

Division of Economic and Financial Studies  
Actuarial Studies Department



ACST305/858

Quantitative Methods for Asset-Liability Management

SECOND SEMESTER 2007

UNIT OUTLINE

Teaching Staff Involved in the Unit

The staff involved in the teaching of this unit are

Staff Member	Email	Telephone	Room
<b>Dr Jiwook Jang</b> (Unit Co-ordinator)	jjang@efs.mq.edu.au	9850 8575	E4A 613
<b>Brian Chu</b> (Lecturer/Tutor)	bchu@efs.mq.edu.au	9850 8455	E4A 609
<b>Michael Sciancalepore</b> (Unit Administrator)	mscianca@efs.mq.edu.au		E4A 622A

Academic queries should be directed to the Unit Co-ordinator. All non-academic queries should be addressed to the Unit Administrator. All questions should be initially posted on WebCT.

Unit Details

Unit Name: Quantitative Methods for Asset-Liability Management

Credit Points: 4

Prerequisites: ACST200(P) or ACST201(P); STAT272(P); COMP124 or COMP125 or COMP115 or COMP155 or COMP165

Please consult the Unit Co-ordinator if you do not meet any of the prerequisite requirements for the unit. **ACST858 does not have formal pre-requisites, but STAT810 and ACST851 is highly desirable.**

### **Unit Description**

This unit aims to introduce students to Brownian motion, stochastic calculus, derivatives pricing, interest rate models, credit risk models, financial market theory and portfolio management.

Insurance companies or superannuation funds receive money from their policyholders and fund members which is invested in order to meet the future liabilities. Often, the accumulated sum is substantial and hence a well-coordinated investment strategy needs to be in place. This requires a strong understanding of the financial markets and the behaviour of the participants; knowledge of the different financial instruments available and how they are priced and being familiar with the various financial models that are used in practice.

The first two weeks of the course will cover random walk, Brownian motion, martingale, stochastic calculus and Ito's lemma. These are essential to know to learn derivatives pricing starting week 3. We introduce the concept of forward, futures and options and their pricing. The binomial lattice model is first used as a method of valuing the European option in discrete time steps, where arbitrage-free pricing framework is explained via replicating portfolio and risk-neutral probability measure. Next, we introduce the Black-Scholes option pricing model, which values the European option in continuous time. The Greeks are introduced and dynamic hedging techniques will also be shown. American and exotic option pricing are covered in Week 5.

With the introduction of the relations among short rate, forward rate and default-free zero coupon bond price in Week 6, we cover the term structure of interest rates and examine various models that are used in practice in this area. Considering the defaultability of the companies, we also study credit risk models based on firm-value and intensity-based approach respectively.

The remaining weeks of the course will cover financial market theory and portfolio management. We introduce the various theories and models that attempt to explain the behaviour of investors in the market and how this affects the pricing of assets in the market as a whole. Various measurements of financial risk are introduced and we relate this to the mean-variance portfolio theory, where the fund manager makes a decision on which assets to include into his/her investment portfolio based on expected returns and risk.

### **Unit Objectives / Syllabus**

**The course will cover most of the material in the UK Institute's syllabus for Subject CT8 Financial Economics.**

## Exemptions

The unit ACST 305/858 corresponds to the professional subject CT8. **You require a Credit grade or higher to receive the exemption.**

## Unit Timetable

Week Number	Week Beginning	Topic Covered	Test	Lecturer
1	30 July	Introduction of stochastic processes		J Jang
2	6 August	Martingale, Introduction of stochastic calculus, Ito's lemma		J Jang
3	13 August	Concept of forward, futures and option, Binomial lattice model, Arbitrage-free pricing via replicating portfolio and risk neutral probability measure.		J Jang
4	20 August	Black-Scholes option pricing model, Girsanov theorem. Greeks and dynamic hedging.		J Jang
5	27 August	American and exotic option pricing		J Jang
6	3 September	Term structure of interest rates, Relations among short rate, forward rate and default-free zero-coupon bond,		J Jang
7	10 September	Interest rate models I (Short rate models)	Test	J Jang
<b>STUDY BREAK</b>	17 September 24 September			
8	2 October	Interest rate models II (Forward rate models)		J Jang
9	8 October	Credit risk models I (Firm-value model)		J Jang
10	15 October	Credit risk models II (Intensity-based model)		J Jang
11	22 October	Utility Theory, Measurements of Investment Risk		J Jang
12	29 October	Mean-Variance Portfolio Theory, Efficient Market Hypothesis		J Jang B Chu
13	5 November	Equilibrium Models, CAPM		B Chu

## Assumed Knowledge and Skills

Students need to be able to use a computer to analyse financial problems. You should be able to use a word processing package (such as WORD), a spreadsheet (such as EXCEL), a statistical package (such as MINITAB) and a programming language (such as Visual Basic or Matlab). **Although the unit does not aim to teach students how to use computers, as this is covered in prerequisite units, you are encouraged to make use of spreadsheets and other software packages in solving in-class exercises.** You need to have a sound grasp of probability, stochastic processes, calculus, matrix algebra, along with a sound understanding of the mathematics of compound interest.

### Lectures and Tutorials

This unit will consist of 4 hours of lectures and 1 hour tutorial per week. Lectures are held at the following times:

Day	Time	Location
Tuesday	1.00 pm – 3:00 pm	C5CT1
Thursday	2:00 pm – 4:00 pm	C5CT1

One tutorial is held on every Thursday:

Day	Time	Location
Thursday	4.00 pm – 5:00 pm	C5CT1

There are **no** tutorials held during Week 1 and 2.

### ACST305/858 Web site

This web site uses software called WebCT. To access this web site, go to <http://online.mq.edu.au> and log on. This leads you to a page which lists all Macquarie University WebCT sites to which you have access.

If you did not understand the above, you can obtain training on how to use a web browser by contacting the Information Technology Training Unit on Level 1 of the Library. If you can't access the site due to having forgotten your password, contact the Information Technology Customer Support Desk also on Level 1 of the Library.

Before logging in to this site, you should follow the link labelled "Technical Information" and read all the information there, including the Computer and Communications Security Policy and the Computer and Communications Usage Rules. This technical information mentions a number of "plug-ins" that may be required. Of those listed, in this unit you will only need Acrobat Reader.

You can access this web site from any computer with internet access including those in the library.

The website will be used extensively for this unit so please consult the website regularly for course information. You are reminded that all initial enquiries about the course material should be posted on WebCT as this will eliminate the case where the same question is asked many times.

<b>Textbooks</b>
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Course notes are from the ActEd Study Materials (subject CT8). You can purchase these notes via ASSOC at a discounted price. Information about their availability and price will be confirmed on WebCT and in the lectures.

The recommended textbooks for this course are:

<b>Title</b>	<b>Author</b>	<b>Chapters</b>
Options, Futures and Other Derivatives (6th edition)	John Hull	Chapters 1, 2, 8, 9, 10, 11, 12, 13, 14, 17, 28, 29
An Introduction to the Mathematics of Financial Derivatives (2nd edition)	Salih N. Neftci	Chapters 2, 4, 6, 7, 9, 10, 11, 13, 14, 15, 17, 18, 19, 20, 21, 22
Interest Rate Models: An Introduction	Andrew J. G. Cairns	Chapter 11

The textbook by Hull includes many worked examples and exercises. You may wish to buy a copy of the Solutions Manual – but a copy of the Solutions Manual will ALSO be placed in the Reserve Section of the Library.

The advanced textbooks for this course are:

<b>Title</b>	<b>Author</b>	<b>Chapters</b>
Risk-Neutral Valuation - Pricing and Hedging of Financial Derivatives	N. H. Bingham and R. Kiesel	Chapters 1, 4, 5, 6, 8
Quantitative Risk Management	Alexander J. McNeil, Rüdiger Frey and Paul Embrechts	Chapter 8
The Theory of Stochastic Processes	D. R. Cox and H. D. Miller	Chapters 2, 5
Introduction to Probability Models (8th edition)	Sheldon Ross	Chapter 6

References you will find useful for the materials covered during Weeks 10 – 13 (which will be available in the Reserve Section of the Library) are:

*Modern Portfolio Theory and Investment Analysis* by Elton and Gruber

*Investment Science* by Luenberger

## Grading

Macquarie University uses the grades HD, D, Cr, P, PC and F for grading the achievements of students in units of study. The grades of achievement are defined as follows:

**High Distinction (HD)** denotes performance which meets all unit objectives in such an exceptional way and with such marked excellence that it deserves the highest level of recognition.

**Distinction (D)** denotes performance which clearly deserves a very high level of recognition as an excellent achievement in the unit.

**Credit (Cr)** denotes performance which is substantially better than would normally be expected of competent students in the unit.

**Pass (P)** denotes performance which satisfies unit objectives.

**Conceded Pass (PC)** denotes performance which meets unit objectives only marginally.

**Fail (F)** denotes performance which does not meet unit objectives.

This subject, while quantitative in nature, requires students to demonstrate substantial problem-solving skills and a clear understanding of the theory. It is not possible to achieve a Distinction grade or above by just memorising formulae or principles.

The assessment tasks in ACST305/858 aim to test your knowledge and understanding of the basic formulae and principles as well as your ability to apply what you have learnt in practical situations. As professionals in the future, you will often encounter business problems that are unfamiliar to you but they are in fact an extension of the theory you have already learnt. In being able to recognise the problem in that context will allow you to come up with a solution. You will encounter more of these business problems when you study Part II and Part III.

This table is a guide to the meaning of each grade in the context of ACST305/858:

Grade	Level of understanding represented by that grade
<b>HD</b>	<ul style="list-style-type: none"><li>• Able to apply basic principles to solve unfamiliar, non-standard problems</li><li>• Able to accurately perform complex numeric procedures &amp; explain or interpret results using non-technical terms</li></ul>
<b>D</b>	<ul style="list-style-type: none"><li>• Able to apply basic principles to solve problems which differ significantly from the familiar</li><li>• Able to accurately perform more demanding numeric procedures &amp; explain or interpret results clearly and concisely</li></ul>
<b>CR</b>	<ul style="list-style-type: none"><li>• Able to apply basic principles to solve problems which differ slightly from the familiar</li><li>• Able to perform numeric procedures that require some problem-solving skills &amp; explain or interpret results on some occasions</li></ul>

<b>P</b>	<ul style="list-style-type: none"> <li>•Able to apply basic principles to solve standard problems in familiar scenarios</li> <li>•Able to accurately perform standard numeric procedures that are more mechanical in nature, or those that require very little problem-solving skills</li> </ul>
<b>PC</b>	<ul style="list-style-type: none"> <li>•Marginally satisfactory achievement of P level understanding</li> <li>•Able to accurately perform a limited range of numeric procedures, but not able to explain them clearly</li> </ul>
<b>F</b>	<ul style="list-style-type: none"> <li>•No evidence of achieving P level understanding</li> </ul>

The numerical marks resulting from assessment of your work in this unit will be used as an initial indicator of the quality of your learning and understanding. The use of these numerical marks is, however, only a starting point in determining the appropriate grade. To obtain a grade you must satisfy the qualitative definition of that grade. Once your grade has been determined, you are allocated a standardised mark indicating your approximate position amongst students assigned that grade. In particular, note that the raw marks may be scaled in order to determine the Single Numerical Grade (SNG).

SNG's are not marks but are a ranking of students based on marks obtained from all facets of the unit assessment. The SNG's awarded in a particular unit are designed to indicate that the students in each performance band, from HD to PC, have satisfied the criteria for inclusion in that band and ranks them by their performance within that band. Since the ranges of SNG's differ from band to band the relationship between the raw marks and the SNG's may differ from band to band even within the same unit. The relationship between raw marks and SNG's would almost always differ between units.

### Assessment

The following table gives an indication of the relative weighting of the assessment components:

Mid-Semester Test	(Cover topics from weeks 1 to 4)	18%
Final Examination	(15% on Weeks 1 to 4 and 85% on Weeks 5 to 13)	82%

You need to achieve a pass both in the final exam and overall to pass the subject.

### Mid-Semester Test

There will be one mid-semester test of ninety (90) minutes duration with five (5) minutes reading time, **which covers the topics from Weeks 1 to 4**. The test is scheduled for Tuesday

11th September 2007 and will be conducted during the lecture time (1:00pm – 3:00pm). The venue for the test will be confirmed in the lectures and posted on the discussion board on WebCT. Please note that the mid-semester test date, time and coverage may be subject to change and that any alterations will be advised in lectures/on WebCT.

The format of the mid-semester test will be a written paper consisting of three (3) questions. You will answer in the spaces provided on the test paper, although a writing booklet will be distributed to you for scribbling (which is NOT collected or marked). All answers must be written in black or blue pen or a pencil (do NOT use a red pen).

Normal examination rules apply to the conduct of mid-semester test. These rules are set out under the heading “Conduct of Examinations” in the Student Information – Assessment section of the current Macquarie University Handbook of Undergraduate Studies. You are responsible for familiarising themselves with these rules prior to the class test. **There will not be a make-up test for those who are absent for the mid-semester test. You must provide a legitimate reason for your absence and where approved, your final grade for ACST305/858 will depend SOLELY on your performance in the final examination.**

When the tests are marked, you will be notified to collect them from ERIC (E4B106).

You will be allowed to take a calculator that is silent and has no text-retrieval capacity **plus** one A4 page into the test (handwritten or typed and filled in on however many sides).

### **Final Examination**

The final examination will be a three-hour written paper with ten (10) minutes reading time. The examination will cover the whole course, but there is a greater emphasis on the material taught in Weeks 5 to 13. There will be 1 question, worth approximately 15% of the paper, which will cover the materials taught in Weeks 1 to 4. The remaining 85% of the paper will cover the material taught in Weeks 5 to 13.

There will be a mix of calculation questions and short answer questions that require you to demonstrate a deeper understanding of the material.

You will be allowed to take a calculator that is silent and has no text-retrieval capacity **plus** one A4 page into the exam (handwritten or typed and filled in on however many sides).

### **Legibility of Handwriting**

You should ensure that your handwriting in the class assessment tasks and in the final examination is legible. Sections of work that are not legible will not be marked. For true/false



questions, answers that are not clearly legible as either T or F will be assumed to be wrong and marked accordingly.

### **Special Consideration**

Applications for special consideration in respect of a class test or other class assessment task must be made on the "Advice of Absence or other Circumstances" form. These are available from and should be submitted to the Student Enquiry Service on Level 1 of the Lincoln Building.

Applications in respect of the final exam must be made on the "Request for Special Consideration" form. These forms are available from and should be submitted to the Academic Program Section on Level 4 of the Lincoln Building.

Applications based on medical grounds (whether for a class test or other class assessment task, or for the final examination) **must** be accompanied by the Professional Authority Form. Applications omitting this form (such as those which only supply a doctor's certificate) will be ignored.

Application forms are also online at <http://www.registrar.mq.edu.au/academic-index.html>

### **Mobile Phones**

Academic Senate has resolved that no mobile phones should be used in classrooms or be brought into examination rooms. Mobile phones must be switched off during class tests.

### **Calculators/Computers**

Calculators will be allowed in the class tests and the final examination but a clear indication of the steps involved in every calculation must be shown. Any machines that have a text-retrieval capacity, whether or not they have a full alphabet on the keyboard, are not allowed.

Calculators may be checked at the commencement of the class tests and final exam, and the make/model may be recorded.

### **Use of Computers for Coursework**

The computer laboratories available to you are the third year labs where you will have access to all the software relevant to this unit. Please take careful note of the policy of the Department of Actuarial Studies regarding the use of computers, which follows.

## **DEPARTMENT OF ACTUARIAL STUDIES**

### **NOTICE TO STUDENTS RE USE OF COMPUTERS FOR COURSEWORK**

1. Computers do occasionally break down. This is a normal part of working life. When completing assignments, you should not leave computer work until the last moment, assuming the system will be available when you need it.
2. You are the person responsible for keeping backup copies of any data or files you create on a computer. If you fail to keep backup copies, loss of data or files, for whatever reason, is not an acceptable excuse for failing to complete an assignment on time.
3. You should have at least two backups. If you have only one backup disk, then a computer malfunction while you are updating your backups may simultaneously corrupt both the original version (on the hard disk or network) and your backup disk. Do not store your two backups together. Spread your risks.
4. If you are planning to write a document on one computer (eg. your home computer) and print it from a different computer, you should test well ahead of the due date that the second computer can print your document. This particularly applies if your documents incorporate graphs, tables, unusual fonts or special formatting.

### **Reference Material**

Copies of any additional readings, assignments, and other unit material will be placed in the Reserve Section of the Library.

Material for at least some sections of work is available online, along with email and chat facilities, from: <http://online.mq.edu.au/student/>

### **The Institute of Actuaries of Australia**

Please refer to [http://www.actuary.mq.edu.au/current\\_students/join\\_institute.shtml](http://www.actuary.mq.edu.au/current_students/join_institute.shtml) for information on the advantages of joining the Institute of Actuaries of Australia as a student.

### **Cheating and Plagiarism**

To cheat in the context of university assignments, tests and examinations is to attempt to gain an unfair advantage by violating the principles of intellectual and scholarly integrity. Cheating also encompasses plagiarism, which is the appropriation or imitation of another person's ideas and manner of expressing them.

You are responsible for familiarising yourself with the document entitled "What is plagiarism?" at <http://www.student.mq.edu.au/plagiarism.html>.