ACTL5105
Life Insurance and Superannuation Models

Course Outline
Semester 1, 2016

Part A: Course-Specific Information

Please consult Part B for key information on Business School policies (including those on plagiarism and special consideration), student responsibilities and student support services.
<table>
<thead>
<tr>
<th>Table of Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>PART A: COURSE-SPECIFIC INFORMATION</td>
</tr>
<tr>
<td>1 STAFF CONTACT DETAILS</td>
</tr>
<tr>
<td>2 COURSE DETAILS</td>
</tr>
<tr>
<td>2.1 Teaching Times and Locations</td>
</tr>
<tr>
<td>2.2 Units of Credit</td>
</tr>
<tr>
<td>2.3 Summary of Course</td>
</tr>
<tr>
<td>2.4 Course Aims and Relationship to Other Courses</td>
</tr>
<tr>
<td>2.5 Student Learning Outcomes</td>
</tr>
<tr>
<td>3 LEARNING AND TEACHING ACTIVITIES</td>
</tr>
<tr>
<td>3.1 Approach to Learning and Teaching in the Course</td>
</tr>
<tr>
<td>3.2 Learning Activities and Teaching Strategies</td>
</tr>
<tr>
<td>4 ASSESSMENT</td>
</tr>
<tr>
<td>4.1 Formal Requirements</td>
</tr>
<tr>
<td>4.2 Assessment Details</td>
</tr>
<tr>
<td>4.3 Late Submission</td>
</tr>
<tr>
<td>5 COURSE RESOURCES</td>
</tr>
<tr>
<td>6 COURSE EVALUATION AND DEVELOPMENT</td>
</tr>
<tr>
<td>7 COURSE SCHEDULE</td>
</tr>
</tbody>
</table>
PART A: COURSE-SPECIFIC INFORMATION

1 STAFF CONTACT DETAILS
The Course Co-ordinator and Lecturer-in-charge is Dr Jinxia Zhu.

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
<th>Email</th>
<th>Room</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecturer-in-charge</td>
<td>Jinxia Zhu</td>
<td><a href="mailto:Jinxia.zhu@unsw.edu.au">Jinxia.zhu@unsw.edu.au</a></td>
<td>Business School Bldg 652</td>
<td>9385 7385</td>
</tr>
</tbody>
</table>

Consultation times will be posted on the course Moodle web site.

2 COURSE DETAILS

2.1 Teaching Times and Locations
The course consists of weekly lectures which start in Week 1 (to Week 13): The lectures are held Monday 6pm-9pm in Old Main Building 150.

The class will combine both lecture and tutorials and will involve interactive learning where participation is highly encouraged. To get the most out of the course, students will need to ensure that they cover the course readings and complete assigned homework problems in advance of the class.

2.2 Units of Credit
The course is worth 6 units of credit.
There is no parallel teaching in this course.

2.3 Summary of Course
This course covers the actuarial mathematics and models for use in the analysis and actuarial management of life insurance and superannuation contracts. Topics include: the main forms of life insurance and annuity contracts; disability and long term care contracts and superannuation fund benefits; actuarial notation and the life table; moments of the value of the benefit payments; Thiele’s differential equation for policy values; stochastic modelling of claims and benefit payments; gross premiums, net premiums, policy values and reserves; allowing for expenses and inflation; use of discounted emerging costs and profit tests; termination and alteration values; cost of guarantees; joint life functions.

This course covers material in the Subject CT5 Contingencies of the Institute of Actuaries.

2.4 Course Aims and Relationship to Other Courses
At the end of the course students should be able to:
A. apply survival models to the pricing and valuation of life insurance and pension contracts
B. apply multiple state models to the pricing and valuation of life insurance and pension contracts
C. understands the main forms of insurance and pension contract and their actuarial aspects.

The primary aim of this course is to provide students with an understanding of the mathematical concepts and techniques that are used to model and value cash flows contingent on survival, death and other uncertain events.

Students are assumed to have a good knowledge of ACTL5102 and ACTL5103. The course should normally be taken at the same time as ACTL5104 Actuarial Statistics.

Students should have a solid background in mathematics and are assumed to be able to use a computer to analyse financial and/or statistics problems. You should be able to use a word processing package (such as WORD) and a spreadsheet (such as EXCEL).
2.5 Student Learning Outcomes

The Course Learning Outcomes are what you should be able to DO by the end of this course if you participate fully in learning activities and successfully complete the assessment items. These are:

1. Explain and apply the fundamental techniques used to value cash flows involving death, survival and other similar contingent events.
2. Assess risk inherent in cash flows resulting from these contingent events.
3. Describe the life insurance and life annuity products that may be available in the market.
4. Explain the basic valuation and funding of superannuation benefits.
5. State and apply contingent valuation concepts to practical situations.
6. Assess calculations of premiums and policy values of financial contingent products for reasonableness.
7. Integrate and apply these technical skills to practical valuation problems in the life insurance and annuity markets.
8. Present orally and explain Life insurance and superannuation problems in simple terms.
9. Participate collaboratively and responsibly in teams, and reflect on their own teamwork, and on the team’s processes and ability to achieve outcomes.

The course covers the following aims and syllabus items of the Institute of Actuaries courses: The course covers the syllabus of the Institute of Actuaries CT5 Contingencies examination. The following table indicates the learning outcomes of CT5 and the lectures in which they are covered.

<table>
<thead>
<tr>
<th>CT5 Learning Objectives</th>
<th>Course Learning Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Define simple assurance and annuity contracts, and develop formulae for the means and variances of the present values of the payments under these contracts, assuming constant deterministic interest.</td>
<td>3</td>
</tr>
<tr>
<td>(ii) Describe and use practical methods of evaluating expected values and variances of the simple contracts defined in objective (i).</td>
<td>6,7</td>
</tr>
<tr>
<td>(iii) Describe and calculate, using ultimate or select mortality, net premiums and net premium reserves of simple insurance contracts.</td>
<td>6,7</td>
</tr>
<tr>
<td>(iv) Describe and calculate, using ultimate or select mortality, net premiums and net premium reserves for increasing and decreasing benefits and annuities.</td>
<td>6,7</td>
</tr>
<tr>
<td>(v) Describe and calculate gross premiums and reserves of assurance and annuity contracts.</td>
<td>6,7</td>
</tr>
<tr>
<td>(vi) Define and use functions involving two lives.</td>
<td>1</td>
</tr>
<tr>
<td>(vii) Describe and illustrate methods of valuing cashflows that are contingent upon multiple transition events.</td>
<td>1,5</td>
</tr>
<tr>
<td>(viii) Describe and use methods of projecting and valuing expected cashflows that are contingent upon multiple decrement events.</td>
<td>1,4,5</td>
</tr>
<tr>
<td>(ix) Describe and use projected cashflow techniques, where and as appropriate for use in pricing, reserving, and assessing profitability.</td>
<td>2</td>
</tr>
<tr>
<td>(x) Describe the principal forms of heterogeneity within a population and the ways in which selection can occur.</td>
<td>Covered in ACTL5104</td>
</tr>
</tbody>
</table>

The Learning Outcomes in this course also help you to achieve some of the overall Program Learning Goals and Outcomes for all undergraduate students in the Business School. Program Learning Goals are what we want you to BE or HAVE by the time you successfully complete your degree (e.g. ‘be an effective team player’). You demonstrate this by achieving specific Program Learning Outcomes - what you are able to DO by the end of your degree (e.g. ‘participate collaboratively and responsibly in teams’).
Business Postgraduate Coursework Program Learning Goals and Outcomes

1. Knowledge: Our graduates will have current disciplinary or interdisciplinary knowledge applicable in local and global contexts.
   You should be able to identify and apply current knowledge of disciplinary or interdisciplinary theory and professional practice to business in local and global environments.

2. Critical thinking and problem solving: Our graduates will have critical thinking and problem solving skills applicable to business and management practice or issues.
   You should be able to identify, research and analyse complex issues and problems in business and/or management, and propose appropriate and well-justified solutions.

3. Communication: Our graduates will be effective communicators in professional contexts.
   You should be able to:
   a. Produce written documents that communicate complex disciplinary ideas and information effectively for the intended audience and purpose, and
   b. Produce oral presentations that communicate complex disciplinary ideas and information effectively for the intended audience and purpose.

4. Teamwork: Our graduates will be effective team participants.
   You should be able to participate collaboratively and responsibly in teams, and reflect on your own teamwork, and on the team’s processes and ability to achieve outcomes.

5. Ethical, social and environmental responsibility: Our graduates will have a sound awareness of ethical, social, cultural and environmental implications of business issues and practice.
   You should be able to:
   a. Identify and assess ethical, environmental and/or sustainability considerations in business decision-making and practice, and
   b. Consider social and cultural implications of business and/or management practice.

For more information on the Postgraduate Program Learning Goals and Outcomes, see Part B of the course outline.

The following table shows how your Course Learning Outcomes relate to the overall Program Learning Goals and Outcomes, and indicates where these are assessed (they may also be developed in tutorials and other activities):

<table>
<thead>
<tr>
<th>Program Learning Goals and Outcomes</th>
<th>Course Learning Outcomes</th>
<th>Course Assessment Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>This course helps you to achieve the following learning goals for all Business School undergraduate students:</td>
<td>On successful completion of the course, you should be able to:</td>
<td>This learning outcome will be assessed in the following items:</td>
</tr>
</tbody>
</table>
| 1 Knowledge | Learning Outcomes 1-5 | • Mid-session exam  
• Final Exam |
| 2 Critical thinking and problem solving | Learning Outcomes 5-7 | • Mid-session exam  
• Final Exam |
| 3a Written communication | Learning Outcomes 8 | • Assignment  
• Mid-session exam  
• Final exam |
| 3b Oral communication | Learning Outcomes 8 - Communicate ideas in a succinct and clear manner. | • Oral presentation |
3 LEARNING AND TEACHING ACTIVITIES

3.1 Approach to Learning and Teaching in the Course
The approach to learning and teaching is to actively engage students in the learning process by guiding students in developing their understanding of course topics and using problems for students to reflect on and gain deeper understanding of the more challenging applications of the course material.

The purpose of the lectures is to introduce and explain concepts in the student learning outcomes of the Course. It is expected that students come to lectures having read the relevant text material, lecture notes or PowerPoint slides. Each lecture will provide an overview of the topics and will focus on explaining concepts and issues along with applications and practical issues. The role of the lecture is also to provide students with an opportunity to reinforce the major concepts. Lectures are designed to ensure students have grasped the key concepts and aims of the course and will not necessarily over all topic material in detail. Completing tutorial problems and other problems from the textbook is the best way to learn much of the course techniques.

3.2 Learning Activities and Teaching Strategies
The course references, lectures and assessment tasks are designed to provide a framework for your learning. Every student has a different approach to learning. How much time you spend on reading in preparation for lectures, completing assessment tasks, reviewing course objectives, deepening your understanding and preparing for final examinations will depend on your learning approach. You would normally expect to spend at least 10 hours per week studying the course. Regular study, completing problems and attending tutorials throughout the course is the best way to master the course and achieve a successful outcome.

The learning activities of this course involve four key components – the lectures, the exercises, the assessment including the assignment, and your private study. The role of the lecture is to help you understand the context of the topic as well as work through the difficult points. Exercises allow you to deepen your knowledge of the course and to work with other students on problems enhancing your understanding. The assignment presents you with a practical application of course concepts. Your private study is the most important component of this course. Weekly readings, solving problems, and your own topic summaries should be considered as a basis of a regular private study regime. Keeping up to date is very important and each week builds on the prior week so it is important that you have your study regime organised early.

4 ASSESSMENT

4.1 Formal Requirements
In order to pass this course, you must:
- achieve a composite mark of at least 50; and
- make a satisfactory attempt at all assessment tasks (see below).

Students must complete and submit all components of assessment at or before the due times. It is important that students be punctual and reliable when submitting assessment. This is an important workplace requirement and students need to ensure they meet deadlines.
Your regular and punctual attendance at lectures is expected in this course; see Part B of the Course Outline for details.

A professional CT5 exemption is achieved by a mark of 65% or higher in order to be recommended for exemptions. If you do not achieve this exemption grade then you can still gain the exemption by successfully completing the Institute of Actuaries equivalent examination as soon as practical after the UNSW course.

4.2 Assessment Details

<table>
<thead>
<tr>
<th>Assessment Task</th>
<th>Weighting</th>
<th>Length</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Class Presentation</td>
<td>5%</td>
<td>Max 6 minutes</td>
<td>Advised on Moodle web site</td>
</tr>
<tr>
<td>Mid-Session Exam</td>
<td>15%</td>
<td>1 hour</td>
<td>Friday 15 April 12:15pm</td>
</tr>
<tr>
<td>Assignment</td>
<td>15%</td>
<td>As in schedule</td>
<td></td>
</tr>
<tr>
<td>Final Exam</td>
<td>65%</td>
<td>2 hours</td>
<td>University Exam Period</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Feedback will be provided to students after their assessments. Students should note that the final assessment can involve standardisation and scaling of overall marks.

In Class Presentation
Communication skills is one of the most important graduate attributes that employers of commerce and actuarial graduates require. Students need to be able to explain complex financial concepts and problems in simple terms and to be able to explain why their answer is reasonable. In class presentations will provide the students an opportunity to develop this skill.

During the session, students will be allocated an oral presentation. Failure to appear on time for an oral presentation will result in a zero mark unless a satisfactory reason is given in writing to the Course Coordinator.

Marks will be assigned based on the presentation assessment criteria that are provided on the course website. Students should review this before their presentation.

Mid-term exam
There will be one written answer mid-session exam in week 6 of 60 minutes duration. The mid-term exam will take place on Friday 15th April 2016, from 12:15pm. It will held in the lecturer theatre. The mid-session exam will be closed book. Students will only be allowed to bring the text “Formulae and Tables for Actuarial Examinations”.

Normal examination rules apply to the conduct of mid-term exams. Calculators will be allowed in the mid-term and final examination but a clear indication of all of the steps involved in your calculations must be shown. The University will not supply calculators to students for use in examinations where the provision of calculators has not been requested by the course examiner. It is the student’s responsibility to be familiar with the rules governing the conduct of examinations. The course exams require written responses, with students earning marks for correct mathematical working as well as part marks for incorrect responses with correct method and reasoning. They test not only their knowledge of the material, but also the depth of their understanding of it.

Assignment
The practical application of the course concepts based on actual financial market problems is an important graduate attribute that employers require and this course aims to provide at least some introductory exposure to this. Writing skills for technical material are also important.
There will be one Assignment for this course. The assignment will involve the practical application of course concepts to actuarial problems. The assignment will be a group assignment. Students will be assigned to a group within their tutorial classes. Each group will be required to submit an assignment report and each student will also need to complete a peer evaluation form to rate the other group members' contribution to the group work in his/her group and submit a Personal Reflection.

The assignment offers students the opportunity to engage in critical analysis, problem solving, team work and self-reflection, as well as to demonstrate their understanding of the concepts and perspectives that are central to actuarial studies. The assignment assists in the development of Program Learning Goals and Outcomes 1, 2, 3 and 4.

The assignment report will be assessed on technical accuracy, how well it is written, and the quality of the assignment presentation. The group process will be assessed by peer evaluation and personal reflection.

The assignment questions, together with the marks allocated to all components of the assignment, will be made available to students on the course website. A guide on effective teamwork will also be posted on the course website.

Students are reminded that the work they submit must be their own. This means that:

- The mathematical solutions you present are written up by you and your group members, without reference to any other group's work.
- The statistical analysis and mathematical calculation you present is done by your own group’s programming code, which your group wrote and ran, without reference to any other group’s work.
- Any spreadsheet solutions you present are from your own group’s spreadsheets, which your group developed, without any reference to any other group’s work.

Assignment reports must be submitted via the Turnitin submission box that is available on the course website. Turnitin reports on any similarities between their own cohort’s assignments, and also with regard to other sources (such as the internet or all assignments submitted all around the world via Turnitin). More information is available at: http://elearning.unsw.edu.au/turnitin/content/TurnItIn_Student_Support.cfm?ss=0

Please read this page, as we will assume that its content is familiar to you. You will be able to make multiple submissions and have access to the originality reports.

You need to check your document once it is submitted (check it on-screen). **We will not mark assignments that cannot be read on screen.**

Students are reminded of the risk that technical issues may delay or even prevent their submission (such as internet connection and/or computer breakdowns). Students should then consider either submitting their assignment from the university computer rooms or **allow enough time (at least 24 hours is recommended) between their submission and the due time.** The Turnitin module will not let you submit a late report. **No paper copy will be either accepted or graded.**

In case of a technical problem, the full document must be submitted to the course coordinator before the due time by e-mail, with explanations about why the student was not able to submit on time. In principle, this assignment will not be marked. It is only in exceptional circumstances where the assignment was submitted before the due time by e-mail that it may be marked—and this only if a valid reason is established.

**Avoid a 0 for your assignment because of plagiarism**

Students are reminded that the work they submit must be their own. While we have no problem with students working together on the assignment problems, the material students submit for assessment must be their own. This means that:

- The mathematical solutions you present are written up by you and your group members, without reference to any other group’s work.
• Any programming code you present are from your own computers, which you yourself and your group members developed, without any reference to any other group's work.

Students should make sure they understand what plagiarism is and to note that cases of plagiarism have a very high probability of being discovered. For issues of collective work, having different persons marking the assignment does not decrease this probability.

Students should keep a copy of all work submitted for assessment and keep their returned marked assignments.

This course is using the Review software for marking and feedback for part of the assignment. The Review login is https://unsw.review-edu.com/unsw

Information on accessing Review will be provided to students with further details of the assignment. You won’t have access to Review until you are advised.

4.3 Late Submission
Please note that it is School policy that late assignments, even by one minute, will not be marked. Assignments MUST be submitted prior to the due time and date. The School of Risk and Actuarial Studies has a policy of grading late assignments with a zero mark. Punctual submission of work is required in order to satisfy the requirements of the course. Turnitin will not accept any late submission. The assignment may be marked at the discretion of the course co-ordinator if there is a valid reason for late submission and used in cases where your final overall results are marginal.

Final examination
The final examination will assess students understanding of the concepts covered in the course and readings and their ability to apply them to practical problems. The final examination will be a two hour written paper. The final examination will be closed book. Students will only be allowed to bring the text “Formulae and Tables for Actuarial Examinations” into the exam. This must not be annotated.

Quality Assurance
The Business School is actively monitoring student learning and quality of the student experience in all its programs. A random selection of completed assessment tasks may be used for quality assurance, such as to determine the extent to which program learning goals are being achieved. The information is required for accreditation purposes, and aggregated findings will be used to inform changes aimed at improving the quality of Business School programs. All material used for such processes will be treated as confidential.

5 COURSE RESOURCES

The prescribed textbook for the course is:


Additional, recommended references are:

• Core Reading for Subject CT5 Contingencies published by The Institute of Actuaries.
• ActEd Course Notes for Subject CT5 Contingencies.

The course draws on and further develops concepts covered in ACTL5102 (Financial Mathematics) and ACTL5103 (Markov Chains). Students should review these concepts as required early in the course.
Formulae & Tables
The only text students are allowed to bring into the examinations for the actuarial course is the text "Formulae and Tables for Actuarial Examinations". It must not be annotated. All students in the actuarial courses should purchase a copy of this text if they wish to use it in tutorials, mid-session exams and the final examinations. The text is available from the UNSW Bookstore, the UK Institute of Actuaries or from ActEd. Visit the ActEd website at http://www.acted.co.uk/estore/.

Course website
The course Moodle website is available from the UNSW TELT platform:
http://elearning.unsw.edu.au/

To access the Moodle online support site for students, follow the links from that website to UNSW Moodle Support/Support for Students. Additional technical support can be obtained from itservicecentre@unsw.edu.au (02 9385 1333). All course contents will be available from the course website (except for the module “Back to Basics” which is available on the ACTL students common website). It is essential that you visit the site regularly (at least weekly) to see any notices posted there by the course coordinator.

The Actuaries Institute
The Actuaries Institute (AI) allows students to become AI University Subscribers free of charge. Full time undergraduates studying at an Institute accredited university who are members of a university student actuarial society are eligible. To sign up, go to http://www.actuaries.asn.au/Membership/MembershipoftheInstitute/Subscriber.aspx

The University Subscriber offer is not a membership of the AI but a subscription to receive information on career opportunities, invitations to selected AI events and online publications. You might also consider joining the AI – there are advantages in doing so while a full-time student. For membership information, go to http://www.actuaries.asn.au/Membership/MembershipoftheInstitute.aspx

6 COURSE EVALUATION AND DEVELOPMENT
Each year feedback is sought from students and other stakeholders about the courses offered in the School and continual improvements are made based on this feedback. UNSW’s Course and Teaching Evaluation and Improvement (CATEI) Process is one of the ways in which student evaluative feedback is gathered. In this course we will seek feedback at least at the end of the session. Feedback received for the 2015 offering of the course has been used to improve the way the course will be taught in 2016. As a result of this feedback, more time will be allocated to each presentation question according to the complexity of the question and 2 or more students will be allocated to present the solution to one question so the audience will benefit more from listening to the student presentation. Moreover, more exam style questions will be included in lectures.
# 7 Course Schedule

This schedule is preliminary. Any variations will be advised through the Moodle course web site.

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture Topics</th>
<th>References</th>
<th>Notes and Assessment</th>
</tr>
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</table>
| Week 1  
29 February | Introduction  
M0-Life tables  
M1-Life Insurance contracts  
M1-Life insurances benefits (single life)  
• Types of insurances: whole life, term, pure endowment, endowment, deferred  
• Insurances payable at the moment of death | Dickson et al. Chapters 1, 3 and 4 |
| Week 2  
7 March | M1- Life insurances benefits (single life)  
• Insurances payable at the end of year of death  
• Insurances payable at the end of m-th year of death  
• Insurances with varying benefits (increasing, decreasing benefits)  
• Relationships between continuous and discrete insurances  
M2-Life annuities (single life)  
• Present value r.v. of annuities with annual payments | Dickson et al Chapters 4 and 5 |
| Week 3  
14 March | M2-Life annuities (single life)  
• Life annuities with m-thly payments  
• Continuous annuities  
• Relationships under the UDD assumptions  
M3-Net Premium Valuation  
• Insurer's net random future loss  
• Equivalence principle for computing net premiums  
• Discrete premiums  
• True m-thly payment premiums | Dickson et al, Chapters 5 and 6 |
| Week 4  
21 March | M3-Net Premium Valuation  
• Fully continuous premiums  
M4-Premium Reserves and Policy Values  
• Insurer’s prospective loss random variable  
• Prospective calculation of reserves | Dickson et al, Chapters 6 and 7 |
| | Mid-semester break: Friday 25 March – Saturday 2 April inclusive |
| Week 5  
4 April | M4-Further Analysis of Reserves  
• Recursive calculations of fully discrete reserves  
• Retrospective calculation of reserves  
• Types of bonuses  
• Net premiums and provisions for with-profit contracts | Dickson et al, Chapter 7 |
| Week 6  
11 April | M5-Gross Premiums and Reserves  
• Types of life insurance contract expenses | Dickson et al, Chapters 6  
**Midsession test Friday** |
| Week 7 18 April | M6- Profit Testing  
   - Discounted emerging costs  
   - Unit-linked contracts  
   - Expected cash flows for whole life,  
     endowment, term, annuities, and unit-linked contracts  
   - Profit measures and profit testing principles: profit vector, profit signatures,  
     net present value and profit margin | Dickson et al Chapters 12 and 13  
   and 7  
   15 April 12:15pm |
| Week 8 25 April | No Lectures  
   (Monday 15 April is Anzac public holiday) | Dickson et al Chapters 12, 13 and 8 |
| Week 9 2 May | M6- Profit Testing  
   - Determining provisions using profit testing  
   - Profit testing universal life insurance  
M7-Multiple Decrement Models  
   - Multiple Decrement Tables (MDT)  
   - The Associated Single Decrement Tables (ASDT) | Dickson et al Chapter 8  
   Assignment Part (a) Due Thursday 12 May 4pm |
| Week 10 9 May | M7-Multiple Decrement Models  
   - Constructing SDT from MDT  
   - Constructing MDT from the ASDT  
   - Statistical treatment  
M8-Multiple state models  
   - Multiple state models: alive-death models,  
     healthy-sickness models  
   - Cash flows in multiple state models  
   - Actuarial present values and their numerical evaluation  
   - Disability benefits with individual life insurance Pension funds | Dickson et al Chapter 9  
   Assignment Part (b) due Thursday 19 May 4pm |
| Week 11 16 May | M9- Insurance and Annuities for Multiple Lives  
   - Joint distributions of future lifetimes  
   - The Joint life status  
   - The Last-survivor status  
   - Simple Contingent Functions  
   - Reversionary Annuities | Dickson et al Chapter 10 |
| Week 12 23 May | M10- Pension funds  
   - Introduction to pension funds  
   - Service tables and salary scales  
   - Pension fund benefits and formulas  
   - Actuarial present values (APVs) of pension benefits  
   Determining pension fund contributions | Dickson et al Chapter 10 |
| Week 13 30 May | M10- Pension funds  
   - Average and final salary schemes  
   - Lump sums on retirement  
   - Death and withdrawal benefits | Dickson et al Chapter 10 |
<table>
<thead>
<tr>
<th></th>
<th>Return of contributions on death or withdrawal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Revision</td>
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