Methods of Applied Mathematics (840G1)
Course Document
Autumn 2007

Lecturer

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Office hours

Mantell building, Room 2B32: Tuesday 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 Tuesdays (week 1, 3, 5, …, 9) will be given in Pevensey 1-1A01 from 17:00-to-18:00. Lectures on Fridays (all 10 weeks) will be given in the Medical School MS 3.07A from 14:00-to-16:00.

Workshop

There is a 1 hour workshop during weeks 2, 4, …, 10. Workshops will be given on Tuesdays in Pevensey 1-1A01 from 17:00-to-18:00. Work should be handed in the same week by Friday the latest. Exercise sheets are already available on my personal webpage.

Lecture notes, exercise sheets and solutions

Lecture notes will be posted on my personal website on a chapter-by-chapter basis, following shortly after lectures (please check regularly!). This can be accessed via the departmental website or by copying/typing **http://www.maths.sussex.ac.uk/~izkiss** in your web browser. There will be 5 exercise sheets that will be handed out regularly or can be downloaded from the web. Solutions to each sheet will be posted on my website approximately one week after the sheet is handed out.

Assessment

Unseen examination (2 hours) in the summer term (May 2008) with 100% weighting.

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.