COURSE DETAILS
Course Code: F70LA
Full Course Title: Life Insurance Mathematics A
SCQF Level: 10
SCAF Credits: 15
Available as Elective: No

DELIVERY LEVEL
Undergraduate: Yes  Postgraduate Taught: No  Postgraduate Research: No
Additional Information:

COURSE AIMS
To consider some general models for mortality, to introduce life insurance policies, to introduce and develop the calculation of premiums, to introduce and develop the calculation of policy values.

LEARNING OUTCOMES – SUBJECT MASTERY
By the end of the course students should be able to:

• Explain the concept of a survival model.
• Derive the survival function from the definition of a random variable measuring the time until exit from a population.
• Use the survival function to evaluate probabilities of events defined in terms of the time until exit.
• Show how a survival table for integer ages can be constructed using discrete rates of decrement.
• Define the probability of survival, the radix of a single decrement table, and the survivorship group at a given duration.
• Define and develop relationships between the life functions \( l_x \), \( tq_x \), \( tp_x \), \( td_x \), the force of mortality and the expectation of life.
• Describe the typical shapes of the curves for \( q_x \), \( l_x \) and the force of mortality, for human mortality.
• Define the concepts of uniform distribution of decrements and a constant hazard rate, and use them to derive certain approximate relationships.
• Write down expressions in terms of life table functions for the probability function of the curtate future lifetime and also the probability density function of the complete future lifetime of a life subject to a given life table.
• Write down expressions in terms of simple life table functions for the mean and the variance of both the curtate and the complete future lifetime of a life subject to a given life table and evaluate these expressions in simple cases.

• demonstrate an understanding of select mortality rates;
• construct a select-life mortality table;
• derive financial functions for non-select and select lives;
• express the variance of the present value of a stream of payments in terms of compound interest and life table functions, and evaluate the expression;
• describe (for a single life) the cash flows implied by pure endowments, level annuities, level whole life, endowment, and term assurances;
• derive expressions for the present value and accumulation of the contracts described above;
• calculate financial functions for benefits payable more frequently than annually;
• list the types of expenses incurred in writing a life insurance contract;
• describe the different types of bonus on a with-profits contract;
F70LA Life Insurance Mathematics A

- calculate net and gross premiums for different types of life insurance and annuity contracts;
- describe how reserves arise, under long-term insurance contracts covering mortality risk;
- define the policy value as the expected future loss, and calculate the net and gross policy values for non-profit and with-profits contracts;
- derive the recursive relationship between policy values at different durations, and use it to calculate policy values at non-integer durations;
- derive and explain Thiele's differential equation in the two-state continuous-time model;
- use an Euler scheme to solve Thiele's differential equation numerically;

use the Central Limit Theorem to show why risk reserves are needed, and to calculate risk reserves for insurance portfolios of different sizes; state and prove Lidstone's theorem, and use it to describe the traditional with-profits model of implicit risk reserving.

LEARNING OUTCOMES – PERSONAL ABILITIES

Participants will develop facility with the main actuarial models and calculations used in life insurance, health insurance and pensions.

They will gain practical experience with the numerical methods through the coursework and project work, which will mainly be based on the main tool used in insurance companies and consultancies, Excel.

SYLLABUS

- Introduction to the life table and the life table functions,
- Selection and select life tables,
- actuarial functions using ultimate and select life tables,
- net and gross premiums,
- equations of value,
- impaired lives,
- with-profits policies,
- expenses and bonuses,
- net and gross premium policy values,
- recursive relationship between policy values,
- Thiele's differential equation and its numerical solution.

COURSE RELATIONSHIPS

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Level</th>
<th>Title</th>
<th>School</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>F70LB</td>
<td>10</td>
<td>Life Insurance Mathematics B</td>
<td>School of Math and Comp Sci.</td>
<td>Taught</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Synoptic</td>
</tr>
<tr>
<td>F78AA</td>
<td>8</td>
<td>Actuarial and Financial Mathematics A</td>
<td>School of Math and Comp Sci.</td>
<td>Pre-Requisite</td>
</tr>
<tr>
<td>F78AB</td>
<td>8</td>
<td>Actuarial and Financial Mathematics B</td>
<td>School of Math and Comp Sci.</td>
<td>Pre-Requisite</td>
</tr>
</tbody>
</table>

LOCATION AND ASSESSMENT METHODS
## F70LA Life Insurance Mathematics A

<table>
<thead>
<tr>
<th>Edi</th>
<th>SBC</th>
<th>Ork</th>
<th>Dub</th>
<th>Malay</th>
<th>IDL</th>
<th>COLL</th>
<th>ALP</th>
<th>OTH</th>
<th>Method</th>
<th>Weight</th>
<th>Exam Mins</th>
<th>Type</th>
<th>Diet</th>
<th>Synoptic Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Examination</td>
<td>70</td>
<td>120</td>
<td>Assessment</td>
<td>Semester 1</td>
<td>F70LB</td>
</tr>
</tbody>
</table>

Note: Synoptically linked with F70LB on all degrees if F70LB is to be assessed in the same academic year. However, where a candidate chooses to register for F70LB in a later academic year, or not at all, then F70LA is not linked to any other course.

| Y   |     |     |     |       |     |      |     |     | Coursework | 30     |           | Assessment | Semester 1 | F70LB |

Note: Synoptically linked with F70LB on all degrees if F70LB is to be assessed in the same academic year. However, where a candidate chooses to register for F70LB in a later academic year, or not at all, then F70LA is not linked to any other course.

| Y   |     |     |     |       |     |      |     |     | Examination | 100    | 120       | Reassessment | Semester 3 | F70LB |

Note: Synoptically linked with F70LB on all degrees if F70LB is to be assessed in the same academic year. However, where a candidate chooses to register for F70LB in a later academic year, or not at all, then F70LA is not linked to any other course.