



MATH34011 - 2008/2009

General Information

- Title: Asymptotic Expansions and Perturbation Methods
- Unit code: MATH34011
- Credits: 10
- Prerequisites: MATH20401 or MATH20411
- Co-requisite units: None
- School responsible: Mathematics
- Members of staff responsible: Prof. [W. Lionheart](#)

Specification

Aims

To introduce the idea of perturbation methods as an approach to the analysis of non-linear phenomena.

Brief Description of the unit

The course unit begins the study of the behaviour of dissipative oscillatory systems governed (mostly) by non-linear ordinary differential equations. Examples include clocks and buzzers, musical instruments, brake judder, wheel shimmy, panel flutter, etc. We develop a systematic approximation technique (perturbation theory) which is available when the equations have (some) small coefficients.

Learning Outcomes

To familiarise the students with a number of basic techniques. By the end of the course unit the students should be able to deploy these techniques in simple examples.

Future topics requiring this course unit

None.

Syllabus

1. Asymptotic series. Order symbols. Introduction to perturbation theory.
2. Revision of theory of plane autonomous systems. Limit cycles.
3. Non-linear oscillators. Examples. Phase diagrams.
4. Energy methods. Lindstedt's method.
5. Method of multiple scales.
6. Floquet theory for the Mathieu equation.
7. WKB method. Estimates of large eigenvalues.

Textbooks

- J.D. Murray, *Asymptotic Analysis*, Springer 1984.
- A. Nayfeh, *Introduction to Perturbation Techniques*, Wiley, 1981.
- J.G. Simmonds and J.E. Mann, *A First Look at Perturbation Theory*, Dover 1998.
- D.W. Jordan and P. Smith, *Non-linear O.D.E.'s*, O.U.P. 2nd edition, 1987.

Teaching and learning methods

Two lectures and an examples class each week. In addition students should expect to spend at least four hours each week on private study for this course unit.

Assessment

End of semester examination: two hours weighting 100%

Arrangements