The University of Southern Queensland

Course Specification

Description: Mathematical Modelling						
Subject	Cat-Nbr	Class	Term	Mode	Units	Campus
MAT	3101	10390	1, 2002	EXT	1.00	TWMBA

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

STAFFING

Examiner: Sergey Suslov
Moderator: David Mander

PRE-REQUISITES

Pre-requisite: MAT2102 or USQ 64622 and MAT2100

RATIONALE

Mathematical modelling is a process of fundamental importance to the practising mathematician. This course uses the mathematical tools developed in the course so far and introduces dimensional analysis and similarity solutions. It continues the development of continuum modelling to viscous fluid flow as these are of common importance in industrial problems.

SYNOPSIS

This course is broadly divided into two interrelated strands. One strand, on 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. The other strand further develops the modelling of fluid dynamics by presenting basic Newtonian viscous fluid flow. It revises some of the second year work and develops further to viscous flow. Applications to slow flows and to similarity solutions in fast flows are also developed. Many flow demonstrations are presented and analysed mathematically.

OBJECTIVES

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

- demonstrate an understanding of the process of mathematical modelling applied to a wide range of problems and using mathematical content from previous studies;
- demonstrate the ability to apply the modelling process to real- life problems;

- use and understand the Navier-Stokes equation describing fluid flow;
- mathematically analyse and interpret fluid flows involving thin films, viscous flows around bodies, or boundary layers.

TOPICS

Description	Weighting (%)
1. Catastrophe theory: Potentials, Bifurcation, Catastrophe	8.00
2. Dimensions: Scaling, Dimensional Analysis, Similarity Solutions	8.00
3. Growth and Relaxation: Exponential growth and decay, Autoregulation, Economic Growth	8.00
4. Aspects of the following topics will be covered: Vibrations: Free Vibrations, Mechanical Vibrations, Nonlinear Oscillations Complex systems: Coupled Oscillators Continuous vs Discrete systems: Continuous vs. Discrete systems, Crystal Vibrations, Electric Circuits	10.00
5. Heat Equation: Similarity Solutions	8.00
6. Inviscid Fluid Flow: Review of the Continuity and Euler Equations, Stream Functions, Complex Potential, Water Waves	10.00
7. Mathematical Modelling of Viscous Flow: Viscosity, Navier-Stokes Equations, Non- dimensionalisation, Vorticity, Some Exact Solutions.	10.00
8. Boundary Layers in Fast Flow: Asymptotics, Flat Plates, Wakes & Jets	10.00
9. Slow Flow: Low Reynolds Number, Flow Past Sphere, Lubrication, Thin Films, Hele Shaw Cells, Porous Media.	20.00

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.

Ockendon, H. & Ockendon, J.R 1995, *Viscous flow*, CUP, Cambridge.

Svobodny, T 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.

Some electronic resources for this course may be available via its home page: http://www.sci.usq.edu.au/units/64638.

Flow Visualisation, Encyclopedia Britannica Educational Corporation, Castle Hill, NSW, Australia.

(Recommended video recordings)

Fluid Dynamics of Drag: Part II, Encyclopedia Britannica Educational Corporation, Castle Hill, NSW, Australia.

(Recommended video recordings)

1987, *Fundamentals of Boundary Layers*, Encyclopedia Britannica Educational Corporation, Castle Hill, NSW, Australia.

(Recommended video recordings)

Low Reynolds Number Flow, Encyclopedia Britannica Educational Corporation, Castle Hill, NSW, Australia.

(Recommended video recordings)

UMAP Modules (Undergraduate mathematics and its applications project), COMAP, USA.

Barker, Andrew (producer) 1985, *Engineering Mechanics: solids and fluids*, BBC TV Production for the Open University,

(Recommended video recordings)

Fowkes, N.D. & Mahony, J.J 1994, *An Introduction to Mathematical Modelling*, John Wiley & Sons, Chichester.

Giordano, F.R. & Weir, M.D 1997, *A First Course in Mathematical Modelling*, 2nd edition, Brooke/Cole, Pacific Grove, CA.

Hughes, W.F. & Brighton, J.A 1999, *Schaum's Outline of Theory and Problems of Fluid Dynamics*, 3rd edition, McGraw-Hill, New York.

Kreyszig, E 1999, *Advanced Engineering Mathematics*, 8th edition, John Wiley & Sons, Brisbane.

National Committee for Fluid Mechanics Films 1963, *Pressure Fields and Fluid Acceleration*, Encyclopedia Britannica Educational Corporation, Castle Hill, NSW, Australia.

(Recommended video recordings)

Schlichting, H 1979, *Boundary-layer theory*, 7th edition, McGraw-Hill, New York.

Van Dyke, M 1982, *An Album of Fluid Motion*, The Parabolic Press, Stanford, California.

White, F.M 1994, *Fluid Mechanics*, 3rd edition, McGraw-Hill, New York.

STUDENT WORKLOAD REQUIREMENTS

ACTIVITY	HOURS
Assessment	45
Examinations	3
Private Study	127

ASSESSMENT DETAILS

Description	Marks Out of	Wtg(%)	Required	Due Date
STRAND 1, ASSIGNMENT 1	999.00	15.00	Y	04 Mar 2002 (see note 1)
STRAND 1, ASSIGNMENT 2	999.00	15.00	Y	04 Mar 2002 (see note 2)
STRAND 1, ASSIGNMENT 3	999.00	15.00	Y	04 Mar 2002 (see note 3)
STRAND 1, HOMEWORK	999.00	5.00	Y	04 Mar 2002 (see note 4)
STRAND 2, ASSIGNMENT	999.00	15.00	Y	04 Mar 2002 (see note 5)
STRAND 2, HOMEWORK	999.00	15.00	Y	04 Mar 2002 (see note 6)
3 HOUR OPEN EXAMINATION	999.00	20.00	Y	END S1 (see note 7)

NOTES:

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

OTHER REQUIREMENTS

1 Attendance Requirements: It is the students' responsibility to actively participate in all classes scheduled for them, and to study all material provided to them or required to be accessed by them to maximize their chance of meeting the objectives of the course and to be informed of course-related activities and administration. Daytime students have to attend at least 80% of all lectures and tutorials.

2 Requirements to Satisfactorily Complete Each Assessment Item: To satisfactorily complete each of the assignments students must obtain at least half of the marks available for each assignment and homework. To satisfactorily complete the examinations in the course, students must obtain at least half of the marks available for each examination.

3 Minimum Requirements to Pass the Course: To be assured of a pass in this course, students must: (a) obtain an overall mark of at least 60%; and (b) obtain at least 50% of the marks available in the examination(s); and (c) obtain an overall mark of at least 50% in the assignments and homework.

4 Grading: Final grades for students will be determined by the addition of the marks obtained in each assessment item, weighted as in the Assessment Details and by considering the students' level of achievement of the objectives of the course.

5 Supplementary and Deferred Examinations: 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.

6 Assignments and Homework: The due date for an assignment is the date by which a student must dispatch the 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 each item submitted for assessment. This must be produced within five days if required by the examiner. In accordance with University's Assignment Extension Policy (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 day (or part thereof) that the assignment is late. The course assessment includes weekly homework. On-campus students must prepare the answers to the homework questions by the time established by the lecturer, normally by the beginning of the next week's first lecture. External students must send the answers in regularly.

7 Examinations: Candidates should be aware that the University has policies and regulations (Regulation 5.6.2.2) 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. Open Examination: Candidates may have access to any material during the examination except the following: electronic communication devices, bulky material, devices requiring mains power and anything likely to disturb other students.