About This Unit

Unit Description:

This unit provides a rigorous mathematical development of compound interest theory, using calculus where appropriate. Topics include the force of interest and its relationship to interest rates, inflation and capital gains tax, discrete and continuous term certain annuities, project appraisal, loans, bonds, yield curves, matching and immunisation, pricing by the 'no arbitrage' assumption and forward rate agreements. Students are assumed to be able to use the basic functionality of a spreadsheet package of their choice.

Unit rationale:

Much of the work that actuaries do involves long term financial problems. For any problem spanning more than a few months, the effects of compound interest are significant. This unit is a detailed study of compound interest. As far as possible, the examples considered are real life problems, though in some cases we deliberately simplify scenarios so that we can concentrate on the interesting maths rather than getting distracted by fiddly details.

Teaching Staff

- Convenor and Lecturer: Jim Farmer

Contacting Staff

You are encouraged to seek help at a time that is convenient to you by using this unit’s iLearn web site, described later in this document.
• Questions about the unit material should be placed in the appropriate Forum in the unit’s web site.
• Administrative questions which have not already been answered in this document or the Student Guide should be sent to the unit’s Teaching Assistant using a Dialog in the unit’s web site.

CLASSES

• There are 5 hours of face-to-face teaching per week consisting of 3 hours of lectures and 2 hours of tutorial.
• Class times can be found at: http://www.timetables.mq.edu.au/
• In this unit, there are tutorials in Week 1.

REQUIRED AND RECOMMENDED TEXTS AND/OR MATERIALS

Lecture notes, tutorial exercises and readings are available on the unit’s web site.

The following is a list of all textbooks we are aware of that cover material from this unit, with their Macquarie University call numbers where appropriate.


Course notes for the UK Institute courses may be purchased from ActEd. (http://www.acted.com.au)

TECHNOLOGY USED AND REQUIRED

• You will require a calculator. For the test and the final exam, you may only use non-programmable calculators which are not able to store text.
• You may find it useful to be able to construct spreadsheets to verify your solutions to tutorial exercises. The assignment will also require construction of simple spreadsheets. We do not prescribe any particular brand of spreadsheet.

UNIT WEB PAGE

• Course material is available on iLearn.
• We use a course management system called Moodle. iLearn is the university’s chosen name for a suite of software packages including Moodle, eStudent, Turnitin and other components. In this unit, only the Moodle component is being used.
• You can login at https://ilearn.mq.edu.au/

LEARNING OUTCOMES

The learning outcomes of this unit are that students should be able to demonstrate a deep understanding of:
1. Compound interest theory in both discrete and continuous time
2. The use of annuities
3. The mathematics of loans
4. The mathematics involved in analysing investment projects
5. Valuation of securities, including the use of yield curves & use of the “no arbitrage” pricing method
6. Immunisation theory in the context of variations in interest rates.
7. The use of spreadsheets to efficiently solve computationally challenging problems

GRADUATE CAPABILITIES

In addition to the discipline-based learning objectives, all academic programs at Macquarie seek to develop the capabilities the University's graduates will need to develop to address the challenges, and to be effective, engaged participants in their world.

This unit contributes to this by developing the following graduate capabilities:

1 Discipline Specific Knowledge and Skills
   (a) Have an appreciation of the time value of money.
   (b) Be an expert in compound interest theory, in both discrete and continuous scenarios.
2 Critical, Analytical and Integrative Thinking
3 Problem Solving Capability
4 Effective Communication

LEARNING AND TEACHING ACTIVITIES

This unit is taught via lectures and tutorials. However, a significant amount of the lecture time will be spent on attempting problems. The emphasis is on learning by doing.
A detailed list of topics is provided at the end of this document.

**RESEARCH AND PRACTICE**

This unit uses research from external sources. While the mathematical techniques used in this unit are often quite complex, most were discovered over a century ago. Hence you can find the research we are using in the textbooks cited above, rather than needing to source recent research papers.

**RELATIONSHIP BETWEEN ASSESSMENT AND LEARNING OUTCOMES**

<table>
<thead>
<tr>
<th></th>
<th>Assessment Task 1</th>
<th>Assessment Task 2</th>
<th>Assessment Task 3</th>
<th>Assessment Task 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title/Name</strong></td>
<td>Online quizzes</td>
<td>Test</td>
<td>Assignment</td>
<td>Final Exam</td>
</tr>
<tr>
<td><strong>Description</strong></td>
<td>Early diagnostic tasks</td>
<td>Test held during class time</td>
<td>Spreadsheet assignment</td>
<td>More detail below</td>
</tr>
<tr>
<td><strong>Due date</strong></td>
<td>See iLearn for the exact dates.</td>
<td>Monday 20 August</td>
<td>Tuesday 16 October, 5pm.</td>
<td>Held during final exam period</td>
</tr>
<tr>
<td><strong>% Weighting</strong></td>
<td>0</td>
<td>10%</td>
<td>20%</td>
<td>70%</td>
</tr>
<tr>
<td><strong>Grading method</strong></td>
<td>Not applicable</td>
<td>To earn a particular grade you must meet the requirements of the definition of that grade.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Submission method</strong></td>
<td>Online</td>
<td>Not applicable</td>
<td>To lecturer during class or to E4A 616 at other times.</td>
<td>Not applicable</td>
</tr>
<tr>
<td><strong>Feedback (type, method, date)</strong></td>
<td>Immediate online feedback</td>
<td>Tasks will be returned at class as soon as possible. Test solutions, with comments on any common errors will be made available on the unit’s web site.</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td><strong>Estimated student workload (hours)</strong></td>
<td>6</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td><strong>Learning outcomes assessed</strong></td>
<td>1-4</td>
<td>1</td>
<td>1,4,7</td>
<td>1-6</td>
</tr>
<tr>
<td><strong>Graduate capabilities assessed</strong></td>
<td>1</td>
<td>1</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>
For task 3, extensions will only be granted in the event of valid special consideration requests being received. The assignment will provide more detail. No other late submissions will be accepted.

- Examinations

A final examination is included as an assessment task for this unit to provide assurance that:
  i) the product belongs to the student and
  ii) the student has attained the knowledge and skills tested in the exam.

A 3 hour final examination for this unit will be held during the University Examination period.

The University Examination period in Second Half Year 2012 is from Monday 12 November to Friday 30 November.

You are expected to present yourself for examination at the time and place designated in the University Examination Timetable. The timetable will be available in Draft form approximately eight weeks before the commencement of the examinations and in Final form approximately four weeks before the commencement of the examinations.

http://exams.mq.edu.au/

The only exception to not sitting an examination at the designated time is because of documented illness or unavoidable disruption. In these circumstances you may wish to consider applying for Special Consideration. The University’s policy on special consideration process is available at

http://www.mq.edu.au/policy/docs/special_consideration/policy.html

If a Supplementary Examination is granted as a result of the Special Consideration process the examination will be scheduled after the conclusion of the official examination period.

The Macquarie university examination policy details the principles and conduct of examinations at the University. The policy is available at:

http://www.mq.edu.au/policy/docs/examination/policy.htm

**Academic Honesty**

The nature of scholarly endeavour, dependent as it is on the work of others, binds all members of the University community to abide by the principles of academic honesty. Its fundamental principle is that all staff and students act with integrity in the creation, development, application and use of ideas and information. This means that:

- all academic work claimed as original is the work of the author making the claim
- all academic collaborations are acknowledged
- academic work is not falsified in any way
• when the ideas of others are used, these ideas are acknowledged appropriately.

Further information on the academic honesty can be found in the Macquarie University Academic Honesty Policy at http://www.mq.edu.au/policy/docs/academic_honesty/policy.html

**GRADES**

Macquarie University uses the following grades in coursework units of study:

- HD - High Distinction
- D - Distinction
- CR - Credit
- P - Pass
- F - Fail

Grade descriptors and other information concerning grading are contained in the Macquarie University Grading Policy which is available at: http://www.mq.edu.au/policy/docs/grading/policy.html

**GRADING APPEALS AND FINAL EXAMINATION SCRIPT VIEWING**

If, at the conclusion of the unit, you have performed below expectations, and are considering lodging an appeal of grade and/or viewing your final exam script please refer to the following website which provides information about these processes and the cut off dates in the first instance. Please read the instructions provided concerning what constitutes a valid grounds for appeal before appealing your grade.

http://www.businessandeconomics.mq.edu.au/new_and_current_students/undergraduate_current_students/how_do_i/grade_appeals

**SPECIAL CONSIDERATION**

The University is committed to equity and fairness in all aspects of its learning and teaching. In stating this commitment, the University recognises that there may be circumstances where a student is prevented by unavoidable disruption from performing in accordance with their ability. A special consideration policy exists to support students who experience serious and unavoidable disruption such that they do not reach their usual demonstrated performance level. The policy is available at: http://www.mq.edu.au/policy/docs/special_consideration/policy.html

**STUDENT SUPPORT SERVICES**

Macquarie University provides a range of Academic Support Services. Details of these and other services for students can be accessed at http://www.student.mq.edu.au.
**IT Conditions of Use**

Access to all student computing facilities within the Faculty of Business and Economics is restricted to authorised coursework for approved units. Student ID cards must be displayed in the locations provided at all times.

Students are expected to act responsibly when using University IT facilities. The following regulations apply to the use of computing facilities and online services:

- Accessing inappropriate web sites or downloading inappropriate material is not permitted. Material that is not related to coursework for approved units is deemed inappropriate.
- Downloading copyright material without permission from the copyright owner is illegal, and strictly prohibited. Students detected undertaking such activities will face disciplinary action, which may result in criminal proceedings.

Non-compliance with these conditions may result in disciplinary action without further notice.

Students must use their Macquarie University email addresses to communicate with staff as it is University policy that the University issued email account is used for official University communication.
### Detailed Schedule & List of Topics

<table>
<thead>
<tr>
<th>Week</th>
<th>Week Begins</th>
<th>Topics Covered in Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30 July</td>
<td>1. Interest Rates – Discrete time scenarios</td>
</tr>
</tbody>
</table>
| 2    | 6 August    | 2. Inflation and Capital Gains Tax  
|      |             | 3. Forces of Interest – Continuous time scenarios |
| 3    | 13 August   | 4. Level Annuities |
| 4    | 20 August   | 5. Varying Annuities  
|      |             | Monday: Test on Topics 1 to 3. |
| 5    | 27 August   | 6. Loans |
| 6    | 3 Sept      | 7. Project Appraisal |
| 7    | 10 Sept     | 9. Bonds |

2-week study break

<table>
<thead>
<tr>
<th>Week</th>
<th>Week Begins</th>
<th>Topics Covered in Lectures</th>
</tr>
</thead>
</table>
| 8    | 1 Oct       | 8. Measuring Investment Performance  
|      |             | Public holiday deletes Monday lectures |
| 9    | 8 Oct       | 10. Yield Curves |
| 10   | 15 Oct      | 11. Forward Contracts  
|      |             | Tuesday 5pm: Assignment due |
| 11   | 22 Oct      | 12. Bond Statistics |
| 12   | 29 Oct      | 13. Immunisation |
| 13   | 5 Nov       | 14. Summary of finance jargon |

The order of Topics 8 and 9 has been reversed to work around the public holiday.

**Detailed list of topics**

1. Compound interest; effective and nominal interest and discount rates; accumulating and discounting at constant and at discretely changing interest rates; simple interest and simple discount; valuation of single payment securities.

2. Inflation; real interest rates; CPI; capital gains tax based on real and nominal gains.

3. The force of interest; accumulating and discounting at continuously changing interest rates; valuing continuous cash flows; continuously removed interest.

4. Level annuities; \(a_n\), \(\bar{a}_n\), \(s_n\), \(\bar{s}_n\); \(a^{(p)}_n\), \(\bar{a}^{(p)}_n\), \(s^{(p)}_n\), \(\bar{s}^{(p)}_n\); limit properties linking discrete annuities to continuous annuities; perpetuities; deferred annuities; dealing with changing interest rates; use of \(i\), \(\bar{i}\), \(d^{(p)}\) and \(\bar{d}^{(p)}\) factors to adjust timing of cash flows.

5. Arithmetically varying annuities; 
\[ (Ia)_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n, (I\bar{a})_n; \] Geometrically varying annuities.

6. Loans; Interest only loans; Reducible Rate loans; Loan repayment schedules; Finding instalments and loan outstanding; dealing with changes in interest rates by
adjusting repayments or by adjusting the term of the loan; the legislation banning flat rate loans.

7. Project Appraisal; IRR; NPV; discounted payback period; problems involving different interest rates on loans and deposits; deficiencies of IRR for project assessment.

8. Money weighted rates of return and time weighted rates of return; calculation from accounts and from unit-pricing system data; linked rates of return.

9. Bonds: Face value; coupon rate; maturing at a premium or discount; valuing with and without allowance for tax given a yield to maturity; calculating yield to maturity given price; indexed (capital) bonds; purchasing cum and ex interest.

10. Yield Curves; spot rates and forward rates; calculations using the no-arbitrage assumption; valuation of bonds using spot rates; spot rate yield curve; par bond yield curve.

11. Forward contracts; derivation of formula for the forward price & the value of an existing contract under the no-arbitrage assumption; allowance for fixed dollar income on the security prior to delivery date; assumptions and limitations of the no-arbitrage model.

12. Bond statistics; Theoretical definitions and practical approximations for calculating: discounted mean term, duration, volatility, modified duration, convexity, $M^2$ or spread.

13. Absolute immunisation and Redington immunisation; derivation of formula and worked examples with fixed and certain liabilities and government bonds.