



The University of Southern Queensland

Course specification

Description: Mathematical Modelling for Dynamics

Subject	Cat-nbr	Class	Term	Mode	Units	Campus
MAT	3103	40918	1, 2005	EXT	1.00	Toowoomba

Academic group:	FOSCI
Academic org:	FOS003
Student contribution band:	2
ASCED code:	010101

STAFFING

Examiner: Sergey Suslov
Moderator: Dmitry Strunin

REQUISITES

Pre-requisite: MAT2100

RATIONALE

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

SYNOPSIS

The course uses mathematical tools introduced in pre-requisite studies to model a variety of realistic phenomena surrounding us in everyday life and introduces calculus of variations for optimisation problems. The course emphasises the importance of dimensional analysis and reaffirms the close connection between boundary conditions and DEs. The basics of technical communication in the mathematical sciences are developed throughout the course. This course is offered only in odd-numbered years.

OBJECTIVES

On completion of this course students will be able to:

1. solve systems of linear differential equations;
2. analyse the dynamics of systems of differential equations to determine stability, sketch phase portraits, and draw qualitative conclusions;
3. demonstrate the ability to apply the modelling process to real-life problems;
4. demonstrate an understanding of the principles of mathematical modelling applied to a range of problems and using mathematical content from previous studies;

5. demonstrate the ability to solve applied problems found in mechanics, physics, engineering and many other areas;
6. apply the Euler-Lagrange equations to find optimal solutions for various optimisation problems;
7. 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

ALL textbooks and materials are available for purchase from USQ BOOKSHOP (unless otherwise stated). Orders may be placed via secure internet, free fax 1800642453, phone 07 46312742 (within Australia), or mail. Overseas students should fax +61 7 46311743, or phone +61 7 46312742. For costs, further details, and internet ordering, use the 'Textbook Search' facility at <http://bookshop.usq.edu.au> click 'Semester', then enter your 'Course Code' (no spaces).

Access to computer or internet facilities for mathematical typesetting.

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

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, University of Southern Queensland 2005, 'Mathematics and Computing CD-Rom Set' (Available: <http://www.sci.usq.edu.au/courses/mat3103>) .

(Some electronic resources for this course may be available via its home page)

Highham, NJ 1998, *Handbook of writing for the mathematical sciences*, 2nd edn, SIAM, Philadelphia.

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

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

STUDENT WORKLOAD REQUIREMENTS

ACTIVITY	HOURS
Assessment	30.00
Directed Study	54.00
Examinations	2.00
Private Study	83.00

ASSESSMENT DETAILS

Description	Marks out of	Wtg(%)	Due date
HOMEWORK	100.00	10.00	01 Mar 2005 (see note 1)
ASSIGNMENT 1	200.00	20.00	15 Apr 2005
ASSIGNMENT 2	200.00	20.00	06 May 2005
ASSIGNMENT 3	200.00	20.00	27 May 2005
EXAM 2HR RESTRICTED	100.00	30.00	END S1 (see note 2)

NOTES

1. Further details about the due dates are given in the study schedule of the Introductory Book.
2. 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 each of 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/corporateservices/calendar/part5.htm> or in 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 despatched to USQ within 24 hours of receipt of a request from the Examiner to do so. In accordance with University Policy, the examiner may grant an extension of the due date of an assignment in extenuating circumstances.

10 It is strongly recommended that external students have regular reliable access to email and the Internet for submitting homework and discussing the course with the lecturer.