Methods of Applied Mathematics (840G1)
Course Document (Autumn 2008)

Lecturer

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Office hours

Mantell building, Room 2B32: Monday 14:00-15:00, Friday 10:00-11:00.

Lectures

There are 3 lectures per week during weeks 1, 3, 5, …, 9 and 2 lectures per week during weeks 2, 4, 6, …, 10. Lectures on Mondays (week 1, 3, 5, …, 9) will be given in Pevensey 1-2A12 from 17:00-to-18:00. Lectures on Fridays will be given in Pevensey 1-1A03 from 14:00-to-16:00.

Workshop

There is a 1 hour workshop during weeks 2, 4, …, 10. Except week2, Workshops will be given on Mondays in Pevensey 1-2A12 from 17:00-to-18:00.

In week 2, the Workshop will be held on Friday (the 2h lecture will be divided into 1h workshop + 1h lecture) to give enough time to cover the course content needed for the first worksheet and to give you enough time for Course Work preparation. On Monday week 2, instead of the Workshop, a 1h lecture will be given.

Lecture notes, exercise sheets and solutions

Lecture notes will be posted on the course's Study Direct page and my personal webpage (**http://www.maths.sussex.ac.uk/~izkiss**). There will be 5 worksheets that will be handed out regularly or can be downloaded from Study Direct or my personal webpage. Solutions to each worksheet will be posted approximately one week after the Course Work is handed in. There will be a small number of extra documents that are intended to either help you understand new concepts or refresh things you already learnt. These will be available on both Study Direct and my personal webpage.

Course Work
The Course Work will be based on exercises from the 5 worksheets that correspond to the 5 Workshops. By working in groups of three you will hand in a single set of solutions to each of the 5 worksheets.

Apart from providing solutions, each group will be responsible for nominating a member who, during one of the 5 Workshops, will have to present the solution to one of the exercises from the worksheet corresponding to that week's Workshop. The exercise will be chosen by the Workshop participants or otherwise the lecturer. These short (20 to 25 minutes) presentations are intended to encourage you to approach and think about solutions in a more rigorous way. I will be happy to help and direct everybody through their presentation.

Assessment
The Course Work for Methods of Applied Mathematics will account for 10% of the final mark. 90% of the mark will be based on an unseen examination (~ sometime in May 2009).

More details about the COURSE WORK format and its ASSESSMENT are provided on Study Direct or my personal webpage.

Syllabus

1. **Dimensional analysis and scaling**
    - physical quantities and their measurement
    - dimensions
    - change of units
    - physical laws
    - Buckingham Pi Theorem
    - scaling
2. **Regular perturbation methods**
    - direct method applied to algebraic equations and initial value problems (IVP)
    - Poincaré method for periodic solutions
    - validity of approximations
3. **Singular perturbation methods**
    - finding approximate solutions to algebraic solutions
    - finding approximate solutions to boundary value problems (BVP) including boundary layers and matching

4. **Calculus of Variations**
    - necessary conditions for a function to be an extremal of a fixed or free end point problem involving a functional of integral form
    - isoperimetric problems

Course outline

The aim of this course is to introduce the student to a variety of techniques primarily involving ordinary differential equations that have applications in various branches of applied mathematics. No particular application is emphasized.

Learning outcomes

At the end of the course a successful student should have:

- a basic understanding of the concept of dimensions of physical quantities and how to express problems involving them in a dimensionless form using appropriate scaling.
- a knowledge of simple perturbation methods and how to handle problems that generate secular terms.
- the ability to tackle singular perturbation problems using scaling to obtain the inner solution valid in the boundary layer.
- a basic understanding of the calculus of variations and its use in solving simple extremal problems.

Library

The course is based mainly on the first three chapters of the book by J.D. Logan, Applied Mathematics: a contemporary approach, Wiley-Interscience.

Other useful books are:

1. C.C. Lin and L.A. Segel: Mathematics applied to deterministic problems in the natural sciences; SIAM reprint 1988.
2. E. J. Hinch, Perturbation methods, Cambridge University Press 1991.
3. A. H. Nayfeh, Perturbation Methods, Wiley, 1973.
4. C. King, J. Billingham and S. R. Otto, Differential equations, Cambridge University Press 2003.

5. M. Gelfand and S. V. Fomin, Calculus of variations, Dover Publications, Inc. 2000 (initially published by Prentice-Hall, 1963).

The library has a large collection of books that focus on the topics of the course. It is often the case that some books are easier to read and understand than others. Therefore, I recommend that you browse through various books and find those that suit you best.