SYLLABUS FOR ACTUARIAL TRAINING IN BELGIUM

ComEd (KVBA-ARAB)

June 2004

The syllabus was approved by the Committee Education during their meeting on Thursday 10 June 2004 as well as by the Board of Directors during their meeting on Monday 14 June 2004.

This syllabus concerns the implementation of Article 35 of the Statutes.

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Belgian Actuarial Syllabus

The Belgian syllabus is intended to be in line with the Groupe's Core Syllabus for actuarial training in Europe, that underpins the mutual recognition agreement, as well as with IAA education guidelines.

This syllabus concentrates on content of courses and does not deal with learning approaches or assessment methods.

The Belgian syllabus is divided into the following three sections:

I. Basic Training: 3-year Bachelor

Included in this stage are subjects that are not unique to actuarial science but are essential background for study in this area.

II. Actuarial Training: 2-year Master in Actuarial Science or 1-year specialized Master after another Master

Included in this stage are subjects that form the fundamental tools for actuarial science and finance as well as subjects in which the principles and practice of actuarial techniques are developed in a variety of applications areas. The purpose at this stage is to provide a generalized framework for actuarial risk management for varying types of risk.

III. CPD

Post-qualification training is necessary to ensure that actuaries are up-to-date with changes in the framework for their practice area. Continuing Professional Development (CPD) schemes are helpful in this respect. CPD is the responsibility of the ComEd and will be organized in collaboration with universities. This issue is not presently addressed in the document.

The literature referenced in the syllabus is recommended but not binding. However, the level of the books mentioned in the syllabus should be approximately respected.

I. Basic Training

Several Bachelor programs are possible to enter an actuarial master (for instance: Mathematics, Quantitative Economics, Applied Science). Nevertheless, minimal requirements are needed to ensure a common basis of knowledge for master students. This is the aim of the present section. Universities are free to accept students who do not comply with the requirements listed hereafter provided appropriate prerequisites are added in the program.

I. 1 Foundations of Mathematics

I.1.1 Calculus

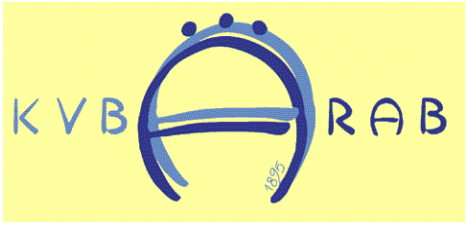
Differential and integral calculus for one and several variables, differential equations.

Introductory measure theory

I.1.2 Linear algebra

Basic knowledge of abstract linear algebra, matrix calculus, eigenvalues and eigenvectors, orthogonal projections, quadratic forms.

References: Any textbook appropriate for an undergraduate course in Calculus and Linear Algebra



I. 2 Probability and Statistics

I.2.1 Probability

Random events, Probability measure, Random Variables, Random Vectors, usual probability distributions, Expectation, Characteristic functions, Conditional Expectation, Law of Large Numbers, Central-limit Theorem

References for I.2.1:

A First Course in Probability, Ross, S.M., Prentice Hall, 2001
ISBN : 0130338516

I.2.2 Statistics

Sampling, estimation, testing procedure, confidence intervals, linear regression, chi-square tests, ... in both the frequentist and the bayesian approaches

References for I.2.2.:

Introductory Statistics, Ross, S.M., Academic Press, 2004
ISBN : 012597132X

I.2.3 Stochastic processes

Basic principles of stochastic processes in discrete and continuous time. Markov chains and Markov processes, processes with independent and stationary increments.

Poisson processes and compound Poisson processes, Wiener process. Martingale and stopping time. Introduction to time-series analysis.

References for I.2.3:

Stochastic Processes, Ross, S.M.

I.2.4 Simulation methods

Simulation of random variables, random vectors and stochastic processes.

References for I.2.4:

Simulation, Ross, S.M., Academic Press, 2001.
ISBN : 0125980531

I. 3 Economics

I.3.1 **Microeconomics**

Supply, demand and equilibrium price (in both free and controlled markets), Elasticity of supply and demand, Utility theory and consumer choice (including analysis of insurance problems), risk aversion, asymmetrical information (moral hazard, adverse selection).

References for I.3.1: any textbook appropriate for an undergraduate course in Microeconomics

I.3.2 **Macroeconomics**

General equilibrium theory, Public sector finance and taxation, Aggregate national income (measurement and analysis), The multiplier, accelerator and aggregate supply and demand, Government policies and their effects (direct and via the banking system), Domestic macroeconomic factors and their management, International trade, exchange rates and the balance of payments.

References for I.3.2: any textbook appropriate for an undergraduate course in Macroeconomics

I.3.3 **Introduction to accounting**

Different types of business entity, Financial structures of business entities, Basic principles of taxation (personal and corporate), Taxation of investments held by individuals, Taxation of investments held by institutions, The role of the main institutions in financial markets, Basic structure of company accounts (profit and loss (revenue) account, balance sheet, cash flow statement, provisions and reserves), Basic principles of group accounts, Calculation and use of accounting ratios, Limitations of company accounts.

References for I.3.3: any textbook appropriate for an undergraduate course in accounting

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Foundations of Law

I.4.1 Private Law

I.4.2 European legislation (recommended)

Purpose of international structures, Understanding variations in country cultures, Structures within EU, Relevant EU legislation, Social aspects of current concepts (e.g. protection of consumers).

II. Actuarial Training

II.1 Deterministic Financial Mathematics

Compound interest, nominal and effective interest rates ,annuities , amortization, internal rate of return of successive cash flows, models with continuous time, cash flow techniques, Term structure of interest rates, calculation of spot rates, Duration and convexity, immunization principles , Redington theory

References for II.1:

Actuarial Mathematics, N.L. Bowers et al., 2nd Edition, Society of Actuaries, 1997.

II.2 Risk theory

II.2.1 Individual and collective models

Models for claim numbers and claim amounts.

Aggregate claim amount distribution: recursive calculation of the compound Poisson and the negative binomial distribution, Recursive calculations for the individual risk model, stochastic orderings, approximation techniques. Properties of the compound Poisson distribution.

II.2.2 Ruin theory

Dynamical models for the risk process, in particular the Poisson process, the compound Poisson process and the renewal equation. Introduction to ruin theory, the role of the adjustment coefficient. Martingales and their applications in ruin theory, in particular the optional sampling theorem.

II.2.3 Risk exchanges

Utility function and applications (principles of premiums calculations), theorem of Borch.

References for II.2:

Actuarial Mathematics, N.L. Bowers et al., 2nd Edition, Society of Actuaries, 1997, chapters 2, 12-14.

Practical Risk Theory for Actuaries, C.D. Daykin, T. Pentikäinen. M. Pesonen, Chapman & Hall, London 1994

Modern Actuarial Risk Theory, R. Kaas, M.J. Goovaerts, J. Dhaene, M. Denuit, Kluwer Academic Publishers, 2001

Modelling Extremal Events for Insurance and Finance, P. Embrechts, C. Klüppelberg, Th. Mikosch, Springer, Berlin, 1997

II.3. Life insurance mathematics

II.3.1 Survival analysis

Construction of life tables and determination of other technical bases with methods statistics and graduation

Binomial and Poisson models of mortality

Comparison of actual against expected mortality experience

Projected lifetables

Future life expectancy, technical bases, commutation functions

Risk classification in life insurance

Multiple state approach to actuarial modeling :

Statistical models of transfers between multiple states.

State-space and Markov models for life insurance.

Maximum likelihood estimators for transition intensities.

Construction of a multiple decrement table.

II.3.2 Premium and reserves calculation

Life insurance, annuities, net premiums, net reserves, deterministic and stochastic interpretations.

Insurance on several lives.

Formulae for annuity values and assurance factors for single life and joint life assurances and annuities.

Random future loss. Net premiums and net premium reserves. Gross premiums and gross premium reserves. Zillmerization, profit participation.

II.3.3 Modern insurance contracts

Actuarial analysis of modern products in life insurance, particularly fund and unit-linked policies.

References for II.3:

Life Insurance Mathematics, H.U. Gerber, 3rd Edition, Springer Verlag, 1997.

Actuarial Mathematics, N.L. Bowers et al., 2nd Edition Society of Actuaries, 1997, chapters 3-11.

Life Insurance Theory, F.E. De Vylder, Kluwer Academic Publishers, 1997.

II.4 Pension mathematics

Basic principles of pension funding (pay as your go, funding methods,..).

Benefits type and management of pension plans including social security arrangements and legal aspects.

Equilibrium relation between pay-as-you-go and individual funding (Samuelson paradox; generation. equilibrium,..)

Description and analysis of the Belgian first pillar of pension.

Actuarial calculations of contributions and provisions for defined benefit plans in various funding methods (individual and collective funding approaches such as individual level premium, unit credit cost ,entry age, aggregate cost,…).

Gains and losses in a pension plan, asset and liability management aspect.

Accounting principles in pension provisions (FAS, IFRS,..) (recommended)

References for II.4:

The fundamentals of pension mathematics, B.N. Berin, Society of actuaries, 1989.

Techniques actuarielles de la sécurité sociale, P.Thullen,B.I.T., Genève, 1974.

Pension mathematics , H. Winklevoss, Homewood, Illinois, 1977.

II.5. Non-life insurance mathematics

II.5.1 A priori ratemaking:

Underwriting

Data requirements and verification

Pricing bases for general insurance contracts

Risk classification (with GLM's, GAM's)

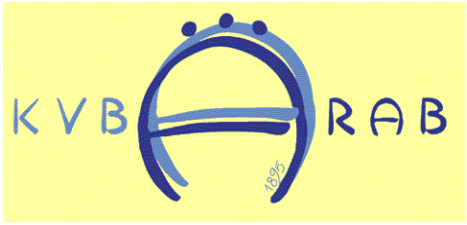
II.5.2 A posteriori ratemaking:

Credibility theory: Bayesian and linear approaches

NCD and bonus-malus mechanisms

II.5.3 Loss reserving

- Use of scenario testing and simulation for **DFA** (dynamic financial analysis) of general insurance business of a company



II.5.4 Solvency

References for II.5:

Modelling Extremal Events for Insurance and Finance, P. Embrechts, C. Klüppelberg, Th. Mikosch, Springer, Berlin, 1997.

Loss Models, From Data to Decisions, S. A. Klugman, H.H. Panjer, G. E. Willmot, John Wiley & Sons Inc., New York, 1998.

Bonus-Malus Systems in Automobile Insurance, J. Lemaire, Kluwer Academic Publishers, Boston, 1995.

Claims Reserving in Non-Life Insurance, G.C. Taylor, North Holland, Amsterdam, 1986.

Loss Reserving : An Actuarial Perspective, G.C. Taylor, Kluwer Academic Publishers, 2000.

Modern Actuarial Risk Theory, R. Kaas, M.J. Goovaerts, J. Dhaene, M. Denuit, Kluwer Academic Publishers, 2001.

Effective Actuarial Methods, M.J. Goovaerts, R. Kaas, A.E. van Heerwaarden, T. Bauwelinckx, North-Holland, Insurance Series 3, 1990.

II.6 Health and Accident insurance

-Main features of the major types of health and accident insurance products.

-Principle of health insurance markets

-Major areas of risk and uncertainty in health

-Pricing of health insurance products .

-Modelling of the uncertainty in claim frequency and amount

References for II.6:

Actuarial Models for disability insurance, S.Haberman, E.Pitacco, Chapman & Hall, London, 1998

II.7 Stochastic Finance

II.7.1 Principles of market finance

Portfolio theory.

Arbitrage pricing principles.

II.7.2 Stochastic calculus

Brownian motion.

Stochastic integrals.

Stochastic differential equations.

II.7.3 Pricing and hedging of derivatives

Discrete time and continuous time models (Binomial; Black and Scholes).

General theorem of pricing.

Complete and incomplete markets.

Exotic options.

II.7.4 Stochastic term structure of interest rates

Discrete time and continuous time models (Ho and Lee; Vasicek, Heath-Jarrow-Merton,..).

Derivatives on interest rates and forward measures.

II.7.5 Stochastic optimal control and application to ALM

Basics of optimal control.

Application to asset and liability management of financial products.

II.7.6 Application to insurance products

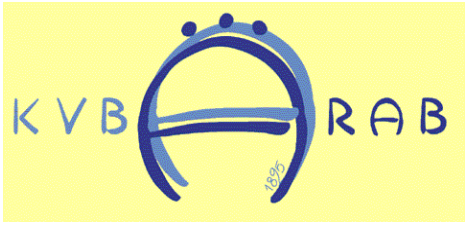
Pricing of life insurance with profit in a stochastic environment.

Pricing of equity linked products with guarantees.

Securitization of insurance arrangements.

<u>References for II.7:</u>

Introduction to Stochastic Calculus Applied to Finance, D. Lamberton, B. Lapeyre, Chapman &Hall.



Finance Stochastique, P. Devolder, Editions ULB.

Options, Futures and Other Derivatives, J.C. Hull, Prentice-Hall.

Martingale methods in financial modeling , M. Musiela, M. Rutkowski, Springer Verlag.

Interest Rate Models: Theory and Practice, D. Brigo, F. Mercurio, Springer, 2001.

Stochastic Integration and Differential equations, P. Protter, Springer-Verlag, 2004.

Lévy Processes in Finance, W. Schoutens, Wiley, 2003.

II.8 Reinsurance

II.8.1 Why buying Reinsurance ?

The classical point of view.
The financial point of view.
Borch Theorem

II.8.2 Forms of Reinsurance

Main provisions of reinsurance contracts (sliding scales, paid reinstatements, stability clause, …).

II.8.3 Applications of Risk Theory to reinsurance :

As if statistics.

Excess of Loss pricing

Stop-Loss pricing.

II.8.4 Exposure rating

II.8.5 Life Reinsurance

II.8.6 Optimal Reinsurance

References:

Manuel de Réassurance, M. Grossmann, 1983, L'Argus.

Reinsurance, RL Carter, LD Lucas, Ralph, N., 2000, Reactions Publishing Group.
Reinsurance Principles and Practice (tome I and II), Gerathewohl, Verlag Versicherungswirtschaft e.V. Karlsruhe, 1980.