



The University of Southern Queensland

Course Specification

Description: Mathematical Modelling for Dynamics

| Subject | Cat-Nbr | Class | Term | Mode | Units | Campus |
|---------|---------|-------|---------|------|-------|--------|
| MAT | 3103 | 21199 | 1, 2003 | EXT | 1.00 | TWMBA |

| | |
|------------------------|--------|
| Academic Group: | FOSCI |
| Academic Org: | FOS003 |
| HECS Band: | 2 |
| ASCED Code: | 010101 |

STAFFING

Examiner: Sergey Suslov

Moderator: Tony Roberts

PRE-REQUISITES

Pre-requisite: MAT2100

RATIONALE

Mathematical modelling is a process of fundamental importance to the practising mathematician. Differential equations and an understanding of their qualitative behaviour provide a structure for the analysis of wide ranging problems. This course uses mathematical tools developed so far and introduces dimensional analysis and the calculus of variations to explore many applications. Developing technical communication is also essential as preparation for the workplace.

SYNOPSIS

Differential equation modelling introduces basic dynamical systems theory which lays the foundation for Chaos. Modelling in general uses mathematical tools developed so far to model a variety of situations. It develops the importance of dimensional analysis and similarity solutions. Calculus of variations introduces the finding of optimal functions and reaffirms the close connection between boundary conditions and DEs. Throughout the course basics of technical communication in the mathematical sciences are developed. This course is offered only in odd-numbered years.

OBJECTIVES

On completion of this course students will be able to:

- solve systems of linear differential equations;

- analyse the dynamics of systems of differential equations to determine stability, sketch phase portraits, and draw qualitative conclusions;
- demonstrate the ability to solve applied problems in mechanics;
- demonstrate an understanding of the process of mathematical modelling applied to a range of problems and using mathematical content from previous studies;
- demonstrate the ability to apply the modelling process to real-life problems;
- apply the Euler-Lagrange equations to find optimal functions for many straightforward problems;
- structure, prepare and deliver documents and presentations of technical material.

TOPICS

| Description | Weighting (%) |
|---|---------------|
| 1. Systems of differential equations: the solution of linear DE's, the conversion of higher-order linear DE's to first-order systems; fixed points and phase portraits, especially in 2-D; qualitative solution of nonlinear, first-order DE's, especially in the region of fixed points. | 16.00 |
| 2. Mathematical writing, LaTeX | 10.00 |
| 3. Potentials, Bifurcations, Catastrophes | 10.00 |
| 4. Dimensions Scaling, Dimensional Analysis | 10.00 |
| 5. Growth and Relaxation: Exponential growth and decay, Autoregulation | 10.00 |
| 6. Vibrations in complex systems: Free Vibrations, Mechanical vibrations, Nonlinear Oscillations, Forced Vibrations, Linear Response, Resonance, Nonlinear response; Coupled Oscillators | 28.00 |
| 7. Calculus of variations: challenge problems and functionals; Euler-Lagrange equation, comparison functions, fundamental lemma; special cases; straight lines minimise arclength; geodesics; brachistochrone; soap films; the Lagrangian of dynamical systems. | 16.00 |

TEXT and MATERIALS required to be PURCHASED or ACCESSED:

Books can be ordered by fax or telephone. For costs and further details use the 'Book Search' facility at <http://bookshop.usq.edu.au> by entering the author or title of the text.

Access to computer or internet facilities for mathematical typesetting.

Thomas Svobodny 1998, *Mathematical Modeling for Industry and Engineering*, Prentice Hall, Upper Saddle River, NJ, USA.

REFERENCE MATERIALS

Reference materials are materials that, if accessed by students, may improve their knowledge and understanding of the material in the course and enrich their learning experience.

Department of Mathematics and Computing CDROM Set 1, S1, 2003 (available from the USQ Bookshop). This CD set contains course material, Windows and Linux Software for

this and various other courses. For more information about the CD sets and their use, please refer to <http://www.sci.usq.edu.au/cdrom>

Highham, N.J. 1998, *Handbook of writing for the mathematical sciences*, 2nd edition, SIAM, Philadelphia.

Kreyszig, E. 1999, *Advanced Engineering Mathematics*, 8th edition, Wiley, New York.

Weinstock, R. 1974, *Calculus of variations; with applications to physics and engineering*, 1974 edition, Dover Publications, New York.

STUDENT WORKLOAD REQUIREMENTS

| ACTIVITY | HOURS |
|---------------|-------|
| Assessment | 30 |
| Examinations | 3 |
| Private Study | 135 |

ASSESSMENT DETAILS

| Description | Marks Out of | Wtg(%) | Required | Due Date |
|---------------------|--------------|--------|----------|----------------------------|
| HOMEWORK | 100.00 | 10.00 | Y | 04 Mar 2003 (see note) |
| ASSIGNMENT 1 | 200.00 | 20.00 | Y | 04 Apr 2003 |
| ASSIGNMENT 2 | 200.00 | 20.00 | Y | 09 May 2003 |
| ASSIGNMENT 3 | 200.00 | 20.00 | Y | 30 May 2003 |
| EXAM 3HR RESTRICTED | 100.00 | 30.00 | Y | END S1 (see note) |

NOTES:

- . Further details about the due dates are given in the study schedule of the Introductory Book.
- . Examination dates will be available during the Semester. Please refer to Examination timetable when published.

IMPORTANT ASSESSMENT INFORMATION

- 1 Attendance requirements:
There are no attendance requirements for this course. However, it is the students' responsibility to study all material provided to them or required to be accessed by them to maximise their chance of meeting the objectives of the course and to be informed of course-related activities and administration.
- 2 Requirements for students to complete each assessment item satisfactorily:
To complete the assignments satisfactorily, students must obtain at least 50% of the marks available for each assignment. To complete the examination satisfactorily, students must obtain at least 50% of the marks available for the examination.
- 3 Penalties for late submission of required work:

If students submit assignments after the due date without prior approval then a penalty of 20% of the total marks gained by the student for the assignment will apply for each working day late.

- 4 Requirements for student to be awarded a passing grade in the course:
To be assured of receiving a passing grade a student must achieve at least 50% of the available weighted marks for the summative assessment items.
- 5 Method used to combine assessment results to attain final grade:
The final grades for students will be assigned on the basis of the weighted aggregate of the marks obtained for each of the summative assessment items in the course.
- 6 Examination information:
In a Restricted Examination, candidates are allowed access to specific materials during the examination. The only materials that candidates may use in the restricted examination for this course are: writing materials (non-electronic and free from material which could give the student an unfair advantage in the examination); calculators which cannot hold textual information (students must indicate on their examination paper the make and model of any calculator(s) they use during the examination; English translation dictionaries (but not technical dictionaries); Students whose first language is not English, may, with the Examiner's approval, take an appropriate non- electronic translation dictionary into the examination. Students who wish to use a translation dictionary MUST request and receive written approval from the Examiner at least one week before the examination date. Translation dictionaries will be subject to perusal and may be removed from the candidate's possession until appropriate disciplinary action is completed if found to contain material that could give the candidate an unfair advantage.
- 7 Examination period when Deferred/Supplementary examinations will be held:
Students who obtain an overall passing mark, but who do not perform satisfactorily in an examination, may, at the discretion of the examiner, be granted a supplementary examination. Students will be granted a deferred examination only if they perform satisfactorily in all other assessment items. Any supplementary or deferred examinations for this course will be held during the examination period at the end of the semester of the next offering of this course.
- 8 University Regulations:
Students should read USQ Regulations 5.1 Definitions, 5.6. Assessment, and 5.10 Academic Misconduct for further information and to avoid actions which might contravene University Regulations. These regulations can be found at the URL <http://www.usq.edu.au/SECARIAT/calendar/Part5/> or in the printed version of the current USQ Handbook.

ASSESSMENT NOTES

- 9 Assignments: The due date for an assignment is the date by which a student must despatch the assignment to the USQ. The onus is on the student to provide proof of the despatch date, if requested by the Examiner. Students must retain a copy of each item submitted for assessment. This must be produced within five days if required by the Examiner. In accordance with University Policy, the examiner may grant an extension of the due date of an assignment in extenuating circumstances.