Math 3C **Mathematical Physics I** Autumn 2005

Purpose of the course

As its title implies, this course aims to teach you the fundamental mathematical methods which are essential for solving a wide variety of physical problems. Examples will be taken from quantum mechanics, heat flow, waves, and mechanical coupled systems. We will focus on the theory of differential equations, and especially its relation to linear algebra. By the end of the course you will be able to solve a wide variety of ordinary and partial differential equations from physics and engineering (e.g. heat equation, wave equation, Schrödinger equation). You will find this course especially useful for understanding and solving problems in quantum mechanics, classical mechanics and electro-magnetism.

Instructor

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Course website

`www.math.mcmaster.ca/kevla/teaching/3c/home`

Please check the course website regularly for important announcements.

Hours

Lectures: Monday (12:30-13:20), Tuesday (13:30-14:20), Thursday (12:30-13:20) in HH 109.
Tutorials: Monday (15:30-16:20) in T13/123, Wednesday (12:30-13:20) in BSB 117.
Office hours: Monday (9:30-10:20), or by appointment.

Text

Main text:
Mathematical Methods for Scientists and Engineers by D.A. McQuarrie (University Science Books, 2003)
Supplementary texts:
Custom courseware: Mathematics 3C/3D by D. Pelinovsky (McMaster, 2005)
Mathematical Methods for Physics and Engineering by K.F. Riley, M.P. Hobson, and S.J. Bence (Cambridge University Press, 2002) *Mathematical Methods for Physicists* by G.B. Arfken and H.J. Weber (Academic Press, 2001)

Tutorials

The weekly tutorials will provide extra help on the lecture material, and will go over assignment questions.

Syllabus

The course is divided into six parts as follows. Chapter references are to the main text and are meant as a rough guide only. The text may be supplemented with additional lecture material.

1. Introduction: differential equations in physics and engineering
2. Advanced linear algebra (Chapters 9 and 10)
    - Vector spaces and linear operators (9.5-9.7)
    - Eigenvalue problems (10.1-10.2)
    - Normal mode solutions (10.3)
    - Diagonalization and quadratic forms (10.4-10.6)
3. Ordinary differential equations (Chapters 11 and 12)
    - Linear equations with constant coefficients (11.3,11.6)
    - General first- and second-order equations (11.2,11.5)
    - Power series solutions about ordinary and regular singular points (12.1-12.5)
4. Sturm–Liouville theory (Chapters 14 and 15)
    - Orthogonal polynomials (14.1-14.2)
    - Sturm–Liouville eigenvalue problems (12.6, 14.3, 14.4)
    - Fourier series expansions (15.1-15.3)
5. Solution of partial differential equations by separation of variables (Chapter 16)
    - Wave and heat equation: one dimension (16.3, 16.5)
    - Laplace's equation: two dimensions (16.2)
    - Schrödinger equation: three dimensions (16.6)
    - Classification of partial differential equations (16.7)
6. Solution of partial differential equations by integral transform (Chapter 17)
    - The Laplace transform (17.1-17.4)
    - The Fourier transform (17.5-17.6)

Assignments

Six assignments with six questions each will be posted on the website. Detailed solutions to assignments will be posted on the course webpage two weeks later.

Although the assignments will not be marked for credit, it is **essential** that you attempt **all questions** before the solutions are posted. **Warning: you will almost certainly fail this course if you do not do the assignments!**

The assignment schedule is as follows:

Assignment posted	**Solutions posted**
September 12	September 26
September 26	October 11
October 10	October 24
October 24	November 7
November 7	November 21
November 21	December 5

Evaluation

There will be two mid-term tests and a final exam.

Tests

There will be two 50 minute tests, held in a location to be announced, during the regularly scheduled class hours on the following tentative dates:

Tuesday 11 October Tuesday 15 November

Only the McMaster standard calculator (Casio FX-991) is allowed to be used in the tests. Please check the course website regularly for any date or time changes.

Final exam

There will be a three-hour final examination during the December examination period. Only standard McMaster University calculators (Casio FX-991) may be used in the final examination.

Grading system

The final mark will be calculated as follows:

Tests (50 minutes)	25% each
Final exam (3 hours)	50%

Percentage marks will be converted into final letter grades using the Registrar's Office scale, possibly subject to final adjustments (that will only increase the final grade).

Official notices

Senate Policy Statement: The course is regulated under the following documents: Statement on Academic Ethics and Senate Resolutions on Academic Dishonesty. Any student who infringes one of these resolutions will be treated according to the published policy. In particular, academic dishonesty includes (1) plagiarism, e.g. the submission of work that is not one's own, (2) improper collaboration in group work on home assignments, (3) copying or using unauthorized aids tests and examinations. It is your responsibility to understand what constitutes academic dishonesty, refering to Academic Integrity Policy.