# Actuarial life insurance

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***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course is designed to provide the students with actuarial and quantitative skills relevant for pricing and reserving of life insurance contract. For this purpose, the course starts from the analysis of traditional life insurance policies. A specific focus will be given to the actuarial life table and to survival models useful for describing mortality patterns.

Subsequently, the course deals with more advanced contracts available in the market. In particular, the actuarial and financial structure of both with-profit and linked policies will be analysed.

A special emphasis is given to loss and profit decomposition in order to emphasize main components of technical profit of a life insurance company. To this end, a specific focus will be given to the structure of a profit test and to the assessment of the embedded value of an insurance company.

The course also gives an overview of the Solvency II framework, with specific focus on Best Estimate Liability and Solvency II Capital Requirement.

The course will mainly be taught through theoretical lectures with specific classes dedicated to exercises. Focus is on both theory and practice. At the end of the course, the students should be able to define rate premiums for life insurance contracts, to evaluate mathematical reserves, to perform a sensitivity analysis to evaluate the effects on the different components of technical profit, to understand the assumption, the process and the methodology underlying the Best Estimate Liability and Life and Market SCR calculation.

Throughout the course a special focus will be placed on the analysis of practical applications and empirical data with respect to the topics studied.

Instructional objectives of the course

*1*. *Basic concept of life insurance contracts*

After having completed the study of the material, the student is expected to be capable of:

– having a knowledge of the actuarial structure of traditional life insurance contracts

– computing single, regular and natural premiums of traditional life insurance contracts

– computing pure mathematical reserves of traditional life insurance contracts

*2*. *Mortality Models*

After having completed the study of the material, the student is expected to be capable of:

– modelling residual lifetime random variable

– understanding the distinction between cohort and period life tables

– having a knowledge of the concepts of survival function and force of mortality

– having a basic knowledge of main methodologies for forecasting mortality rates

* Understanding of selected and projected mortality tables

*3*. *Participating (with profit) Policies*

After having completed the study of the material, the student is expected to be capable of:

– having a knowledge of legal and regulatory framework defined for with-profit policies and segregated funds

– computing the revaluation rate and having a knowledge of different methods used for defining the participation rule

– computing single, regular and natural premiums of participating life insurance contracts

– computing pure mathematical reserves of participating life insurance contracts

*4*. *Actuarial Profit*

After having completed the study of the material, the student is expected to be capable of:

– having a knowledge of the concepts of first order and second order technical bases

– computing the expected present value of in and out cash-flows related to life insurance contracts

– splitting the technical profit into the main components

– performing a sensitivity analysis to identify main drivers of technical profit for alternative life insurance contracts

1. *Unit and Index Linked products*

After having completed the study of the material, the student is expected to be capable of:

– having a knowledge of the financial and actuarial structure underlying unit and index linked policies

– computing single and recurrent premiums of unit and index linked policies

– computing the mathematical reserve for survival and death benefits of a linked contract

– having a knowledge of the Brennan and Schwartz model

1. *Financial Option Pricing*

After having completed the study of the material, the student is expected to be capable of:

– having a knowledge of the derivative security types

– having a knowledge of the difference between a Risk-Neutral and a Real-World approaches

*7*. *Valuation methods of a Life Insurance Company*

After having completed the study of the material, the student is expected to be capable of:

– having a knowledge of the concept of Market Consistent Embedded Value (MCEV)

– calculating the Technical Provisions (BEL & Risk Margin) for a life insurance portfolio

– having a knowledge of the SCR calculation for an Insurance Company using the Standard Formula

***COURSE CONTENT***

1*. Basic concept of life insurance contracts*

* characteristics of basic life insurance contracts: technical bases, different types of traditional life insurance contracts
* single and regular premiums of basic life insurance contracts
* natural premiums and pure mathematical reserves of basic life insurance contracts

2*. Mortality Models*

* random variable residual lifetime
* cohort and period life table
* survival function and force of mortality
* forecasting mortality rates and projected/selected mortality tables

3. *Participating (with profit) Policies*

* Financial and actuarial structure of participating policies
* Participation rules and revaluation rate
* Single, regular and natural premiums of participating policies
* Mathematical reserves of participating policies

4*. Actuarial Profit*

* First order and second order technical bases
* Technical profit and loss and decomposition.
* Mortality and financial profit

5*. Unit and Index Linked policies*

* Main characteristics of linked policies
* Financial and Actuarial Structure of unit and index linked policies
* Mathematical reserves of linked policies
* Brennan and Schwartz model

6*. Financial Option Pricing*

* Derivative securities: forwards, futures, swap, option
* Option most popular valuation methods
* Risk-Neutral and Real-World approaches

7*. Valuation methods of a Life Insurance Company*

* Technical Provisions (BEL & Risk Margin)
* Life and Market SCR calculation within the Standard Formula
* Market Consistent Embedded Value (MCEV)

– Appraisal Value

– New Business Value

***READING LIST***

Given the particular structure of the course and the analysis of certain practical topics over a long term horizon, it is not possible to identify specific textbooks that cover all course topics.

Instructional material will be made available on the Blackboard platform throughout the course.

Series of readings and supplemental instructional materials will be made available on the course site of the Blackboard platform or in the references of the provided teaching material.

***TEACHING METHOD***

The course is divided into a cycle of lessons carried out with the aid of slides and other support material. The course includes frontal lectures by the lecturers as well as tutoring hours for practical exercises.

***ASSESSMENT METHOD AND CRITERIA***

The exam is based on both a written and an oral examination.

The written examination includes 2-3 questions on the fundamental topics lasting usually 1 hour and 30 minutes and will be based on the excel software. Some changes will be eventually provided according to the Covid-19 emergency

The written examination is based on both open-ended questions and exercises.

The compulsory oral exam can be taken only if the written exam has been passed (i.e. with a mark greater or equal than 18).

The final mark is the weighted average of grades of written and oral exam (respectively 40% and 60%)

In case the exam has been failed, both written and oral examination must be taken again.

The examination regards the entire course syllabus. The examination is aimed at assessing reasoning, analytical rigour with regard to course topics.

***NOTES AND PREREQUISITES***

In order to understand the topics dealt with in the course, the concepts of basic mathematics, probability, statistics, financial mathematics and basic actuarial mathematics are necessary.

At the beginning of this course the student should have an active knowledge of a basic course in probability theory, statistics, financial mathematics and actuarial mathematics (at bachelor level).

In particular, before taking the course, the student should have an understanding of:

– the concepts of discrete and continuous random variables;

– the concepts of the probability function, density function and generating functions;

– the concepts of mean, variance and skewness;

– main distributions of discrete and continuous random variables used in insurance field;

– the definition of risk premium, pure premium and safety loading;

– basic principles of financial mathematics

– the definition of financial annuities

– term structure of interest rates,

– calculation of risk/gross premiums and mathematical reserves for the basic insurance contracts (term, endowment, etc.).

*Other information and Office hours*

Further information can be found on the lecturers' webpages or on the Faculty notice board. Office hours take place at the Department of Mathematics for Economics, Finance and Actuarial Sciences, Room 219, 2° floor, Via Necchi 9, or on remote.