The University of Southern Queensland

Course specification

Description: Vector Calculus and the Mathematical Modelling of Fluid Flows

Subject	Cat-nbr	Class	Term	Mode	Units	Campus
MAT	3106	54854	2, 2006	EXT	1.00	Toowoomba

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

STAFFING

Examiner: Sergey Suslov
Moderator: Tony Roberts

REQUISITES

Pre-requisite: MAT2100 and MAT3105

RATIONALE

Concepts and methods for the modelling and analysis of vector functions in space are required for an understanding of the principles that permeate much of applied mathematics, mathematical physics and engineering science. These principles are developed in the context of their application to the dynamics of fluid flow as it is important in industrial and environmental problems.

SYNOPSIS

First this course unifies vector algebra and differential calculus into the calculus of vector functions. It develops the differential and integral calculus, establishes their properties, and shows how these properties give useful formula in general coordinate systems. The course integrates the application of these mathematical tools to inviscid and incompressible fluid dynamics. It then extends the modelling of dynamics to the flow of a Newtonian viscous fluid such as air and water. Applications to channel flows, boundary layers, wakes, jets and lubrication are developed. This course is offered only in even numbered years.

OBJECTIVES

On completion of this course students will be able to:

1. use conservation principles to mathematically model inviscid fluid mechanics;
2. use vector calculus to anlayse the structure of physical fields in Cartesian and general curvilinear coordinates;
3. interpret and evaluate integrals over curves, surfaces and spatial domains;
4. appreciate the close connection between advanced mathematical concepts and real physical processes;
5. use and understand the fundamental equations describing viscous fluid flow;

6. mathematically analyse and interpret fluid flows involving thin films, viscous flows around bodies, or in boundary layers.

TOPICS

	Description	Weighting (%)
1.	Modelling fluid flow needs vector differentiation: scalar and vector fields of fluid flow; material derivatives and the gradient; divergence does not conserve mass; vorticity is the curl of velocity; continuity and Euler equations; streamfunction and velocity potential; conservation of momentum and the Venturi effect.	25.00
2.	Vector integration and applications: circulation is a work integral; scalar potentials lead to path independence; surface integrals measure flux; Gauss' divergence theorem transforms volume integrals; vorticity and circulation are related by Stokes' theorem.	20.00
3.	Mathematical modelling of viscous flow: viscosity, Navier-Stokes equations, non-dimensionalisation, some exact solutions.	20.00
4.	Boundary layers in fast flow: asymptotics, flat plates, wakes, jets.	15.00
5.	Slow flow: low Reynolds number, lubrication, thin films.	20.00

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).

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

Ockendon, H & Ockendon, JR 1995, *Viscous flow*, Cambridge University Press,

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/courses/MAT3106

Hughes, WF & Brighton, JA 1999, *Schaum's Outline of Theory and Problems of Fluid Dynamics*, 3rd edn, McGraw-Hill, New York.

Schlichting, H 2000, *Boundary-layer theory*, 8th edn, Springer, Berlin.

Study Book 2006, *Course MAT2100 Algebra and Calculus II*, USQ Distance and e-Learning Centre, Toowoomba.

Study Book 2006, *Course MAT3105 Harmony of Partial Differential Equations*, USQ Distance and e-Learning Centre, Toowoomba.

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

Videorecording : Barker, A (Producer) BBC TV Production for the Open University 'Engineering Mechanics: solids and fluids' (Available:).

Videorecording : Encyclopedia Britannica Educational Corporation, Castle Hill, NSW 'Flow Visualisation' (Available:).

Videorecording : Encyclopedia Britannica Educational Corporation, Castle Hill, NSW 'Fluid Dynamics of Drag: Part II' (Available:).

Videorecording : Encyclopedia Britannica Educational Corporation, Castle Hill, NSW 'Funda mentals of Boundary Layers' (Available:).

Videorecording : Encyclopedia Britannica Education Corporation, Castle Hill, NSW 'Low Reynolds Number Flow' (Available:).

Videorecording : National Committee for Fluid Mechanics Films, Encyclopedia Britannica 'Pressure Fields and Fluid Acceleration' (Available:).

White, FM 2003, *Fluid Mechanics*, 5th edn, McGraw-Hill, New York.

STUDENT WORKLOAD REQUIREMENTS

ACTIVITY	HOURS
Assessment	45.00
Directed Study	65.00
Examinations	2.00
Private Study	58.00

ASSESSMENT DETAILS

Description	Marks out of	Wtg(%)	Due date
HOMEWORK	100.00	20.00	24 Jul 2006 (see note 1)
ASSIGNMENT 1	100.00	15.00	04 Sep 2006
ASSIGNMENT 2	100.00	15.00	16 Oct 2006
2HR OPEN EXAMINATION	100.00	50.00	END S2 (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 the 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 of the assessment items satisfactorily, students must obtain at least 50% of the marks available for each assessment 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. Students who do not qualify for a Passing grade may, at the discretion of the Examiner, be awarded a Supplementary Examination and/or assigned additional work to demonstrate to the Examiner that they have achieved the required standard. It is expected that such students will have gained at least 45% of the total marks available for all 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 obtained for each of the summative assessment items in the course.

6 Examination information:
In an Open Examination, candidates may have access to any material during the examination except the following: electronic communication devices, bulky materials, devices requiring mains power and material likely to disturb other students.

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 examnination, 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 Deferred or Supplementary 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

1 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.

2 Students must retain a copy of each item submitted for assessment. If requested, students will be required to provide a copy of assignments submitted for assessment purposes. Such copies should be despatched to USQ within 24 hours of receipt of a request being made.

3 In accordance with University policy, the Examiner may grant an extension of the due date of an assignment in extenuating circumstances.

OTHER REQUIREMENTS

1 Students will need reliable regular access to e-mail and Internet for this course, and it is required that external students enrolled in this course, establish an electronic contact with the lecturer at their earliest opportunity, during the first week of studies. External students must communicate with the lecturer weekly (while e-mail is a preferable option, fax and phone exchanges can be used as well). Refer to the Lecturer's Contacts information in the Introductory Book.
