useful Links**

Handbook Class Timetable

## Course Details & Outcomes

### Course Description

A variety of methods for solving ordinary and partial differential equations are considered. Examples and applications used to motivate the course will be drawn from areas such as solid and fluid mechanics, electrical circuits, pattern formation, heat and river pollution. The types of

problems and methods of solution considered may include: systems of differential equations (including phase-plane analysis), boundary-value problems, partial differential equations and elementary perturbation analysis. Computational methods for solution of ordinary and partial differential equations will be introduced and software packages will be used to implement the algorithms and visualise the results.

## Course Aims

The course aims to to extend and enrich the students' knowledge, understanding and technical ability with differential equations. In doing so, the student will also gain an insight in how differential equations may be used to model a plethora of phenomena.

## Relationship to Other Courses

The course builds on the mathematics of stage 2 by widening the applicability of exact analytical techniques. The course also compliments the analytical approach from stage 1 and 2 with approximation methods and numerical analysis. Computer based approaches are an ever increasingly important part of mathematics and the wider physical sciences and ZPEM3311 provides the student with an introduction to such methods.

## Course Learning Outcomes

| Course Learning Outcomes |
|---|
| CLO1 : Gain appreciation of where differential equations arise |
| CLO2 : Be familiar with a variety of solution methods, both analytical and numerical |
| CLO3 : Interpret the solutions in terms of physical quantities |

| Course Learning Outcomes | Assessment Item |
|---|---|
| CLO1 : Gain appreciation of where differential equations arise | • Final Exam |
| CLO2 : Be familiar with a variety of solution methods, both analytical and numerical | • Combined MATLAB and written assignment x 4<br>• In-class quizzes x 4<br>• Final Exam |
| CLO3 : Interpret the solutions in terms of physical quantities | • Combined MATLAB and written assignment x 4<br>• Final Exam |

## Learning and Teaching Technologies

Moodle - Learning Management System

## Learning and Teaching in this course

ZPEM3311 will be delivered as lectures, tutorials and laboratories.

Lectures will primarily be used to teach analytical techniques and the necessary mathematical concepts those techniques are based upon. Further, lectures provide a forum for students' questions.

Tutorials are used for handson practise on the material that has been taught in lectures.

Laboratories will be used for hands-on application of numerical methods which complement the analytical methods and are informed by the approximation techniques studied in lectures. The practical nature of the labs allows students to familiarise themselves with the computer software, MATLAB, as well as the concepts and logic of programming.

# Assessments

## Assessment Structure

| Assessment Item | Weight | Relevant Dates |
|---|---|---|
| Combined MATLAB and written assignment x 4<br>Assessment Format: Individual | 40% | Start Date: Not Applicable<br>Due Date: Not Applicable |
| In-class quizzes x 4<br>Assessment Format: Individual | 20% | Start Date: Not Applicable<br>Due Date: Not Applicable |
| Final Exam<br>Assessment Format: Individual | 40% | Start Date: Not Applicable<br>Due Date: Not Applicable |

## Assessment Details

### Combined MATLAB and written assignment x 4

**Assessment Overview**

A written assignment which combines numerical and analytical solutions to problems. Feedback delivered with assignments returned to students.

**Course Learning Outcomes**

- CLO2 : Be familiar with a variety of solution methods, both analytical and numerical
- CLO3 : Interpret the solutions in terms of physical quantities

Detailed Assessment Description

The four assessments are due at 5pm on the following dates

1. Regular perturbations - 22 March 2024
2. Singular perturbations - 3 May 2024
3. Nonlinear systems - 17 May 2024
4. PDEs and Fourier series - 7 June

For each assessment, a scanned version of the written answers and the MATLAB code need to be submitted using the appropriate Moodle dropbox by the due time.

Assignment submission Turnitin type

Not Applicable

## In-class quizzes x 4

Assessment Overview

Short quizzes covering various aspects of the course, held during the tutorial class. Feedback delivered with assignments returned to students.

Course Learning Outcomes

- CLO2 : Be familiar with a variety of solution methods, both analytical and numerical

Detailed Assessment Description

There will be quizzes held during the following tutorial classes

1. Regular perturbations - 15 March 2024
2. Linear systems - 5 April 2024
3. Nonlinear systems - 3 May 2024
4. PDEs and Fourier series - 7 June 2024

Assignment submission Turnitin type

Not Applicable

## Final Exam

Course Learning Outcomes

- CLO1 : Gain appreciation of where differential equations arise
- CLO2 : Be familiar with a variety of solution methods, both analytical and numerical
- CLO3 : Interpret the solutions in terms of physical quantities

**Assignment submission Turnitin type**

Not Applicable

# General Assessment Information

**Use of Generative Artificial Intelligence (AI) – such as ChatGPT – in UNSW Assessments**

It is prohibited to use any software or service to search for or generate information or answers. If its use is detected, it will be regarded as serious academic misconduct and subject to the standard penalties, which may include 00FL, suspension and exclusion.

**Grading Basis**

Standard

**Requirements to pass course**

The assessment for the course has been designed so that an overall mark of 50% or greater indicates that the student has unambiguously demonstrated satisfactory completion of each learning outcome. For this reason, and consistent with the UNSW policy of abolishing the Pass Conceded grade, students who receive less than 50% overall for the course will receive a Fail grade.

# Course Schedule

| Teaching Week/Module | Activity Type | Content |
|---|---|---|
| Week 1 : 26 February - 1 March | Lecture | • Lecture 1 Introduction to the course Nondimensionalisation<br>• Lecture 2 Introduction to regular perturbation |
| Week 2 : 4 March - 8 March | Lecture | • Lecture 3 Series solution of regular perturbation problems<br>• Lecture 4 Introduction to singular perturbation problems Outer solution |
| Week 3 : 11 March - 15 March | Lecture | • Lecture 5 Coordinate trransformations Inner solutions Matching solutions<br>• Lecture 6 Prandtl's matching criteria Composite solutions |
| Week 4 : 18 March - 22 March | Lecture | • Lecture 7 Revision of second order ODEs Systems of linear ODEs<br>• Lecture 8 Revision of eigenvalues and eigenvectors Classification of solutions of linear systems |
| Week 5 : 25 March - 29 March | Lecture | • Lecture 9 Revision of linear systems Introcuction to nonlinear systems Finding equilibrium points<br>• Lecture 10 Linearising a nonlinear system Finding the Jacobian of a nonlinear system Classification of equilibrium points of a nonlinear system |
| Week 6 : 1 April - 5 April | Lecture | • Lecture 11 Unforced Duffing's equation Working through first nonlinear system example<br>• Lecture 12 Worked solution to nonlinear system example Sketching solutions |
| Week 7 : 22 April - 26 April | Lecture | • Lecture 13 Introduction to PDEs<br>• Lecture 14 No lecture due to ANZAC Day |
| Week 8 : 29 April - 3 May | Lecture | • Lecture 15 Separable solutions to PDEs<br>• Lecture 16 Eigenvalue problems for PDEs/ODEs |
| Week 9 : 6 May - 10 May | Lecture | • Lecture 17 General solution to PDEs<br>• Lecture 18 Worked example of a nuclear reactor |
| Week 10 : 13 May - 17 May | Lecture | • Lecture 19 Worked example of solving Laplace's equation<br>• Lecture 20 Introduction to Fourier series |
| Week 11 : 20 May - 24 May | Lecture | • Lecture 21 Application of Fourier series<br>• Lecture 22 Worked solution to modelling a guitar string |
| Week 12 : 27 May - 31 May | Lecture | • Lecture 23 Lecture lost due to a Monday timetable<br>• Lecture 24 Worked solution to modelling a disc brake |
| Week 13 : 3 June - 7 June | Lecture | • Lecture 25 Exam tips Revision Non-dimensionalisation Regular perturbation problems Singular perturbation problems Linear systems Nonlinear systems<br>• Lecture 26 Revision Separable solutions of PDEs Eigenvalue problems in ODEs/PDEs General solutions of PDEs Fourier series |

## Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

# Course Resources

## Prescribed Resources

There are no prescribed textbooks for this course. There will be extensive class notes that will cover all of the material.

## Course Evaluation and Development

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by listening to our own students. Students will be asked to complete the myExperience survey

towards the end of this course.  Students can also provide feedback during the semester via: direct contact with the lecturer, the “On-going Student Feedback” link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups. Student opinions really do make a difference. Refer to the Moodle site for this course to see how the feedback from previous students has contributed to the course development.

# Staff Details

| Position | Name | Email | Location | Phone | Availability | Equitable Learning Services Contact | Primary Contact |
|---|---|---|---|---|---|---|---|
| Lecturer | Simon Watt | | Building 22 Room 311 | | | No | Yes |

# Other Useful Information

## Academic Information

### Course Evaluation and Development

One of the key priorities in the 2025 Strategy for UNSW is a drive for academic excellence in education. One of the ways of determining how well UNSW is progressing towards this goal is by listening to our own students. Students will be asked to complete the myExperience survey towards the end of each course.

Students can also provide feedback during the semester via: direct contact with the lecturer, the “On-going Student Feedback” link in Moodle, Student-Staff Liaison Committee meetings in schools, informal feedback conducted by staff, and focus groups (where applicable). Student opinions really do make a difference. Refer to the Moodle site for your course to see how the feedback from previous students has contributed to the course development.

Important note:  Students are reminded that any feedback provided should be constructive and professional and that they are bound by the Student Code of Conduct.

https://www.gs.unsw.edu.au/policy/documents/studentcodepolicy.pdf

### Equitable Learning Services (ELS)

Students living with neurodivergent, physical and/or mental health conditions or caring for someone with these conditions may be eligible for support through the Equitible Learning

Services team. Equitable Learning Services is a free and confidential service that provides practical support to ensure your mental or physical health conditions do not adversely affect your studies.

Our team of dedicated **Equitable Learning Facilitators** (ELFs) are here to assist you through this process. We offer a number of services to make your education at UNSW easier and more equitable.

Further information about ELS for currently enrolled students can be found at: https://www.student.unsw.edu.au/equitable-learning

## Academic Honesty and Plagarism

UNSW has an ongoing commitment to fostering a culture of learning informed by academic integrity. All UNSW staff and students have a responsibility to adhere to this principle of academic integrity. All students are expected to adhere to UNSW's Student Code of Conduct. Find relevant information at: Student Code of Conduct (unsw.edu.au)

Plagiarism undermines academic integrity and is not tolerated at UNSW. It is defined as using the words or ideas of others and passing them off as your own, and can take many forms, from deliberate cheating to accidental copying from a source without acknowledgement.

For more information, please refer to the following:

https://student.unsw.edu.au/plagiarism

## Submission of Assessment Tasks

### Special Consideration

Special Consideration is the process for assessing and addressing the impact on students of short-term events, that are beyond the control of the student, and that affect performance in a specific assessment task or tasks.

Applications for Special Consideration will be accepted in the following circumstances only:

- Where academic work has been hampered to a substantial degree by illness or other cause;
- The circumstances are unexpected and beyond the student's control;
- The circumstances could not have reasonably been anticipated, avoided or guarded against by the student; and either:

(i) they occurred during a critical study period and was 3 consecutive days or more duration, or a total of 5 days within the critical study period; or

(ii) they prevented the ability to complete, attend or submit an assessment task for a specific date (e.g. final exam, in class test/quiz, in class presentation)

Applications for Special Consideration must be made as soon as practicable after the problem occurs and at the latest within three working days of the assessment or the period covered by the supporting documentation.

By sitting or submitting the assessment task the student is declaring that they are fit to do so and cannot later apply for Special Consideration (UNSW 'fit to sit or submit' requirement).

Sitting, accessing or submitting an assessment task on the scheduled assessment date, after applying for special consideration, renders the special consideration application void.

Find more information about special consideration at: https://www.student.unsw.edu.au/special/consideration/guide

Or apply for special consideration through your MyUNSW portal.

**Late Submission of assessment tasks (other than examinations)**

UNSW has a standard late submission penalty of:

- 5% per day,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

**Electronic submission of assessment**

Except where the nature of an assessment task precludes its electronic submission, all assessments must be submitted to an electronic repository, approved by UNSW or the Faculty, for archiving and subsequent marking and analysis.

**Release of final mark**

All marks obtained for assessment items during the session are provisional. The final mark as published by the university following the assessment review group meeting is the only official mark.