MATH11222 - 2008/2009

General Information

- Title: Calculus and Applications
- Unit code: MATH10222
- Credits: 10
- **This course unit consists of the first half of MATH10222. It may not be taken with that course unit.**
- Prerequisites: MATH10121
- Co-requisite units: None
- School responsible: Mathematics
- Members of staff responsible: Prof. Matthias Heil

Specification

Aims

1. Provide a classification of ODEs
2. Provide methods of solving both first and second-order ODEs
3. Introduce the concepts of scaling and non-dimensionalisation.
4. Introduce the concept of a regular perturbation expansion.

Brief Description of the unit

The unit provides a basic introduction to ordinary differential equations (ODEs) and classical mechanics. The course will discuss both the methods and theory associated with general first and second order ODEs. A brief introduction to the concepts of scaling, non-dimensionalisation and regular perturbation methods will be given.

Learning Outcomes

On successful completion of this unit students will be able to

1. Classify and first and second order ODEs.
2. Solve linear ODEs using standard methods.
3. Apply the ideas of scaling and non-dimensionalisation.
4. Apply regular perturbation methods to solve simple ODE problems.

Future topics requiring this course unit

A large number of course units in applied mathematics, pure mathematics and statistics.

Syllabus

1. **General introduction.** Notation. What are ODEs? Implicit versus explicit form. Classification: order, linearity, autonomous ODEs. Boundary and initial conditions. Boundary and initial value problems. Existence and uniqueness for linear and nonlinear ODEs. [3]
2. **First-order ODEs.** Graphical methods; separable ODEs, ODEs of homogeneous type; integrating factor. [4]
3. **Second-order ODEs.** Existence and uniqueness. Linear ODEs: superposition of solutions, fundamental solutions and the general solution for homogeneous ODEs. The general solution of constant-coefficient ODEs; particular solutions for specific RHS; the method of undetermined coefficients. [If time permits (probably not): Power series expansions about regular points.] Some nonlinear ODEs with special properties (autonomous ODEs and ODEs that do not contain the dependent variable). [8]
4. **Mechanics applications of second-order ODEs** Damped harmonic motions of mechanical oscillators; harmonic forcing and resonance. [3]
5. **Non-dimensionalisation and scaling.** Exploiting small parameters in an ODE: perturbation methods. Motivation via the roots of quadratic polynomials (singular perturbations only mentioned); applications to selected (regularly perturbed) ODEs. [4]

Textbooks

Teaching and learning methods

Four lectures and one supervision class each week. In addition, students should expect to spend at least six hours each week on private study. The course unit only lasts for the first six weeks of the semester.

Assessment

Attendance at supervisions: weighting 5%
Submission of coursework at supervisions: weighting 5%
In-class test: weighting 15%
Three hours end of semester examination: weighting 75%

Arrangements