



The University of Southern Queensland

Course Specification

Description: Chaos

Subject	Cat-Nbr	Class	Term	Mode	Units	Campus
MAT	4102	10368	1, 2002	ONC	1.00	TWMB A

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

STAFFING

Examiner: Tony Roberts
Moderator: Sergey Suslov

RATIONALE

Dynamical systems describe how any system of interest evolves in time. Nonlinear dynamics generally give rise to chaos. A modern understanding and appreciation of chaos is essential for all scientists in any field of endeavour which seeks to understand and quantify evolution.

SYNOPSIS

This course introduces concepts, analysis and appearances of chaos in dynamical systems, both theoretically and in applications. The approach is in the context of modern dynamical systems theory and relies mainly upon geometrical intuition rather than algebraic virtuosity. Starting from a classical view of dynamics, the course discusses strange attractors, the analysis of chaotic data series, and the period doubling and intermittent routes to chaos.

OBJECTIVES

On successful completion of this course students will be able to:

- appreciate the classic view of nonlinear dynamics;
- demonstrate an understanding of the generic features of chaos and strange attractors in continuous time dynamical systems, and in discrete maps;
- analyse an experimental data series for signs of chaos, and to compute some quantifiable characteristics;
- demonstrate an understanding of some of the finer features of chaotic dynamics through analysis of the period doubling and intermittent routes to chaos.

TOPICS

Description	Weighting (%)
1. Order: state space, equilibria, oscillations, quasi- periodic dynamics, Fourier transforms	20.00
2. Strange attractors: stretching and folding, Lyapunov exponents, 1D return maps, fractal microstructure	20.00
3. Data analysis: state space reconstruction, inverse problem, chaotic prediction, noise	20.00
4. Subharmonic cascade: return maps, period doubling, inverse cascade, renormalisation, universality	20.00
5. Intermittency: bursts and laminar phases, 1/f noise, renormalisation	20.00

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.

Abraham & Shaw, 1992 *Dynamics, The Geometry of Behaviour: Part 1, Periodic Behaviour; Part 2, Chaotic Behaviour; Part 3, Global Behaviour; Part 4, Bifurcation Behaviour*, Addison Wesley, Calif.

Baker, G.L. & Gollub, J.P. 1996 *Chaotic Dynamics: An Introduction*, 2nd edn., C.U.P., Cambridge.

Berge, P., Pomeau, Y. & Vidal, C. 1984 *Order Within Chaos: Towards a Deterministic Approach to Turbulence*, Wiley, New York.

Ford, J. 1989 *What is Chaos, That We Should Be Mindful of It?*, Chapter 12 in {The New Physics, } P. Davies (ed.) C.U.P., Cambridge.

Gleick, J. 1988 *Chaos: Making of A New Science*, Penguin, New York.

Hall, N. 1992 *New Scientist Guide to Chaos*, Penguin, London.

Nicolis, G. 1989 *Physics of Far-From-Equilibrium Systems and Self Organisation, Chapter 11 in {The New Physics, P. Davies (ed.) C.U.P., Cambridge.*

Ruelle, D. 1989 *Chaotic Evolution and Strange Attractors*, C.U.P., Cambridge.

Ruelle, D. 1993 *Chance and Chaos*, Penguin, London.

Schroeder, M. 1990 *Fractals, Chaos, Power Laws: Minutes From An Infinite Paradise*, Freeman, New York.

Schuster, H.G. 1995 *Deterministic Chaos, An Introduction*, 3rd edn., Physik-Verlag, Weinheim.

Stewart, I. 1987 *The Problems of Mathematics*, Chapters 13-16. O.U.P., New York.

STUDENT WORKLOAD REQUIREMENTS

ACTIVITY	HOURS
Assessment	40
Examinations	3
Lectures	39
Private Study	80

ASSESSMENT DETAILS

Description	Marks Out of	Wtg(%)	Required	Due Date
ASSIGNMENT 1	20.00	5.00	Y	04 Mar 2002 (see note 1)
ASSIGNMENT 2	20.00	5.00	Y	04 Mar 2002 (see note 2)
ASSIGNMENT 3	20.00	5.00	Y	04 Mar 2002 (see note 3)
ASSIGNMENT 4	20.00	5.00	Y	04 Mar 2002 (see note 4)
3 HOUR RESTRICTED EXAMINATION	100.00	80.00	Y	END S1 (see note 5)

NOTES:

1. Further details about the due dates are detailed in the assessment section of the Course Specifications.
2. Further details about the due dates are detailed in the assessment section of the Course Specifications.
3. Further details about the due dates are detailed in the assessment section of the Course Specifications.
4. Further details about the due dates are detailed in the assessment section of the Course Specifications.
5. Examination dates will be available during the Semester. Please refer to Examination timetable when published.

OTHER REQUIREMENTS

- 1 Attendance Requirements: It is the student's responsibility to participate in classes to ensure the best chance to meet the objectives of the course and to be informed of course-related activities and administration.
- 2 Minimum Requirements to Pass the Course: To be certain of obtaining a passing grade in this course, students must : (a) obtain an overall mark of at least 40%; (b) obtain at least 40% in the examination(s); and (c) attain at least 50% in the assignments as a whole.
- 3 Grading: A final grade will be allocated as follows: raw marks for the assessments will be summed with weightings specified in the Assessment Details; performance

- demonstrated in the examination will be reviewed with reference to the objectives of the course and a scaling decided; the scaled marks then determine the final grade.
- 4 Supplementary and Deferred Examinations: If a student obtains an overall passing mark, but does not perform satisfactorily in an examination, the student may, at the discretion of the examiner, be granted a supplementary examination. A student will normally not be granted a deferred examination unless he/she performs satisfactorily in the other components of the assessment. Any supplementary or deferred examinations for this course will normally be held at the end of the semester of the next offering of this course.
- 5 Assignments: The due date for assessments is the date by which a student must dispatch an assignment to the USQ. The onus is on the student to provide proof of the dispatch date, if requested by the examiner. Students must retain a copy of all assignments which must be produced within five days if and when required by the examiner. In accordance with the University's Policy on Assignments (Regulation 5.6.1), the examiner of a course may grant an extension of the due date of an assignment in extenuating circumstances. This policy may be found in the USQ Handbook, the Distance Education Student Guide and the Faculty of Sciences' Orientation Handbook for on-campus students. All students are advised to study and follow the guidelines associated with this policy. An assignment, submitted after the due date without an extension approved by the examiner, will attract a penalty of 20 percent of the assigned mark for each working day (or part thereof) that the assignment is late.
- 6 Examinations: Restricted Examination: only specific materials may be brought into a restricted examination. The only materials that students may bring into the examination room and use in the restricted examination are normally: (a) writing materials (non-electronic and free from material which could give the student an unfair advantage in the examination); (b) 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 should be aware that the University has policies and regulations about the use of unfair means and electronic devices in an examination and they should refer to them to determine whether or not actions they intend to take are acceptable to the University.
-