

MACQUARIE  
UNIVERSITY



FACULTY OF  
BUSINESS AND ECONOMICS

ACST202  
Mathematics of Finance

Semester 1, 2011

*Department of Applied Finance and Actuarial  
Studies*

**MACQUARIE UNIVERSITY  
FACULTY OF BUSINESS AND ECONOMICS  
UNIT GUIDE**

**Year and Semester: Semester 1 2011**

**Unit convenor: Jim Farmer**

**Prerequisites:** ACST101(Cr) and MATH133(P) and a GPA of at least 2.50.

**Credit points: 3**

Lectures are shared with the postgraduate unit ACST851.

Students in this unit should read this unit guide carefully at the start of semester. It contains important information about the unit. If anything in it is unclear, please consult one of the teaching staff in the unit.

#### **ABOUT THIS UNIT**

Unit Description:

The unit develops the techniques required to deal with compound interest problems which are more complex than those discussed in ACST101. Topics include the force of interest and its relationship with the annual rate of compound interest; loans repayable by instalments of principal and interest; the effect of income and capital gains tax; the use of discounted cash flow techniques in product appraisal; simple stochastic interest rate models; unit-pricing systems; yield curves, matching or immunisation; forward rate agreements; pricing using the no-arbitrage assumption. It is assumed students are able to use spreadsheets.

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

#### **CONSULTATION METHOD**

Use the unit's web site.

- Questions about the unit material should be placed in the Discussion Area.

- Administrative questions which have not already been answered in this document or the Student Guide should be sent to the “Administration Inquiries” account using the mail tool in the unit’s web site.

Tutors cannot be contacted other than during tutorials.

## CLASSES

There are 4 hours of face-to-face teaching per week consisting of 3 hours of lectures and 1 hour of tutorial.

Class times can be found at: <http://www.timetables.mq.edu.au/>

In this unit, there are no tutorials in Week 1.

Since all ACST202 tutorials are scheduled at the same time, we take the opportunity to stream the classes based on past performance. Ignore the tute location you selected in eStudent. Check the unit’s web site around Thursday of Week 1 to find the location of your tutorial.

## 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.

- Broverman, Samuel. “Mathematics of Investment & Credit” 3rd Edition. Mad River Books. (<http://www.actexmadriv.com>) HG4515.3.B76/2004. (2nd edition: HG4515.3.B76/1996.)
- Daniel, James W and Vaaler, Leslie J F. “Mathematical Interest Theory”. Pearson Prentice Hall. 2007. HB539.D33/2007.
- Donald D.W.A. “Compound Interest and Annuities Certain” 1970. Heinemann HG8790.D65/1970. Out of print. (While this book is dated 1970, the section explaining how to use hand-cranked calculating machines suggests this edition wasn’t significantly updated from the earlier 1953 edition. Given the existence of cheap electronic calculators, many of the techniques described in this book are now irrelevant.)
- Kellison, Stephen G. “The Theory of Interest” Irwin, HB539.K28/1991
- Knox, Zima and Brown. “Mathematics of Finance” 2nd Edition. McGraw Hill. HF5691.K56/1999 (This book does not cover any significant amount of ACST200 material, but is useful for revising ACST101 material.)
- McCutcheon, J.J. and Scott W.F. “An Introduction to the Mathematics of Finance” Heinemann. 1986. HF5691.M27. (Available for purchase via <http://wam.actuaries.org.uk>.)
- Sherris, Michael. “Money and Capital Markets” 2nd Edition. HG4515.S54
- Course notes for the UK courses may be purchased from ActEd. (<http://www.acted.com.au>)

## **TECHNOLOGY USED AND REQUIRED**

- You will require a calculator. Calculators which can store text may not be used in the tests or exam.
- You may find it useful to be able to construct spreadsheets to verify your solutions to tutorial exercises. We do not prescribe any particular brand of spreadsheet.

## **UNIT WEB PAGE**

- Course material is available on the learning management system (BlackBoard)
- You can login at <http://learn.mq.edu.au>

## **LEARNING OUTCOMES**

The learning outcomes of this unit are:

- 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 fixed interest securities, including the use of yield curves.
  6. The “no arbitrage” pricing method
  7. Immunisation theory in the context of variations in interest rates.

## **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 and Research Capability
- 4 Effective Communication

## **TEACHING AND LEARNING STRATEGY**

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.

Students are expected to make a serious attempt at all tutorial problems prior to the relevant tutorial.

Week	Week Begins	Topics Covered
1	21 Feb	1. Interest Rates – Discrete time scenarios 2. Inflation and Capital Gains Tax
2	28 Feb	3. Forces of Interest – Continuous time scenarios
3	7 March	4. Level Annuities
4	14 March	5. Varying Annuities Thursday: Test on Topics 1 to 3.
5	21 March	6. Loans
6	28 March	7. Project Appraisal Thursday: Test on Topics 4 and 5.
7	4 April	8. Measuring Investment Performance
2-week study break		
8	25 April	9. Bonds Monday public holiday deletes tute
9	2 May	10. Yield Curves
10	9 May	11. Forward Contracts
11	16 May	12. Bond Statistics
12	23 May	13. Immunisation
13	30 May	

#### 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;  $a_{\overline{n}|}, \ddot{a}_{\overline{n}|}, \bar{a}_{\overline{n}|}$ ;  $s_{\overline{n}|}, \ddot{s}_{\overline{n}|}, \bar{s}_{\overline{n}|}$ ;  $a_{\overline{n}|}^{(p)}, \ddot{a}_{\overline{n}|}^{(p)}, s_{\overline{n}|}^{(p)}, \ddot{s}_{\overline{n}|}^{(p)}$ ; limit properties linking discrete annuities to continuous annuities; perpetuities; deferred annuities; dealing

with changing interest rates; use of  $\frac{i}{i^{(p)}}$ ,  $\frac{i}{d^{(p)}}$  and  $\frac{i}{\delta}$  factors to adjust timing of cash flows.

5. Arithmetically varying annuities;

$(Ia)_{\overline{n}|}, (I\ddot{a})_{\overline{n}|}, (I\bar{a})_{\overline{n}|}, (\bar{I}\bar{a})_{\overline{n}|}, (Is)_{\overline{n}|}, (I\ddot{s})_{\overline{n}|}, (I\bar{s})_{\overline{n}|}, (\bar{I}\bar{s})_{\overline{n}|}$ ; 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; Hardy's formula; 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.

#### RELATIONSHIP BETWEEN ASSESSMENT AND LEARNING OUTCOMES

	<b>Assessment Task 1</b>	<b>Assessment Task 2</b>	<b>Assessment Task 3</b>	<b>Assessment Task 4</b>
Title/Name	Online quizzes	Test 1	Test 2	Final Exam
Description	Early diagnostic tasks	Tests held during class time		Held during final exam period
Due date	Available from start of classes	See timetable above		
% Weighting	0	15%	15%	70%
Grading method	Not applicable	To earn a particular grade you must met the requirements of the definition of that grade.		
Submission method	Online	Not applicable		

	<b>Assessment Task 1</b>	<b>Assessment Task 2</b>	<b>Assessment Task 3</b>	<b>Assessment Task 4</b>
Feedback ( <i>type, method, date</i> )	Immediate online feedback	Tests will be returned as soon as possible		Not applicable
Estimated student workload (hours)	30 minutes per quiz	Tests run approximately 40 minutes		3 hours plus 10 minutes reading time
Learning outcomes assessed				
1	√	√	√	√
2	√		√	√
3	√			√
4	√			√
5				√
6				√
Graduate capabilities assessed				
1(a)	√	√	√	√
1(b)	√	√	√	√
2			√	√
3			√	√
4			√	√

- 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 First Half Year 2011 is from 6 June to 24 June.

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://www.timetables.mq.edu.au/exam>

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](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>  
This policy also applies to the class test.

## **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](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.businessandconomics.mq.edu.au/new\\_and\\_current\\_students/undergraduate\\_current\\_students/how\\_do\\_i/grade\\_appeals](http://www.businessandconomics.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/procedure.html](http://www.mq.edu.au/policy/docs/special_consideration/procedure.html)

### **STUDENT SUPPORT SERVICES**

Macquarie University provides a range of Academic Student Support Services. Details of these services 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 utilising 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 unit 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.