FACULTY OF SCIENCE

SCHOOL OF MATHEMATICS AND STATISTICS

MATH2221

Higher Theory and Applications of Differential Equations

Semester 2, 2017

Cricos Provider Code: 00098G

Information about the course

Course Authority: Dr Jan Zika RC-4074.

Consultation: See my timetable on the course home page.

Credit: This course counts for 6 Units of Credit (6UOC).

Prerequisites: The formal prerequisite is a mark of at least 70 in MATH1231 or MATH1241 or MATH1251. However, this is a minimum requirement. I do not recommend enrolling in MATH2221 unless you are also getting marks of at least 70 in any other second-year mathematics courses you have taken. In fact, if you only just meet this requirement then you should enrol in Math2121 instead (unless Math2221 is a compulsory course in your program).

Exclusions: MATH2130, MATH2019, MATH2029, MATH2059 and MATH2120.

Lectures: For weeks 1-12 lectures take place at the following times and places.

Day	Time	Room
Tuesday	9AM-10AM	Red Centre Theatre (K-H13-G001)
Wednesday	2PM-3PM	Old Main Building 229 (K-K15-229)
Friday	2PM-3PM	Red Centre Theatre (K-H13-G001)

Tutorials: For weeks 2–13 you will attend one tutorial per week. The key to successfully completing this course is to work through the tutorial exercises. Only **some** of these exercises will be solved in the tutorials: you should work through as many of the remaining exercises as you can in your own time.

TELT: All course materials will be available on the course home page, which is accessed by logging on to

`http://moodle.telt.unsw.edu.au/my/`.

You should check regularly for new materials.

Course aims

This course aims to build on your previous study of ordinary differential equations (ODEs) as part of first year calculus. We begin by studying initial-value problems for second and higher-order linear ODEs. Next is an overview of first-order systems of ODEs, touching on a range of topics that are treated at greater depth in our third-year courses. We then return to the topic of linear second-order ODEs, but consider boundary-value problems, as well as a first look at separation of variables for partial differential equations (PDEs). The remainder of the course treats eigenproblems for ordinary and partial differential operators, and their use for solving initial boundary-value problems for PDEs using Cartesian or polar coordinates.

Although the main focus of the course is on analytical methods of solution, we also discuss a variety of applications that give rise to differential equation models.

Relation to other mathematics courses

MATH2221 is a core second-year course, and will prepare you for a range of later-year courses offered by the School of Mathematics and Statistics that treat topics in the theory and applications of differential equations. In particular, MATH3121 Mathematical Methods and Partial Differential Equations and MATH3201 Dynamical Systems and Chaos are natural sequels to MATH2221.

Assessment

The course has three assessment tasks:

Class Test 1	45 minutes	Week 4	15%
Class Test 2	45 minutes	Week 9	15%
Final Exam	2 hours	November	70%

Refer to the course home page for further details, such as the topics covered in each class test.

If you are absent from a class test, you must provide a medical certificate. A further test may be offered at the discretion of the lecturer. Otherwise an M will be recorded and your final mark will be calculated from the other assessment tasks. Do not apply for special consideration if you are sick for a class test. (Applying for special consideration is necessary only for an assessment worth 20% or more of your final mark.)

Reference books

There is no prescribed textbook for the course, but you may find the following texts useful:

- W.E. Boyce and R.C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiley, P515.35/18.
- E. Kreyszig, Advanced Engineering Mathematics, Wiley, P510.2462/5.
- Steven H. Strogatz, Nonlinear Dynamics and Chaos, Addison-Wesley, P531.11/94.
- R.K. Nagle and E.B. Saff, Fundamentals of Differential Equations and Boundary Value Problems - 4th Edition, Addison-Wesley, P517.382/197.

The content of the course will be defined by the lectures and the tutorial problems.

School Rules and Regulations

Details of the general rules regarding attendance, release of marks, special consideration etc are available via the School of Mathematics and Statistics Web site:

`http://www.maths.unsw.edu.au/currentstudents/assessment-policies`

In particular, for the additional assessment policies see

`http://www.maths.unsw.edu.au/currentstudents/additional-assessment`

The dates for the additional assessment exams are available from the online Student Noticeboard.

Syllabus

Linear ODEs

- Linear differential operators
- Differential operators with constant coefficients
- Wronskians and linear independence

- Methods for inhomogeneous equations
- Solution via power series
- Singular ODEs
- Bessel and Legendre equations

Dynamical systems: an overview

- Examples and terminology
- Existence and uniqueness
- Practical solution methods
- Linear dynamical systems
- Stability
- Final remarks on nonlinear DEs

Initial-boundary value problems in 1D

- Two-point boundary-value problems
- Existence and uniqueness
- Inner products and norms of functions
- Self-adjoint differential operators
- The vibrating string
- Heat equation

Generalised Fourier series

- Complete orthogonal systems
- Sturm–Liouville problems
- Fourier–Bessel series
- Schrödinger equation

Initial-boundary value problems in 2D

- Elliptic differential operators
- Green identities and boundary value problems
- Elliptic eigenproblems
- Wave and diffusion equations