Course Code: MATH3402
Course Title: Functional Analysis
Semester 1 2006

1. GENERAL COURSE INFORMATION

Brief description of course content:

The subject aims to introduce students to rigorous examination of some basic concepts of Functional Analysis: Metric spaces; elements of topology; compactness; completeness; contraction mapping principle; theorems on continuity & compactness. Normed, Banach & Hilbert spaces: strong & weak convergence; orthogonal systems; orthogonal complements; Riesz representation theorem. General topological spaces

Staff:

Lecturers:

Name  Dr Min-Chun Hong

Campus: St Lucia
Room number/ Building : Room 67-549, Priestley Building
Phone number: 334-69036
Email: hong@maths.uq.edu.au
Consultation hours or Office hours: 2pm-4pm, Thursday

Tutorial Coordinator: Dr Min-Chun Hong

Web page  The course profile and course material can be found on the web at the following address:  http://www.maths.uq.edu.au/courses/MATH3402

This also contains up-to-date news about the course material and announcements for students. Please check this regularly during the semester.

Class contact hours:   eg 3L, 1T

Timetable:  
Timetables are available on mySI-net.
Assumed background:

It is assumed that students know how to know the definition of the limit of a sequence and a continuous function. It is a student’s own responsibility to fill in any gaps in their assumed knowledge.

- You should have completed courses (MATH2000 or MP204 or 274 or MT250 or 252) + (MATH2400 or MP212 or 282 or MT251)
- You may need to do background reading to understand the lecture materials

2. AIMS, OBJECTIVES AND GRADUATE ATTRIBUTES

Course Aims:

The subject aims to introduce students to rigorous examination of some basic concepts of Functional Analysis: Countability and Density, Metric spaces; elements of topology; General topological spaces, Hausdorff Space; compactness; completeness; contraction mapping principle; theorems on continuity & compactness. Normed, Banach & Hilbert spaces: strong & weak convergence; orthogonal systems; orthogonal complements.

Learning Objectives:
On successfully completing this course students will be able to:

- understand the definition of Sets, Metric space and Topological Spaces.
- obtain a sound knowledge of open sets, closed sets, compactness and completeness in Metric space and Topological Spaces
- understand the proof of the contraction mappings principle.
- prove the existence of solutions of ordinary differential equations by the contraction mappings principle
• understand the basic concepts about Normed Linear Spaces and Inner Product Spaces

Graduate Attributes:

For more information on the University policy on development of graduate attributes in courses, refer to the web [http://www.uq.edu.au/hupp/contents/view.asp?si=3&s2=20&s3=5](http://www.uq.edu.au/hupp/contents/view.asp?si=3&s2=20&s3=5)

The following graduate attributes will be developed in the course –

In-Depth Knowledge of the Field of Study:

• A comprehensive and well-founded knowledge of the field of study: - through solving problems.
• An understanding of how other disciplines relate to the field of study: - through applying the mathematical techniques of the course to simple problems from other disciplines.
• An international perspective on the field of study: - through using internationally accepted standards of mathematical rigour and notation.

Effective Communication:

• The ability to collect, analyse, and organise information and ideas, and to convey those ideas clearly and fluently, in both written and spoken forms: - through tutorial participation.
• The ability to interact effectively with others in order to work towards a common outcome: - through cooperative learning strategies in tutorials.
• The ability to select and use the appropriate level, style and means of communication: - through assignments and tutorials.
• The ability to engage effectively and appropriately with information and communication technologies: - through practical use of pen, ink, and computers.

Independence and Creativity:

• The ability to work and learn independently: - through assignments and tutorials.
• The ability to generate ideas and adapt innovatively to changing environments: - through solving problems.
• The ability to identify problems, create solutions, innovate and improve current practices: - through assignments and tutorials.

Critical Judgement:

• The ability to define and analyse problems: - through solving problems.
• The ability to apply critical reasoning to issues through independent thought and informed judgement:- through solving problems in assignments and tutorial questions.
• The ability to evaluate opinions, make decisions and to reflect critically on the justifications for decision:- through learning lectures.

Ethical and Social Understanding:

• An understanding of social and civic responsibility - through cooperative learning strategies in tutorials and lectures
• An appreciation of the philosophical and social contexts of a discipline:- through the experience of a discipline where the concepts of right and wrong are supported by universal and absolute standards
• A knowledge and respect of ethics and ethical standards in relation to a major area of study-through tutorial participation in a subject taken by students with diverse backgrounds and interests
• A knowledge of other cultures and times and an appreciation of cultural diversity-through tutorial participation in a subject taken by students with diverse backgrounds and interests

For more information on the University policy on development of graduate attributes in courses, refer to the web http://www.uq.edu.au/hupp/contents/view.asp?s1=3&s2=20&s3=5

3. LEARNING RESOURCES

Required Resources:
No textbook.

Recommended Resources:

The University offers a range of resources and services to support student learning. Details are available on the myServices website (https://student.my.uq.edu.au/)

Library contact:
The liaison librarian for the physical sciences disciplines is located in the Physical Sciences and Engineering Library in the Hawken Building and may be consulted for assistance in the course:

Leith Woodall
Email: l.woodall@library.uq.edu.au
Extension: 52367
4. TEACHING AND LEARNING ACTIVITIES

Three hours of lectures and one hour of tutorials per week. There are no tutorials in week 1 and week 13. An extra tutorial in week 13 can be held by special arrangements with lecturer. Students should attend all their lectures. Since the theory presented in this course is developed logically, it is necessary to study lecture notes from previous lectures prior to attending each subsequent lecture. By following this procedure, you will find this course both enjoyable and informative.

There are 9 tutorial sheets. Tutorial sheets will be handed out in lectures. Solutions to tutorial problems will be available in the following week at tutorials. You should aim to do as many problems as possible on the tutorial sheet before the tutorial and ask about anything you do not understand at the tutorial and lecture.

If you do not work through the tutorial sheets, then you will have difficulty with the assignments. You can get help with any difficulties from lecturer (or another student) at the tutorials. But check you understand the answers to the problems by writing out your own solution by yourself. (Students who work through the problems and make sure they understand any slips they made are very unlikely to have problems with this subject.) Although we are happy to give help on the tutorial sheets, lecturer will not give help on the assignments that are to be handed in. These should be entirely your own work.

Questions can be answered outside tutorial hours by visiting the lecturer in their contact hours.

5. ASSESSMENT

Required assessment tasks:

The assessment will be based on two assignments each worth 20 marks, and an end of semester examination. The final exam 60 marks.

<table>
<thead>
<tr>
<th>Assessment Item</th>
<th>%</th>
<th>Due date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1 (due to week 7)</td>
<td>20%</td>
<td>13 April</td>
</tr>
<tr>
<td>Assignment 2 (due week 12)</td>
<td>20%</td>
<td>26 May</td>
</tr>
<tr>
<td>The end of semester exam (departmental)</td>
<td>60%</td>
<td>June</td>
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Assignments
There will be two assignments containing problems that demand analytical solution. The assignments will be available on the web at least 2 weeks before they are due, and are to be submitted at the end of weeks 7 and 13. Students should solve the assignments on their own, without the direct assistance of lecturers, or other students. Students whose solutions are copied from other students are violating the University’s plagiarism policy (given below); even if they rewrite the solution sentence by sentence, or change notation in the mathematics or code. Students who copy solutions from the web or from books without referencing the original source are violating the University’s policy on plagiarism (given below). Students whose work does not display an independent approach in an assignment will not receive credit for the assignment.

- Marks are awarded for correctness and clarity of presentation. One bonus mark per assignment may be awarded for innovative solutions. Part marks will be awarded for the successful completion of subtasks.

- **If you miss an assessment item:** In case of illness (or bereavement) you may be exempted from an assignment if a medical certificate (or other documentation) is received by the course co-ordinator within one week of the due date of the assignment. If you are exempted, then your assignment marks are weighted on a pro-rata basis. Note that ad hoc excuses (car trouble and the like!) will not be accepted; only documentation in connection with illness or bereavement. If you enrolled late then exemption will automatically be granted for anything missed before the date of enrolment.

- **Missed assignments items:** Failure to submit any assignment before due date will result in a mark for zero for that component.

### Final Exam

There will be a closed-book two-hour exam in the examination period at the end of first semester (June 2006). The *final exam counts 60%* towards the final mark.

- The exam will cover material from the entire semester.

The lecture notes and tutorial sheets are not allowed for the final exam. Any pocket calculators are permitted but contents of memory must be erased.

### Assessment criteria

Answers to written examination questions for the final examination will be assessed in terms of the extent to which they demonstrate the ability of the student:

- Define, explain and interrelate main concepts involved in the course.
- Present proofs of the key theorems developed in the course.
- Apply the theory to solve some practical questions.

Answers to both assignments will be assessed in terms of which they demonstrate the ability to apply theory to solve some practical questions.
Criteria for the award of grades:

Grades will be awarded according to the following scale:

- 1% - 24% marks grade 1
- 25% - 44% marks grade 2
- 45% - 49% marks grade 3
- 50% - 64% marks grade 4
- 65% - 74% marks grade 5
- 75% - 84% marks grade 6
- 85% - 100% marks grade 7

Your grade for this course will be determined by which of the following levels of achievement that you consistently display in the items of summative assessment.

Grade of 7: (85% - 100%) the student demonstrates an excellent understanding of the theory of the topics listed in the course outline and is highly proficient in applying the techniques to solve both theoretical and practical problems.

Grade of 6: (75% - 84%) the student demonstrates a comprehensive understanding of the theory of the topics listed in the course outline and is proficient in applying the techniques to solve both theoretical and practical problems.

Grade of 5: (65% - 74%) the student demonstrates a good understanding of the theory of the topics listed in the course outline and can apply the techniques to solve problems.

Grade of 4: (50 – 64%) the student demonstrates an understanding of the theory of the topics listed in the course outline and demonstrates a knowledge of the techniques used to solve problems.

Grade of 3: (45% - 49%) the student demonstrates some understanding of the theory of the topics listed in the course outline and demonstrates some knowledge of the techniques used to solve problems, but fails to satisfy all of the basic requirements for a pass.

Grade of 2: (25 – 44%) the student demonstrates limited understanding of the theory of the topics listed in the course outline and demonstrates limited knowledge of the techniques used to solve problems. This includes attempts at expressing their deductions and explanations and attempts to answer a few questions accurately.

Grade of 1: (1 – 24%) the student demonstrates very limited understanding of the theory of the topics listed in the course outline and of the basic concepts in the course material. This includes attempts at answering some questions but demonstrating very limited understanding of the key concepts.

6. POLICIES & GUIDELINES
Assessment policy:

As solutions to assignments are distributed promptly, credit cannot be given for late assignments. Students who miss assignments through bereavement, ill health, or other serious unavoidable problems should document their problems and discuss this with Min-Chun Hong. An alternative assessment scheme may be negotiated with the student.

Allowance cannot be made for reasons such as sporting fixtures (unless you are representing Queensland or Australia in open competition), social commitments (unless at least one Hilton sister will be present), or overwork in other courses.

Students should be familiar with the rules which relate to assessment in their degrees as well as general university policy such as found in the General Award Rules. These are all set out on the myAdvisor page on the UQ website http://www.uq.edu.au/student/GeneralRules2006/2006GARs.htm

Plagiarism:

The University has adopted the following definition of plagiarism:

“Plagiarism is the action or practice of taking and using as one’s own the thoughts or writings of another, without acknowledgment. The following practices constitute acts of plagiarism and are a major infringement of the University's academic values:

- Where paragraphs, sentences, a single sentence or significant parts of a sentence are copied directly, and are not enclosed in quotation marks and appropriately footnoted;
- Where direct quotations are not used, but are paraphrased or summarised, and the source of the material is not acknowledged either by footnoting or other simple reference within the text of the paper; and
- Where an idea which appears elsewhere in printed, electronic or audio-visual material is used or developed without reference being made to the author or the source of that material.”

When a student knowingly plagiarises someone’s work, there is intent to gain an advantage and this may constitute misconduct.

Students are encouraged to study together and to discuss ideas, but this should not result in students handing in the same or similar assessment work. Do not allow another student to copy your work. While students may discuss approaches to tackling a tutorial problem, care must be taken to submit individual and different answers to the problem. Submitting the same or largely similar answers to an assignment or tutorial problem may constitute misconduct.
The results of the assessment may be annulled and other action may be taken as is considered appropriate in the circumstances of the case.

For more information on the University policy on plagiarism, please refer to http://www.uq.edu.au/hupp/index.html?page=25128&pid=25075

Supplementary examinations:

A supplementary examination may be awarded in one course to students who obtain a grade of 2 or 3 in the final semester of their program and require this course to finish their degree. You should check the rules for your degree program for information on the possible award of supplementary examinations. Applications for supplementary examinations must be made to the Director of Studies in the Faculty.

Special examinations:

If a student is unable to sit a scheduled examination for medical or other adverse reasons, she/he can and should apply for a special examination. Applications made on medical grounds should be accompanied by a medical certificate; those on other grounds must be supported by a personal declaration stating the facts on which the application relies.

Applications for special examinations for central and end-of-semester exams must be made through the Student Centre. Applications for special examinations in school exams are made to the course coordinator.

More information on the University’s assessment policy may be found http://www.uq.edu.au/hupp/index.html?page=25109&pid=25075

EPSA Faculty policy on the award of special and supplementary exams may be found via the Faculty Guidelines on Examinations from the EPSA student page http://www.epsa.uq.edu.au/index.html?page=9329&pid=0 for special exams and http://www.epsa.uq.edu.au/index.html?page=7675&pid=0 for supplementary exams.

Feedback on assessment:

You may request feedback on assessment in this course progressively throughout the semester from the course coordinator. Feedback on assessment may include discussion, written comments on work, model answers, lists of common mistakes and the like.

Students may peruse examinations scripts and obtain feedback on performance in a final examination provided that the request is made within six months of the release of final course results. After a period of twelve months following the release of results, examination scripts may be destroyed.

Information on the University’s policy on access to feedback on assessment may be found at http://www.uq.edu.au/hupp/index.html?page=25114&pid=25075

EPSA Faculty policy on assessment feedback and re-marking may be found at
Students with disabilities:

Any student with a disability who may require alternative academic arrangements in the course is encouraged to seek advice at the commencement of the semester from a Disability Adviser at Student Support Services. Refer to the University policy – Students with A Disability (Disability Action plan) HUPP 3.40.6

Assistance for Students:

Students with English language difficulties should contact the course coordinator or tutors for the course.

Students with English language difficulties who require development of their English skills should contact the Institute for Continuing and TESOL Education on extension 56565.

The Learning Assistance Unit located in the Relaxation Block in Student Support Services. You may consult learning advisers in the unit to provide assistance with study skills, writing assignments and the like. Individual sessions are available. Student Support Services also offers workshops to assist students. For more information, phone 51704 or on the web http://www.sss.uq.edu.au/index.html.

Student Liaison Officer:

The School of Physical Sciences has a Student Liaison Officer as an independent source of advice to assist students with resolving academic difficulties.

The Student Liaison officer during 2006 will be Dr Peter Adams, Room 547 Priestley Building, (email pa@maths.uq.edu.au)

Other Policies and Guidelines:

Working with Children: Students who will be required to work with children as part of their studies should refer to the University policy – Working with Children Check – “Suitability Card” HUPP 1.60.7

Occupational Health and Safety: Students should be familiar with the University policy on Occupational Health and Safety in the Laboratory (Undergraduate Student) HUPP 2.30.14

Course Learning Summary:

Week plan for the semester is
• Week 1: Introduction
• Week 2: Countability and Density
• Week 3: Limits and Continuity
• Week 4: Metrics
• Week 5: Metric Space Topology
• Week 6: Compactness
• Week 7: Topological Spaces and Topological Spaces (cont)
• week 8: Topological Spaces (iii) and Hausdorff Spaces
• week 9 Completeness
• Week 10: Contraction mappings and
• Week 11: Contraction mappings - examples and applications
• Week 12. Normed Linear Spaces
• Week 13. Inner Product Spaces