



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: Harmony of Partial Differential Equations

| Subject | Cat-nbr | Class | Term    | Mode | Units | Campus    |
|---------|---------|-------|---------|------|-------|-----------|
| MAT     | 3105    | 62746 | 1, 2007 | ONC  | 1.00  | Toowoomba |

|                                   |        |
|-----------------------------------|--------|
| <b>Academic group:</b>            | FOSCI  |
| <b>Academic org:</b>              | FOS003 |
| <b>Student contribution band:</b> | 2      |
| <b>ASCED code:</b>                | 010101 |

### STAFFING

Examiner: Dmitry Strunin

### REQUISITES

Pre-requisite: MAT2100

### RATIONALE

This course develops methods needed to apply the mathematics of partial differential equations. An understanding of their qualitative behaviour provides a structure for the analysis of wide ranging problems. The methods of systematic approximation introduced with Fourier series and power series. Computer algebra is a necessary tool of modern mathematics which is here introduced to perform routine tedious algebra. The application of conservation principles in mechanics enable the modelling of physical problems as partial differential equations.

### SYNOPSIS

This course establishes properties of the basic partial differential equations (PDEs) that arise commonly in applications such as the heat equation, the wave equation and Laplace's equation. It also develops the mathematical tools of Fourier transforms and special functions necessary to analyse such PDEs. The theory of infinite series is used to introduce special functions for solutions of ODEs and the general Sturm-Liouville theory. These methods are implemented in computer algebra. A modelling part introduces the use of partial differential equations to mathematically model the dynamics of cars, gases and blood. The analysis is based upon conservation principles, and also emphasises mathematical and physical interpretation. This course is offered only in even numbered years.

### OBJECTIVES

On completion of this course students will be able to:

1. classify partial differential equations; (on campus students - assignment 1, workshops; external students - assignment 1)

2. use separation of variables to solve basic partial differential equations; (on campus students - assignments 2, 3, exam, workshops; external students - assignments 2, 3, exam)
3. construct special functions needed to understand differential equations; (on campus students - assignment 2, exam, workshops; external students - assignment 2, exam)
4. work with infinite series in one or many dimensions; (on campus students - assignments 1, 2, 3, exam, workshops; external students - assignments 1, 2, 3, exam)
5. investigate the convergence of a Taylor series; (on campus students - assignment 1, workshops; external students - assignment 1)
6. find approximate power series solutions of differential equations; (on campus students - assignment 1, exam, workshops; external students - assignment 1, exam)
7. use Fourier analysis to approximate periodic functions and to help solve differential equations; (on campus students - assignments 1, 2, exam, workshops; external students - assignments 1, 2, exam)
8. use computer packages to perform tedious algebraic manipulations; (on campus students - assignment 3, workshops; external students - assignment 3)
9. appreciate the properties of the families of special functions engendered from differential equations; (on campus students - assignments 2, 3, exam, workshops; external students - assignments 2, 3, exam)
10. use conservation principles to mathematically model one-dimensional dynamics of car traffic, gas and blood flow. (on campus students - assignment 3, exam, workshops; external students - assignment 3, exam)

## TOPICS

|    | Description   | Weighting (%) |
|----|---|---------------|
| 1. | Fourier Analysis: Fourier series for functions with arbitrary period; half-range expansions; Fourier integrals; approximation by eigenfunction expansions; computer algebra; evaluates integrals.   | 16.00         |
| 2. | Classify Partial Differential Equations: PDE's model physical systems; the wave equation; the heat equation; Laplace's equation; classification of PDE's; waves on a membrane.  | 16.00         |
| 3. | Series Solutions of Differential Equations: power series, radius and interval of convergence; Power series method leads to Legendre polynomials; Frobenius methods is needed for Bessel functions; orthogonal solutions to second order differential equations; orthogonal eigenfunction expansions; computer algebra for repetitive tasks. | 20.00         |
| 4. | Methods for PDEs: circular membranes and Bessel functions; Laplacian in polar and spherical coordinates.  | 16.00         |
| 5. | Describing the conservation of material: the motion of a continuum, Eulerian description, the material derivative, conservation of material, car traffic & nonlinear characteristics.   | 18.00         |
| 6. | Dynamics of momentum: conservation of momentum, sound in ideal gases, dynamics of quasi-one-dimensional blood flow.   | 14.00         |

## **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).

Access to computer or internet facilities for computer algebra

Introductory Book 2006, *Course MAT3105 Harmony of Differential Equations*, USQ Distance Education Centre, Toowoomba.

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

Roberts, A.J 1994, *A one-dimensional introduction to continuum mechanics*, New Scientific, Singapore.

Selected Readings 2006, *Course MAT3105 Harmony of Differential Equations*, USQ Distance Education Centre, Toowoomba.

Study Book 2006, *Course MAT3105 Harmony of Differential Equations*, USQ Distance Education Centre, Toowoomba.

## **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.

Department of Mathematics and Computing CDROM SET 1, 2006 (available from the USQ Bookshop). This CD set contains course material, Windows and Linux Software relevant to this course offering only. For more information about the CD sets and their use, please refer to <http://www.sci.usq.edu.au/cdrom> and the course web site.

Some electronic resources for this course may be available via its home page:  
<http://www.sci.usq.edu.au/courses/mat3105>

Haberman, R 1998, *Elementary applied partial differential equations*, 3rd edn, Prentice-Hall,

Highham, N.J 1998, *Handbook of writing for the mathematical sciences*, 2nd edn, SIAM,

## **STUDENT WORKLOAD REQUIREMENTS**

| ACTIVITY      | HOURS |
|---------------|-------|
| Assessment    | 30.00 |
| Examinations  | 2.00  |
| Lectures      | 48.00 |
| Private Study | 89.00 |

## ASSESSMENT DETAILS

| Description          | Marks out of | Wtg(%) | Due date               |
|----------------------|--------------|--------|------------------------|
| WORKSHOPS            | 100.00       | 9.00   | 06 Mar 2006            |
| ASSIGNMENT 1         | 100.00       | 9.00   | 07 Apr 2006            |
| ASSIGNMENT 2         | 100.00       | 9.00   | 05 May 2006            |
| ASSIGNMENT 3         | 100.00       | 9.00   | 02 Jun 2006            |
| 2HR OPEN EXAMINATION | 64.00        | 64.00  | END S1<br>(see note 1) |

### NOTES

1. 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:  
Not applicable.
- 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 a passing grade, students must demonstrate that they have achieved the required minimum standards in relation to the objectives of the course by obtaining at least 50% of the total (weighted) marks over all assessments.
- 5 Method used to combine assessment results to attain final grade:  
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 assessment items will be reviewed with reference to the course's objectives and a scaling decided; the scaled marks then determine the final grade.
- 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:  
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.