The University of Southern Queensland

Course specification

This version produced 7 Jul 2008.
The current and official versions of the course specifications are available on the web at <http://www.usq.edu.au/coursespecification/current>.
Please consult the web for updates that may occur during the year.

Description: Mathematical Modelling for Dynamics

<table>
<thead>
<tr>
<th>Subject</th>
<th>Cat-nbr</th>
<th>Class</th>
<th>Term</th>
<th>Mode</th>
<th>Units</th>
<th>Campus</th>
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<tbody>
<tr>
<td>MAT</td>
<td>3103</td>
<td>62712</td>
<td>1, 2007</td>
<td>EXT</td>
<td>1.00</td>
<td>Toowoomba</td>
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Academic group: FOSCI
Academic org: FOS003
Student contribution band: 2
ASCED code: 010101

STAFFING
Examiner: Sergey Suslov

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. The course goals include developing technical communication skills as essential 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; (Assignment 1, 2, Exam)
2. analyse the dynamics of systems of differential equations to determine stability, sketch phase portraits, and draw qualitative conclusions; (Assignment 1, 2, Exam)
3. demonstrate the ability to apply the modelling process to real-life problems; (Assignments 1-3)
4. demonstrate an understanding of the principles of mathematical modelling applied to a range of problems and using mathematical content from previous studies; (Assignments 1-3)
5. demonstrate the ability to solve applied problems found in mechanics, physics, engineering and many other areas; (Assignment 1-3, Homework)
6. apply the Euler-Lagrange equations to find optimal solutions for various optimisation problems; (Assignment 3, Exam)
7. structure, prepare and deliver documents and presentations of technical material. (Assignments 1-3, Homework)

TOPICS

<table>
<thead>
<tr>
<th>Description</th>
<th>Weighting (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Systems of differential equations: the solution of linear DE's, fixed points and phase portraits, especially in 2-D; qualitative solution of nonlinear, first-order DE's, especially in the region of fixed points.</td>
<td>16.00</td>
</tr>
<tr>
<td>2. Mathematical writing, LaTeX</td>
<td>10.00</td>
</tr>
<tr>
<td>3. Potentials, bifurcations, catastrophes</td>
<td>10.00</td>
</tr>
<tr>
<td>4. Dimensions, scaling, dimensional analysis</td>
<td>10.00</td>
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<tr>
<td>5. Growth and relaxation: exponential growth and decay, autoregulation</td>
<td>10.00</td>
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<tr>
<td>6. Vibrations in complex systems: free vibrations, mechanical vibrations, nonlinear oscillations, forced vibrations, linear response, resonance, nonlinear response; coupled oscillators</td>
<td>28.00</td>
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<tr>
<td>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.</td>
<td>16.00</td>
</tr>
</tbody>
</table>

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.

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.

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


STUDENT WORKLOAD REQUIREMENTS

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>HOURS</th>
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<tbody>
<tr>
<td>Assessment</td>
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<tr>
<td>Directed Study</td>
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<tr>
<td>Examinations</td>
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<td>Private Study</td>
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ASSESSMENT DETAILS

<table>
<thead>
<tr>
<th>Description</th>
<th>Marks out of</th>
<th>Wtg(%)</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOMEWORK</td>
<td>100.00</td>
<td>10.00</td>
<td>01 Mar 2007</td>
</tr>
<tr>
<td>(see note 1)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>ASSIGNMENT 1</td>
<td>200.00</td>
<td>20.00</td>
<td>05 Apr 2007</td>
</tr>
<tr>
<td>ASSIGNMENT 2</td>
<td>200.00</td>
<td>20.00</td>
<td>11 May 2007</td>
</tr>
<tr>
<td>ASSIGNMENT 3</td>
<td>200.00</td>
<td>20.00</td>
<td>01 Jun 2007</td>
</tr>
<tr>
<td>EXAM 2HR RESTRICTED</td>
<td>100.00</td>
<td>30.00</td>
<td>END S1</td>
</tr>
<tr>
<td>(see note 2)</td>
<td></td>
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</tr>
</tbody>
</table>

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 each assessment item satisfactorily, students must obtain at least 50% of the
   marks available for each item.

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 total
   weighted marks available for the course and submit all 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 aggregate of the weighted
   marks/grades 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. 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.
It is strongly recommended that external students have regular reliable access to email and the Internet for submitting homework and discussing the course material with the lecturers.