The University of Southern Queensland

Course specification

Description: Advanced Low-Dimensional Modelling of Complex Systems

Subject	Cat-nbr	Class	Term	Mode	Units	Campus
MAT	8104	55423	2, 2006	ONC	1.00	Toowoomba

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

STAFFING

Examiner: Tony Roberts
Moderator: Dmitry Strunin

REQUISITES

Pre-requisite: MAT8102 and MAT3103 and MAT2100

OTHER-REQUISITES

Recommended prior studies: MAT3104, MAT3105 and MAT3106

RATIONALE

Most physical situations and complex systems of interest in the world around us have an enormous number of fine details which are of little concern in many situations. The practical equations which scientists deal with are simplifications of the "true" but intractable or overly-complicated equations that describe all the fine detail. Just one example is the derivation of a numerical model for simulation. The process of creating simple model approximations for otherwise intractably detailed dynamical descriptions, sometimes called dimensional reduction, is addressed in this Course.

SYNOPSIS

This course flexibly combines aspects of modern dynamical systems theory with numerical techniques, fluid dynamics and other application areas. We develop how to derive relatively simple dynamical models in the application of the techniques to important classes of applications. The principles of the modelling process that are developed apply universally to any evolving system. The triple aim is to explore: algebraic techniques; general modelling principles; and application areas. This course is normally offered only in even years. Contact the Examiner to study this course by distance education.

OBJECTIVES

On completion of this course students will be able to:

1. discuss how separation of time scales forms a basis of modelling;
2. construct slow and manifold models of dynamics with the aid of computer algebra;
3. explore bifurcation scenarios;
4. use normal forms to understand modelling transformations;
5. understand large spatial scale, slowly varying approximations;
6. use the techniques in applications such as fluid flows, beam and shell theory, population dynamics, queueing theory, stochastic systems, and numerical discretisations.

TOPICS

	Description	Weighting (%)
1.	Mathematical modelling topics to be negotiated with examiner but should include some of: 1.1. a rational theory of modelling is exponential collapse; centre manifold theory ensures fidelity; existence, relevance and approximation; computer algebra handles the details; slow space variations---dispersion in a channel; structural stability; lubrication models of thin fluid films; cross-sectional averaging is unsound; inertial dynamics in thin fluid films; bands of critical modes---convection; competing small effects should be independent; the slow manifold is central, beam models, quasi-geostrophic approximation; initial conditions are long-lasting; normal forms show the way; enforcing some surprises; stochastic dynamical systems possess noise induced drift; two layer ocean dynamics; slice domains into finite elements; high order consistent approximations; maintain accuracy with moving meshes; boundary conditions are straightforward; multi-dimensional discretisations; initial conditions are subtle; two-scale modelling and the Ginzburg--Landau equation; the same paradigm serves numerical and analytic models	100.00

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).

' ' (Available: http://www.sci.usq.edu.au/courses/mat8104).

Roberts, A J ' ' (Available: http://www.sci.usq.edu.au/staff/aroberts/Modelling).

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.

Kuznetsov, Y A 1995, *Elements of Applied Bifurcation Theory, Applied Mathematical Sciences*, 2nd edn, Springer-Varlag, electronic book available through Ebrary catalogue, Vol 112.

Murdock, J 2003, *Normal forms and unfoldings for local dynamical systems*, Springer,

Robert, A J 2005, ' ' (Available: http://www.sci.usq.edu.au/staff/aroberts/LaTeX/latexintro.html).

Roberts, A J 2003, Low-Dimensional Modelling of Dynamical Systems Applied to Some Dissipative Fluid Mechanics, *Nonlinear dynamics: from lasers to butterflies*, World Scientific Lecture Notes in Complex Systems, Vol 1, pp257-313.

Roberts, A J 2001, Holistic discretisation illuminates & enhances the numerical modelling of differential equations, *Topics in Applied and Theoretical Mathematics and Computer Science*, WSES Press, pp81-89.

STUDENT WORKLOAD REQUIREMENTS

ACTIVITY	HOURS
Assessment	40.00
Consultation	7.00
Directed Study	120.00

ASSESSMENT DETAILS

Description	Marks out of	Wtg(%)	Due date
TO BE ADVISED	100.00	100.00	19 Jul 2005

IMPORTANT ASSESSMENT INFORMATION

1. Attendance requirements:
   It is the students' responsibility to attend and participate appropriately in all activities (such as lectures, tutorials, laboratories and practical work) scheduled for them, and 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 satisfactorily complete an assessment items, a student must obtain achieve at least 50% of the marks or a grade of at least C-. (Depending upon the requirements in Statement 4 below, students may not have to satisfactorily complete each assessment item to receive a passing grade in this course.)
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 30% in all of the weighted assessment items, achieve a total mark of at least 50% in Part A and 50% in Part B of the examination, and 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 aggregate of the weighted marks/grades obtained for each of the summative assessment items in the course.

6 Examination information:
To be advised

7 Examination period when Deferred/Supplementary examinations will be held:
To be advised

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 http://www.usq.edu.au/corporateservices/calendar/part5.htm or in the current USQ Handbook.

ASSESSMENT NOTES

9 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.

10 Students may be required to provide a copy of assignments submitted for assessment purposes. Such copies should be dispatched to the USQ within 24 hours of receipt of a request to do so.