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CORE SYLLABUS

FOR

ACTUARIAL TRAINING IN EUROPE

September 2005

GROUPE CONSULTATIF SYLLABUSES

A CORE SYLLABUS FOR ACTUARIAL TRAINING IN EUROPE

PART ONE: GUIDELINES FOR THE SYLLABUS

Introduction

1. The core syllabus for actuarial training in Europe is presented in Part Two of this document. In this section guidelines to the use of the syllabus are presented.

Purpose of Syllabus

2. This syllabus is intended to underpin the mutual recognition agreement.
3. The core syllabus will also provide a tool to aid associations in reviewing their own syllabuses. All associations will wish to implement it in their own way.
4. The core syllabus will provide a tool to new associations wishing to develop a syllabus.

Syllabus Presentation

5. The syllabus has been prepared as four stages:

Stage 0 : Preliminary Stage

Included in this stage are subjects that are not unique to actuarial science but are essential background for study in this area. The subjects need not be covered individually but could be integrated with other subjects.

Stage 1 : Actuarial Foundation Stage

Included in this stage are subjects that form the fundamental tools for actuarial science and finance.

Stage 2 : Generalised Applications Stage

Included in this stage are 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 generalised framework for actuarial risk management for varying types of risk. The subjects need not be covered individually but the actuarial concepts are important with examples to demonstrate different approaches depending on the different nature of risk.

Stage 3 : Country Specific and Specialist Stage

As a final stage student actuaries will need to study the detailed regulatory, legislative, cultural and administrative framework of the country in which they intend to work. Students may also study one particular area of risk management in greater depth to gain the full qualification for their association. This stage will thus be unique to each country and hence will not form part of the common core.

6. Post-qualification training will be necessary to ensure that actuaries are up-to-date with changes in the framework for their practice area. Continuing Professional Development (CPD) schemes will be helpful in this respect.
7. Within each stage topics have been presented under a number of subject headings. This grouping has been done to aid comprehension and assimilation. The subjects should not be considered to be of equal weight. It is anticipated that each country and institution will choose to regroup the topics in ways that are appropriate for each particular organisation and method of syllabus delivery.

8. The subjects, particularly for the preliminary stage, contain many topics that might be covered before starting any formal actuarial education. Again there will be differences between countries and institutions in this respect and the entry requirements for each individual organisation and association will reflect this. It is not important at which stage topics are covered, only that students gain proficiency in them. Organisations may well regroup topics presented here in different stages to be covered within a subject which covers several stages. Thus in some countries the mathematical background and practical consideration of particular topics may be covered together.
9. It is not necessary for all topics, particularly in the preliminary stage, to be directly assessed during formal actuarial education but consideration might be given to ways of helping the actuarial student cover relevant material.
10. The order in which subjects and topics are covered will also be the decision of each individual organisation.
11. It is recognised that in different countries actuarial education may be offered through universities, through the professional association or through a combination of both. The balance between more theoretical and more practical considerations will vary under different systems. Emphasis will also vary between countries.
12. Student actuaries need to develop higher order skills of analysis, synthesis and judgement. This may be achieved through different forms of study and assessment such as a dissertation or through practical work experience.
13. This syllabus concentrates on content of courses and does not deal with learning approaches or assessment methods.
14. The reading lists are intended to be indicative of sources of reading on topics providing guidance to students and are not required reading. Some references quoted under the generalised applications section are country specific but are included for completeness.

Syllabus Themes for the Training of Actuaries

15. In the training of actuaries it is important that the actuaries understand the principles of modelling with the practical considerations for the use of models. This theme will be encouraged where appropriate in all syllabuses.
16. Through the generalised applications stage students are encouraged to understand the principles of actuarial risk management. Actuaries are increasingly working with new products covering new types of risk and for this reason students are encouraged to consider wider types of risk than the ones in which they are currently practising.
17. The core syllabus contains no details on professionalism skills. Again each association will need to ensure that each actuary on qualification is aware of the code of conduct and relevant standards of practice.
18. It is important that student actuaries are aware of the business environment in which they will be working.

Syllabus Development

19. There is a commitment to keep this syllabus under review and to update it as appropriate on a regular basis. It is important that the syllabus does not become obsolete over time.
20. This syllabus has been developed concurrently with the development of the syllabus for the International Actuarial Association. However, the IAA syllabus is not intended to support mutual recognition of full qualifications and does not include Stage 3.
21. Within the Groupe Consultatif there is a mutual recognition agreement of qualifications and the purpose of this syllabus is to develop as far as Stage 2 a harmonisation of syllabuses throughout member countries. In order to benefit from the mutual recognition agreement it is proposed that an actuary must have three years' practical experience, including one year's experience in the country in which they wish to practise.

PART TWO: GROUPE CONSULTATIF SYLLABUSES

STAGE 0: PRELIMINARY STAGE

The subjects at this stage are:

1. Mathematics
2. Probability and Statistics
3. Stochastic Processes
4. Computing
5. Economics
6. Accounting and Financial Reports
7. Structures and Legislative Instruments of the European Union
8. Communication Skills
9. Language Skills

Actuarial students may have studied many of these topics before starting formal actuarial education. In some subjects, in particular 4, 7, 8 and 9, no formal assessment requirements are suggested. In the others, assessment may have been at earlier stages of education.

1. Mathematics

Aim: To provide a grounding in mathematical techniques to support the understanding of the other subjects and to provide an understanding of mathematical modelling.

- (a) Functions, equations and inequalities
- (b) Differential and integral calculus
- (c) Differential equations
- (d) Sequences and series
- (e) Linear algebra
- (f) Introductory measure theory
- (g) Difference equations
- (h) Fourier analysis
- (i) Numerical analysis

Suggested reading:

Fraleigh, J. B. (2003) *A first course in abstract algebra*. 7th ed. Boston, MA: Addison-Wesley. 520 pages. ISBN: 0201763907.

Gramain, A. (1998) *Integration*. New ed. Paris: Hermann. 226 pages. ISBN: 2705663754.

McGregor, C. M.; Nimmo, J. J. C.; Stothers, W. W. (1994) *Fundamentals of university mathematics*. Chichester: Albion Publishing. 540 pages. ISBN: 1898563098.

Any textbook appropriate for an undergraduate degree course in Calculus and Linear Algebra.

2. Probability and Statistics

Aim: To provide a grounding in statistics and probability.

- (a) Main features of data sets
- (b) Basic probability theory
- (c) Random variables and related concepts
- (d) Transformation of variables
- (e) Generating functions

- (f) Central limit theorem
- (g) Concepts of sampling
- (h) Methods of estimation
- (i) Confidence intervals.
- (j) Hypothesis testing
- (k) Correlation analysis and regression analysis
- (l) Analysis of variance
- (m) Decision theory
- (n) Simulation methods

Suggested reading:

Escruder, R.; Murgui, S. (1995) *Estadística aplicada*. Valencia: Tirant lo Blanc.

Faculty and Institute of Actuaries. *Core reading for Subject CT3*.

Miller, I.; Miller, M.; [Freund, J. E.] (2004) *John E Freund's mathematical statistics with applications*. 7th ed. Upper Saddle River, NJ: Prentice Hall. x, 614 pages. ISBN: 0131246461.

Saporta, G. (1990) *Probabilité, analyse des données et statistique*. Paris: Editions Technip. 493 pages. ISBN: 2710805650.

Tassi, P. (1985) *Méthodes statistiques*. Paris: Économica. 369 pages. ISBN: 2717809600.

Any textbook appropriate for a first year degree course in statistics.

3. Stochastic Processes

Aim: To provide a grounding in stochastic processes and their use in models for actuarial work.

- (a) Principles of modelling
- (b) Principles and classification of stochastic processes
- (c) Markov chains
- (d) Markov processes
- (e) Time series
- (f) Gauss-Wiener processes
- (g) Simulation methods for stochastic processes

Suggested reading:

Faculty and Institute of Actuaries. *Core reading for Subject CT4*.

Dana, R. A.; Jeanblanc-Picque, M. (1998) *Marchés financiers en temps continu: valorisation et équilibre*. 2nd ed. Paris: Économica. 330 pages. ISBN: 2717837108.

Demange, G.; Rochet, J.-C. (1997) *Méthodes mathématiques de la finance*. Paris: Économica. 305 pages. ISBN: 2717831320.

Devolder, P. (1993) *Finance stochastiques*. Brussels: Editions de l'Université de Bruxelles. 269 pages. ISBN: 2800410620.

Embrechts, P.; Kluppelberg, C. and Mikosch, T. (2001) *Modelling extremal events for insurance and finance*. Springer.

Gourieroux, C.; Monfort, A. (1995) *Séries temporelles et modèles dynamiques*. 2nd ed. Paris: Économica. 664 pages. ISBN: 2717828710.

Karlin, S.; Taylor, H. M. (1975) *A first course in stochastic processes*. 2nd ed. San Diego, CA: Academic Press. 557 pages. ISBN: 0123985528.

Lamberton, D.; Lapeyre, B. (1996) *Introduction to stochastic calculus applied to finance*. London: Chapman & Hall. 185 pages. ISBN: 0412718006.

Roger, P. (2000) *Les outils de la modélisation financière*. Paris: Presses Universitaires de France. 296 pages. ISBN: 2130429165.

Society of Actuaries. *Monograph on stochastic calculus (to appear)*

Torrelles, E.; Viladomiu, N. (1995) *Anàlisi de Sèries Temporals (I i II)*. Barcelona: Departament d'Econometria, Estadística i Econòmica Espanyola de la Facultat de Ciències Econòmiques, Universitat de Barcelona.

4. Computing

Aim: To provide a grounding in modern computing methods necessary for the work of an actuary

The student is expected to have a working knowledge of modern Information Communications Technology appropriate for the work of an actuary.

5. Economics

Aim: To provide a grounding in the fundamental concepts of economics as they affect the operation of insurance and other financial systems

- (a) Supply, demand and equilibrium price (in both free and controlled markets)
- (b) Elasticity of supply and demand
- (c) Utility theory and consumer choice (including analysis of insurance problems)
- (d) Theory of the firm under differing market structures
- (e) General equilibrium theory
- (f) Public sector finance and taxation
- (g) Aggregate national income: measurement and analysis
- (h) The multiplier, accelerator and aggregate supply and demand
- (i) Government policies and their effects (direct and via the banking system)
- (j) Domestic macroeconomic factors and their management
- (k) International trade, exchange rates and the balance of payments

Suggested reading:

Faculty & Institute of Actuaries *Core Reading for Subject CT7* would be suitable.

There are many suitable textbooks at an introductory undergraduate level although most have a fairly strong national bias.

Begg, D. K. H.; Fischer, S.; Dornbusch, R. (2003) *Economics*. 7th ed. London: McGraw-Hill. 552 pages. ISBN: 0077099478.

would be suitable for the UK.

6. Accounting and Financial Reports

Aim: To provide the ability to interpret the accounts and financial statements of companies and financial institutions

- (a) Different types of business entity
- (b) Financial structures of business entities
- (c) Basic principles of personal and corporate taxation
- (d) Taxation of investments held by individuals

- (e) Taxation of investments held by institutions
- (f) The role of the main institutions in financial markets
- (g) Basic structure of company accounts
 - profit and loss (revenue) account
 - balance sheet
 - cash flow statement
 - provisions and reserves
- (h) Basic principles of group accounts
- (i) Calculation and use of accounting ratios
- (j) Limitations of company accounts

Suggested reading:

The relevant parts of the Faculty & Institute of Actuaries *Core Reading for Subject CT2* would be suitable.

Accounting texts tend to be too detailed and country specific, although the introductory parts of standard accounting courses may be suitable. Other suitable texts are likely to be written for general management studies rather than for accountants.

On the analysis of accounts, most books written for investment analysts are likely to contain too much industry and country detail. A treatment at a suitable level is provided, for example, in the chapter "Analysing Financial Performance" in

Brealey, R. A.; Myers, S. C. (2003) *Principles of corporate finance*. 7th ed. New York: McGraw-Hill. 1,004 pages. ISBN: 0071151443.

Another suitable text might be the training manual for the Investment Management Certificate of the Institute for Investment Management and Research (IIMR).

7. Structures and Legislative Instruments of the European Union (EU)

Aim: To give students an appreciation of the structures and legislative instruments of the EU. This part would not be compulsory but is recommended as part of a European qualification.

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

A formal assessment of this part is not necessary.

8. Communication Skills

Aim: To develop the ability to present actuarial ideas and arguments both on paper and orally in a manner which will enable them to be understood by non-actuaries.

Objectives:

- (a) The student would be expected to be able to draft a written communication intended to be read by a lay person to a standard where the draft would:
 - be acceptable as a final document without major changes or rewriting, though a moderate number of more minor changes might still be required (a standard which might be appropriate for a newly qualified actuary, rather than a specialist experienced actuary),
 - convey the major concepts and contain no major mis-statements of fact or omissions or unsupported opinion.
- (b) The student would also be expected to be able to make an oral presentation on a technical subject to a lay person.

A formal assessment of this part is not necessary.

Suggested reading:

Any textbook on good writing style and presentation.

Any textbook on grammar, spelling and punctuation.

9. Language Skills

Aim: To enable students to communicate in business discussions and to read actuarial literature in at least two of the languages of the countries within the EU.

This part would not be compulsory but is recommended as part of a European qualification.

A formal assessment of this part is not necessary.

STAGE 1: ACTUARIAL FOUNDATION STAGE

The subjects at this stage are:

10. Financial Mathematics
11. Survival Models
12. Contingencies
13. Risk Mathematics
14. Finance and financial markets

10. Financial Mathematics

Aim: To provide a grounding in financial mathematics and their applications to actuarial science.

- (a) Deterministic theory of interest
 - traditional compound interest
 - cash-flow modelling; annuities certain
 - bond market theory
- (b) Introduction to contingent claims analysis
 - definition of derivative securities
 - no arbitrage principle
- (c) Stochastic calculus for finance
 - conditional expectation, introduction to martingales
 - stochastic integrals and differential equations
 - pricing and hedging of derivatives
- (d) Stochastic theory of interest
 - interest rate models (discrete and continuous time)
 - derivatives on interest rates and bonds
- (e) Dynamic portfolio management
 - asset-liability modelling
 - introduction to stochastic optimal control
- (f) Introductory applications to insurance liabilities
 - embedded options in life insurance
 - valuation techniques for embedded options

Suggested reading:

Betzuen Zalbidegoitia, A. (2001) *Curso de matemáticas financieras: Análisis financiero fundamental, rentas y constitución de capitales*. Bilbao: Instituto de Estudios Financiero-Actuariales.

Betzuen Zalbidegoitia, A. (2003) *Curso de matemáticas financieras: Operaciones de préstamo. Operaciones de empréstito-obligaciones*. Bilbao: Instituto de Estudios Financiero-Actuariales.

Bjork, T. (2004) *Arbitrage theory in continuous time*. Oxford University Press.

Bowers, N. L.; Gerber, H. U.; Hickman, J. C. et al (1997) *Actuarial mathematics*. 2nd ed. Schaumburg, IL: Society of Actuaries. 753 pages. ISBN: 0938959468.

Brigo, D. and Mercurio, F. (2001) *Interest rate models: theory and practice*. Springer.

Broverman, S. A. (2004) *Mathematics of investment and credit*. 3rd ed. Winsted, CT: Actex. 521 pages. ISBN: 1566984750.

Butcher, M. V.; Nesbitt, C. J. (1971) *Mathematics of compound interest*. Michigan: Ulrich's Books. 324 pages. ISBN: 0960300015.

De Felice, M.; Moriconi, F. (1991) *La teoria dell'immunizzazione finanziaria: modelli e strategie*. Bologna: il Mulino. 364 pages. ISBN: 8815024573.

Devolder, P. *Finance Stochastique*. Editions ULB

Elliott, R.J. and Kopp, P.E. (1999) *Mathematics of Financial Markets*. Springer.

Faculty and Institute of Actuaries. *Core reading for Subjects CT1 and CT8.*

Fontanals, H ; Galisteo, M. (1997) *Estructura temporal de los tipos de interés*. Col·lecció de Publicacions del Departament de Matemàtica Econòmica, Financiera i Actuarial N.35, Universitat de Barcelona.

Gil Pelaez, L. (1989) *Matemática de las operaciones financieras: problemas resueltos*. Madrid: Ediciones A.C. 504 pages. ISBN: 8472881229.

Gil Peláez, L. (1987) *Matemática de las operaciones financieras*. Madrid: Ediciones A.C. 735 pages. ISBN: 8472881237.

González Catalá V.T. (1992) *Análisis de las operaciones financieras, bancarias y bursátiles*. Madrid: Ciencias Sociales.

González Catalá V.T. (1993) *Operaciones financieras, bancarias y bursátiles*. Curso practico. Madrid: Ciencias Sociales

Hull, J.C. (2002) *Options, futures and other derivatives*. 5th ed. Upper Saddle River, NJ: Prentice Hall. 744 pages. ISBN: 0130465925

Ingersoll, J. E. (1987) *Theory of financial decision making*. Savage, MD: Rowman & Littlefield. 474 pages. ISBN: 0847673596.

Lamberton, D. and Lapeyre, B. (1996) *Introduction to stochastic calculus applied to finance*. Chapman & Hall (CLC Press, London)

Kellison, S. G. (1991) *The theory of interest*. 2nd ed. Homewood, IL: Irwin. 446 pages. ISBN: 0256091501.

McCutcheon, J. J.; Scott, W. F. (1986) *An introduction to the mathematics of finance*. London: Heinemann. 463 pages. ISBN: 043491228X.

Meneu, V.; Jordá, M.P. and Barreira, M.T. (1996) *Operaciones financieras en el Mercado español*. Barcelona: Ariel.

Mikosch, T. (1998) *Elementary stochastic calculus with finance in view*. World Scientific.

Moriconi, F. (1995) *Matematica finanziaria*. Bologna: il Mulino. 319 pages. ISBN: 8815048189.

Musiela, M and Rutowski, M. (?) *Martingale methods in financial modelling*. Springer Verlag.

Panjer, H. H. (1986) *Actuarial mathematics*. Providence, R.I.: American Mathematical Society. 127 pages. ISBN: 0821800965.

Parmenter, M. M. (1999) *Theory of interest and life contingencies, with pension applications: a problem-solving approach*. 3rd ed. Winsted, CT: Actex. 301 pages. ISBN: 1566983339.

Poncet, P.; Portrait, R.; Hayat, S. (1999) *Mathématiques financières*. Paris: Dalloz-Sirey. 448 pages. ISBN: 2247015255.

Rodríguez, A. (1994) *Matemática de la financiación*. Barcelona: Ediciones S.

Rodríguez, A. (1998) *Fundamentos de la matemática financiera*. Barcelona: Alfonso Rodríguez.

Ross, S.M. (2003) *An elementary introduction to mathematical finance*. Cambridge

Shreve, S. (2004) *Stochastic calculus for Finance (vol I and II)*. Springer.

Trowbridge, C. L. (1989) *Fundamental concepts of actuarial science*. Schaumburg, IL: Society of Actuaries. 79 pages.

Zima, P.; Brown, R. L. (1993) *Mathematics of finance*. 4th ed. Toronto: McGraw-Hill Ryerson. 350 pages. ISBN: 0075515148.

11. Survival Models

Aim: To provide a grounding in survival models

- (a) Survival models
- (b) Statistical models of transfers between multiple states

- (c) State-space and Markov models for life insurance
- (d) Maximum likelihood estimators for transition intensities
- (e) Construction of a multiple decrement table.
- (f) Binomial model of mortality
- (g) Graduation
- (h) Comparison of actual against expected experience.
- (i) The use of single figure indices, for describing the variation of mortality and sickness.
- (j) Heterogeneity within a population with regard to mortality and sickness.

Suggested Reading:

Andersen, P. K.; Brogan, O.; Gill, R. D. et al (1993) *Statistical models based on counting processes*. New York: Springer. 767 pages. ISBN: 0387978720.

Ayuso, M.; Corrales, H.; Guillén, M; Pérez. A.M.; Rojo, J.L. (2001) *Estadística Actuarial Vida*. Edicions UB.

Cipra, T. (1990) *Matematicke metody demografie a pojistení; (Mathematical methods of demography and insurance)* Praha: SNTL. ISBN: 8003002222.

Collett, D. (2003) *Modelling survival data in medical research*. 2nd ed. Boca Raton, FL: Chapman & Hall/CRC. 391 pages. ISBN: 1584883251.

Cox, D. R.; Oakes, D. (1984) *Analysis of survival data*. London: Chapman & Hall. 201 pages. ISBN: 041224490X.

Elandt-Johnson, R. C.; Johnson, N. L. (1999) *Survival models and data analysis*. Chichester: John Wiley. 457 pages. ISBN: 0471349925.

Faculty and Institute of Actuaries. *Core reading for Subject CT4*.

Haberman, S.; Pitacco, E. (1999) *Actuarial models for disability insurance*. Boca Raton, FL: Chapman & Hall. 280 pages. ISBN: 0849303893.

Leguina, J. (1989) *Fundamentos de demografía*. 4th ed. Madrid: Siglo XXI de España. 338 pages. ISBN: 8432304123.

London, D. (1988) *Survival models and their estimation*. Actex.

London, D. (1985) *The revision of estimates*. Actex.

Marubini, E.; Valsecchi, M. G. (2004) *Analysing survival data from clinical trials and observational studies*. 2nd ed. Chichester: John Wiley. 424 pages. ISBN: 0470093412.

Miller, R.G. (1981) *Survival Analysis*. Wiley

12. Contingencies

Aim: To provide a grounding in the mathematical techniques which are of particular relevance to actuarial work in life insurance, health insurance and pensions.

- (a) Formulae for annuity values and assurance factors for single life and joint life assurances and annuities.
- (b) Surrender values and policy alternations.
- (c) The use of computational tools.
- (d) Random future loss.
- (e) Net premiums and net premium reserves.
- (f) Gross premiums and gross premium reserves.

Suggested Reading:

Alegre, A. (2001) *Operaciones actuariales sobre varias vidas*. Col·lecció de Publicacions del Departament de Matemàtica Econòmica, Financera i Actuarial N.55, Universitat de Barcelona.

Booth, P. M.; Chadburn, R. G.; Cooper, D. R. et al (1999) *Modern actuarial theory and practice*. Boca Raton, FL: Chapman & Hall. 716 pages. ISBN: 0849303885.

Bowers, N. L.; Gerber, H. U.; Hickman, J. C. et al (1997) *Actuarial mathematics*. 2nd ed. Schaumburg, IL: Society of Actuaries. 753 pages. ISBN: 0938959468.

Bruijns, H. G. W. K.; Pinkse, C. C. W. (2000) *Levensverzekeringwiskunde*. 4th ed. Groningen: Wolters-Noordhoff. 167 pages. ISBN: 9001180922.

Faculty and Institute of Actuaries. *Core reading for Subject CT5*.

Gerber, H. U. (1997) *Life insurance mathematics*. 3rd ed. Berlin: Springer; Swiss Association of Actuaries. 217 pages. ISBN: 354062242X.

Gil Fana, J.A.; Heras Martínez, A. and Vilar Zanón, J.L. (1999) *Matemática de los seguros de vida*. Madrid: Mapfre.

Isenbart, F.; Münzner, H. (1994) *Lebensversicherungsmathematik für Praxis und Studium*. 3rd ed. Wiesbaden: Gabler. 120 pages. ISBN: 3409858342.

Nieto de Alba, U.; Vegas Asensio, J. (1993 (repr 2001)) *Matemática actuarial*. Madrid: Mapfre. 364 pages. ISBN: 8471009722.

Wolff, K.-H. (1970) *Versicherungsmathematik*. Vienna: Springer. 405 pages.

Wolthuis, H. (1994) *Life insurance mathematics (the Markovian model)* (CAIRE Education Series 2) Brussels: CAIRE. 255 pages. ISBN: 907495802X.

13. Risk Mathematics

Aim: To provide a grounding in risk mathematics and its use in actuarial work.

- (a) Loss distributions.
- (b) Risk models.
- (c) Aggregate claim distributions for short term insurance contracts.
- (d) Ruin theory.
- (e) The impact of reinsurance.
- (f) Credibility theory.
- (g) Loss reserving
- (h) No claim discount (NCD) systems.
- (i) Use of scenario testing and simulation for dynamic financial analysis of general insurance business of a company

Suggested reading:

Bowers, N. L.; Gerber, H. U.; Hickman, J. C. et al (1997) *Actuarial mathematics*. 2nd ed. Schaumburg, IL: Society of Actuaries. 753 pages. ISBN: 0938959468.

Bühlmann, H. (1970) *Mathematical models in risk theory*. Springer.

Claramunt, M.M.; Costa, T. (2003) *Matemàtica Actuarial No Vida. Un enfoque pràctic*. Col·lecció de Publicacions del Departament de Matemàtica Econòmica, Financera i Actuarial N.63, Universitat de Barcelona.

Claramunt, M.M.; Mármol, M. (2003) *Solvencia: una introducció a la probabilitat de ruina*. Col·lecció de Publicacions del Departament de Matemàtica Econòmica, Financera i Actuarial N.65, Universitat de Barcelona.

Daykin, C. D.; Pentikäinen, T.; Pesonen, M. (1994) *Practical risk theory for actuaries*. London: CLC Press. 545 pages. ISBN: 0412428504.

Faculty and Institute of Actuaries. *Core reading for Subject CT6.*

Gerber, H. U. (1979) *An introduction to mathematical risk theory*. Philadelphia: University of Pennsylvania. 164 pages. ISBN: 0918930081.

Goovaerts, M. and Hoogstad, W.J. (1987) *Credibility theory*. Nationale Nederlanden

Heilmann, W.-R. (1988) *Fundamentals of risk theory*. Karlsruhe: Verlag Versicherungswirtschaft. 288 pages. ISBN: 388487151X.

Herzog, T. N. (1999) *Introduction to credibility theory*. 3rd ed. Winsted, CT: Actex. 273 pages. ISBN: 1566983746.

Herzog, T. N.; Lord, G. (2003) *Applications of Monte Carlo methods to finance & insurance*. Winsted, CT: Actex. 264 pages. ISBN: 1566984335.

Hossack, I. B.; Pollard, J. H.; Zehnwirth, B. (1999) *Introductory statistics with applications in general insurance*. 2nd ed. Cambridge: Cambridge University Press. 282 pages. ISBN: 052165534X.

Klugman, S. A.; Panjer, H. H.; Willmot, G. E. (2004) *Loss models: from data to decisions*. 2nd ed. Hoboken, NJ: John Wiley. 688 pages. ISBN: 0471215775.

Koutsopoulos, C.J. (1999) *A??a??t??a ??a??a: ?e??a t?? d????* Symmetria, Athens. ISBN 960-11-0006-7.

Latorre Llorens, L. (1992) *Teoría del riesgo y sus aplicaciones a la empresa aseguradora*. Madrid: Mapfre.

López Cachero, M.; López de la Manzanara Barbero, J.L. (1996) *Estadística para actuarios*. Madrid: Mapfre

Mikosch, T. (2004) *Non-life Insurance Mathematics*. Springer-Verlag, Berlin.

Nieto de Alba, U. and Vegas Asensio, J. (1993) *Matemática Actuarial*. Madrid: Mapfre.

Panjer, H.H. and Willmot, G.E. (1992) *Insurance risk models*. Society of Actuaries.

Sarrasí, F.J. (2003) *Matemática del Reaseguro*. Col·lecció de Publicacions del Departament de Matemática Económica, Financera i Actuarial N.61, Universitat de Barcelona.

14. Finance and financial markets

Aim: To instil the ability to apply, in simple situations, the principles of actuarial planning and control to the appraisal of investments, to the measurement of investment performance, and to the selection and management of investments appropriate to the needs of investors.

Section 14.1 (Financial markets)

- (a) Characteristics of different types of investment
- (b) Investment indices
- (c) Price and valuation
- (d) Principles of regulation and accounting
- (e) Arbitrage-free markets

Section 14.2 (Corporate finance)

- (f) Cash-flow techniques (deterministic v. stochastic; risk neutral v. deflators)
- (g) Cost of capital and capital budgeting
- (h) Performance measurement (e.g. EVA, economic profit, economic capital, RAROC etc) and management

Section 14.3 (Portfolio theory)

- (i) Market efficiency
- (j) Financial risk management and diversification
- (k) Capital Asset Pricing Model (CAPM)
- (l) Arbitrage Pricing Theory (APT)

Suggested reading:

The relevant parts of the Faculty & Institute *Core Reading for Subjects CT8, CA1 and perhaps ST6* would be suitable.

Most investment text books are either too theoretical or too practical, not mathematical enough and country specific. There are, however, several US text books which contain material at about the right level. These include:

Augros, J.-C. (1999) *Les options sur taux d'intérêt*. Paris: Économica. 298 pages. ISBN: 2717817190.

Bodie, Z.; Kane, A.; Marcus, A. J. (2005) *Investments*. 6th ed. Boston, MA: McGraw-Hill. 1,090 pages. ISBN: 0072861789.

Booth, P. M.; Chadburn, R. G.; Cooper, D. R. et al (1999) *Modern actuarial theory and practice*. Boca Raton, FL: Chapman & Hall. 716 pages. ISBN: 0849303885.

Bouchard, J.-P.; Potter, M. (1999) *Théorie des risques financiers*. Paris: Commissariat à l'Energie Atomique. 208 pages. ISBN: 2727201907.

Boyle, P. P. (1992) *Options and the management of financial risk*. Schaumburg, IL: Society of Actuaries. 210 pages. ISBN: 0938959263.

Costa, T.; Lecina, J.M.; Pons, M.A. (2001) *Fras y futuros financieros*. Col·lecció de Publicacions del Departament de Matemàtica Econòmica, Financera i Actuarial N.44, Universitat de Barcelona.

Cox, J. C.; Rubinstein, M. (1985) *Options markets*. Englewood Cliffs, NJ: Prentice-Hall. 498 pages. ISBN: 0136382053.

De Felice, M.; Moriconi, F. (1991) *La teoria dell'immunizzazione finanziaria: modelli e strategie*. Bologna: il Mulino. 364 pages. ISBN: 8815024573.

Elton, E. J.; Gruber, M. J.; Brown, S. J. et al (2003) *Modern portfolio theory and investment analysis*. 6th ed. New York: John Wiley. 705 pages. ISBN: 0471238546.

Fernández, P. (1996) *Opciones, futuros e instrumentos derivados*. Bilbao: Deusto. 588 pages. ISBN: 8423414345.

González Catalá V.T. (1992) *Análisis de las operaciones financieras, bancarias y bursátiles*. Madrid: Ciencias Sociales.

González Catalá V.T. (1993) *Operaciones financieras, bancarias y bursátiles*. Curso practico. Madrid: Ciencias Sociales

Ho, T. S. Y. (1990) *Strategic fixed-income investment*. Homewood, IL: Irwin. 372 pages. ISBN: 1556231202.

Hull, J. C. (2002) *Options, futures and other derivatives*. 5th ed. Upper Saddle River, NJ: Prentice Hall. 744 pages. ISBN: 0130465925.

Lamothe Fernández, P. (1993) *Opciones financieras: un enfoque fundamental*. Madrid: McGraw-Hill

Maginn, J. L.; Tuttle, D. L. (eds) (1990) *Managing investment portfolios: a dynamic process*. 2nd ed. Boston: Warren, Gorham & Lamont. ISBN: 0791303225.

Meneu, V.; Jordá, M.T. and Barreira, M.T. (1996) *Operaciones financieras en el mercado español*. Barcelona: Ariel.

Merton, R. C. (1992) *Continuous-time finance*. Revised ed. Oxford: Blackwell. 732 pages. ISBN: 0631185089.

- Navarro, E. and Nave, J.M. (2001) *Fundamentos de matemáticas financieras*. Barcelona: Antoni Bosch Editor.
- Ontiveros, E. (1991) *Mercados financieros internacionales*. Madrid: Espasa-Calpe. 687 pages. ISBN: 8423962334.
- Panjer, H. H. (ed) (1998) *Financial economics: with applications to investments, insurance and pensions*. Schaumburg, IL: The Actuarial Foundation. 669 pages. ISBN: 0938959484.
- Quittard-Pinon, F. (2003) *Marchés des capitaux et théorie financière*. 3rd ed. Paris: Économica. 555 pages. ISBN: 2717845755.
- Reilly, F. K. (2003) *Investment analysis and portfolio management*. 7th ed. Cincinnati, OH: Thomson/South Western. 1,162 pages. ISBN: 0324171730.
- Rodriguez, A. (1994) *Inmunidad financiera: (matemática de la inversión)* Barcelona: Ediciones S. 62 pages. ISBN: 8487736181.
- Rodriguez, A. (1997) *Matemática de la inversión*. Barcelona: Romargraf. 172 pages. ISBN: 8460561992.
- Roger, P. (1996) *L'évaluation des actifs financiers. Modèles à temps discret*. Paris: De Boeck. 368 pages. ISBN: 2804124274.
- Sharpe, W. F. (1998) *Investments*. 6th ed. Upper Saddle River, NJ: Pearson. 962 pages. ISBN: 0130101303.
- Shimko, D. (1995) *Finance in continuous time: a primer*. Oxford: Blackwell. 109 pages. ISBN: 1878975072.
- Stoll, H. R.; Whaley, R. E. (1992) *Futures and options: theory and applications*. Cincinnati, OH: South-Western Publishers. 419 pages. ISBN: 0538801158.
- Whelan, S. F., Bowie, D.C. and Hibbert, A.J. (2002) A primer in financial economics. *British Actuarial Journal*, **8(1)**, 27-74.

STAGE 2: GENERALISED APPLICATIONS STAGE

The subjects at this stage are:

15. Life Insurance
16. General Insurance
17. Pensions
18. Living Benefits

The emphasis during this stage is on actuarial risk management in different circumstances. These subjects might be presented separately or under a common theme of actuarial management which brings out the actuarial concepts that are involved. It is not necessary that all concepts are covered with examples from each applications area but it is helpful if students understand the differences between long and short term risk. The need for the actuary to operate within a commercial environment should also be addressed. This stage is covered under the International Actuarial Association Core Syllabus and Guidelines as "Principles of Actuarial Management".

Suitable general reading for the generalised applications stage would include:

Bellis, C., Shepherd, J. and Lyon, R. (editors) (2003) *Understanding actuarial management: the actuarial control cycle*. Institute of Actuaries of Australia, Sydney.

Faculty and Institute of Actuaries. *Core reading for Subject CA1*.

15. Life Insurance

Aim: To instil the ability, in simple situations, to use judgement and apply the principles of actuarial planning and control needed for the operation on sound financial lines of providers of life insurance.

- (a) Principal terms
- (b) The main contract types
- (c) The principles of life insurance markets
- (d) Data requirements and verification
- (e) Product pricing
- (f) Reserving
- (g) Surrender values
- (h) Policy alterations
- (i) Derivation of actuarial assumptions
- (j) Measurement and analysis of surplus
- (k) Methods of distributing surplus to policyholders
- (l) Principles of investment and asset-liability modelling
- (m) Principles of regulation and accounting
- (n) Risk and uncertainty in life insurance business
- (o) Principles of risk management including reinsurance
- (p) Life insurance regulations, including:
 - Taxation
 - Accounting
 - Supervisory regulation
 - EU requirements
- (q) Experience rating
- (r) Future financial requirements including dynamic financial analysis

- (s) Value of a life company
- (t) Evaluation of the capital requirements of a life insurer for the purpose of determining the strategy for growth in business.

Suggested Reading

- Black, K.; Skipper, H. D. (1999) *Life and health insurance*. 13th ed. Upper Saddle River, NJ: Prentice-Hall. 1,072 pages. ISBN: 0138912505.
- Bluhm, W.F. (1992) *Group insurance*. Actex.
- Booth, P. M.; Chadburn, R. G.; Cooper, D. R. et al (1999) *Modern actuarial theory and practice*. Boca Raton, FL: CLC Press. 716 pages. ISBN: 0849303885.
- Bruijns, H. G. W. K.; Pinkse, C. C. W. (2000) *Levensverzekeringswiskunde*. 4th ed. Groningen: Wolters-Noordhoff. 167 pages. ISBN: 9001180922.
- Chabannes, J.-A.; Gauclin-Eymard, N. (2004) *Le manuel de l'assurance-vie: assurances individuelles; assurances collectives*. 3rd ed. Paris: L'Argus. 612 pages. ISBN: 2247050859.
- Collignan, D.; Collignan, C. (1989) *L'assurance vie: contrats individuels*. 2nd ed. Paris: L'Argus. 426 pages. ISBN: 2853841766.
- Faculty and Institute of Actuaries. *Core reading for Subjects CA1 and SA2*.
- Gil Fana, J.A., Heras Martínez, A. and Vilar Zanón, J.L. (1999) *Matemática de los seguros de vida*. Madrid: Mapfre.
- Hairs, C.J., Belsham, D.J., Bryson, N.M. et al (2002) Fair valuation of liabilities. *British Actuarial Journal*, **8(2)**, 203-340.
- Hare, D.J.P., Craske, G., Crispin, J.R. et al (2004) The realistic reporting of with-profits business. *British Actuarial Journal*, **10(2)**, 223-316.
- IAA (2004) *A global framework for insurer solvency assessment*. Report of the Insurer Solvency Assessment Working Party.
- Isenbart, F.; Münzner, H. (1994) *Lebensversicherungsmathematik für Praxis und Studium*. 3rd ed. Wiesbaden: Gabler. 120 pages. ISBN: 3409858342.
- Laiter, J.-D. (1994) *Les clés de l'assurance-vie: produits et techniques*. Boulogne: SEFI. 277 pages. ISBN: 1895354277.
- Lamelot, G.; Leriche, J. (1994) *Assurance-vie: prévoyance, épargne, retraite*. 3rd ed. Paris: Delmas. 248 pages. ISBN: 2714430597.
- Le Pape, J.; Leroy, G. (1995) *Assurance vie et fonds de pension, analyse financière et actuarielle*. Paris: Lamy. 421 pages. ISBN: 2902189613.
- Linares Peña, A. (1998) *Contabilidad de entidades aseguradoras*. Madrid: Mapfre.
- Lozano Aragües, R. (1999) *Análisis práctico de la normativa patrimonial de las entidades aseguradoras*. Madrid: Consejo Económico y Social.
- Nieto de Alba, U. and Vegas Asensio, J. (1993) *Matemática Actuarial*. Madrid: Mapfre.
- Pétauton, P. (2004) *Theorie et pratique de l'assurance-vie*. 3rd ed. Paris: Dunod. 252 pages. ISBN: 2100486853.
- Pitacco, E. (1992) *Lezione di tecnica attuariale delle assicurazioni libere sulla vita*. 2nd ed. Trieste: Edizioni Lint.
- Sheldon, T.J. and Smith, A.D. (2005) Market consistent valuation of life assurance business. To be published in *British Actuarial Journal*, **10(3)**, 543-626.
- Tosetti, A. (2002) *Assurance: comptabilité, réglementation, actuariat*. Economica, Paris.
- Wilkie, A.D., Waters, H.R. and Yang, S.Y. (2003) Reserving, pricing and hedging for policies with guaranteed annuity options. *British Actuarial Journal*, **9(2)**, 263- 426.
- Wolff, K.-H. (1970) *Versicherungsmathematik*. Wien: Springer. 405 pages.

Relevant Actuarial Guidance Notes should also be read by specialists.

16. General Insurance - Principles and Practice

Aim: To instil the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation of providers of general insurance on sound financial lines.

- (a) Principal terms
- (b) Product types.
- (c) The principles of general insurance markets.
- (d) Data requirements and verification.
- (e) Pricing bases for general insurance contracts.
- (f) Tariff systems.
- (g) Methods of determining the value of the insurance liabilities of a general business insurer and the value of the assets, in terms of emerging costs and in terms of discounted values, for the purposes of
 - the establishment of provisions and reserves for the accounts
 - the estimation of solvency
 - the pricing of products
- (h) Experience rating.
- (i) Claim reserving.
- (j) Modelling the uncertainty in claim frequency and amount.
- (k) Bases for valuing the assets and liabilities of a general business insurer.
- (l) Methods of analysing the experience of a general business insurer for the purposes of determining pricing and valuation assumptions and identifying the main sources of profit and loss.
- (m) Principles of investment for general business insurers' assets.
- (n) Principles of regulation and accounting for general insurance.
- (o) Risk and uncertainty in general insurance business.
- (p) Principles of risk management including reinsurance.

Suggested reading:

Blondeau, J. and Partrat, C. (2003) *La Réassurance : approche technique*. Economica, Paris.

Booth, P. M.; Chadburn, R. G.; Cooper, D. R. et al (1999) *Modern actuarial theory and practice*. Boca Raton, FL: Chapman & Hall. 716 pages. ISBN: 0849303885.

Casualty Actuarial Society. (2001) *Foundations of casualty actuarial science*. 4th ed. Arlington, VA: CAS. 817 pages. ISBN: 0962476226.

Claramunt, M.M.; Costa, T. (2003) *Matemática Actuarial No Vida. Un enfoque práctico*. Col·lecció de Publicacions del Departament de Matemàtica Econòmica, Financera i Actuarial N.63, Universitat de Barcelona.

Claramunt, M.M.; Mármol, M. (2003) *Solvencia: una introducció a la probabilitat de ruina*. Col·lecció de Publicacions del Departament de Matemàtica Econòmica, Financera i Actuarial N.65, Universitat de Barcelona.

Daykin, C. D.; Pentikäinen, T.; Pesonen, M. (1994) *Practical risk theory for actuaries*. London: CLC Press. 545 pages. ISBN: 0412428504.

Dorfman, M.S. (1987) *Introduction to insurance*. Prentice Hall.

England, P.D. and Verrall, R.J. (2002) Stochastic claims reserving in general insurance. *British Actuarial Journal*, **8(3)**, 443-544.

Faculty and Institute of Actuaries. *Core reading for Subjects CA1 and SA3.*

Faculty and Institute of Actuaries. (1997) *Claims reserving manual (2 vols)* 2nd ed. ISBN: 0901066281.

Hart, D. G.; Buchanan, R. A.; Howe, B. A. (1996) *The actuarial practice of general insurance.* 5th ed. Sydney: Institute of Actuaries of Australia. 592 pages. ISBN: 0858130556.

Huebner, S.S.; Black, K. and Cline, R.S. (1982) *Property and liability insurance.* Prentice Hall.

IAA (2004) *A global framework for insurer solvency assessment.* Report of the Insurer Solvency Assessment Working Party.

Jacob, N. (1979) *Les assurances.* Dalloz.

Latorre Llorens, L. (1992) *Teoría del riesgo y sus aplicaciones a la empresa aseguradora.* Madrid: Mapfre.

Linares Peña, A. (1998) *Contabilidad de entidades aseguradoras.* Madrid: Mapfre.

Lozano Aragües, R. (1999) *Análisis práctico de la normativa patrimonial de las entidades aseguradoras.* Madrid: Consejo Económico y Social.

Lucca, J. L. de (1992) *Elsevier's dictionary of insurance and risk prevention: in English, French, Spanish, German and Portuguese.* Amsterdam: Elsevier. 429 pages. ISBN: 0444896147.

Mack, T. (1994) Measuring the variability of chain ladder reserve estimates. *Casualty Actuarial Society Forum*, **Spring**, 101-182.

Mikosh, T. (2004) *Non-life Insurance Mathematics.* Springer-Verlag, Berlin.

Nieto de Alba, U. and Vegas Asensio, J. (1993) *Matemática Actuarial.* Madrid: Mapfre

Partrat, C. and Besson, J.-L. (2005) *Assurance non-vie : Modélisation, simulation.* Economica, Paris.

Riegel, R., Miller, J.S. and Williams, C.A. (1976) *Insurance principles and practices: property and liability.* Prentice Hall

Ryan, J.P., Archer-Lock, P.R., Czernuszewicz, A.J. et al (2001) Financial condition assessment. *British Actuarial Journal*, **7(4)**, 519-604.

Sarrasí, F.J. (2003) *Matemática del Reaseguro.* Col·lecció de Publicacions del Departament de Matemàtica Econòmica, Financera i Actuarial N.61, Universitat de Barcelona.

Straub, E. (1988) *Non-life insurance mathematics.* Berlin: Springer; Swiss Association of Actuaries. 136 pages. ISBN: 3540187871.

Sundt, B. (1991) *An introduction to non-life insurance mathematics.* 2nd ed. Karlsruhe: Verlag Versicherungswirtschaft. 163 pages. ISBN: 3884872559.

Taylor, G. C. (1986) *Claims reserving in non-life insurance.* Amsterdam: North-Holland. 232 pages. ISBN: 0444878467.

Relevant Actuarial Guidance Notes should also be read by specialists.

17. Pensions

Aim: To instil the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation on sound financial lines of providers of pensions of all types.

- (a) Principal terms
- (b) Benefit types
- (c) The needs and roles of the various parties that may be involved
- (d) Methods of financing provision
- (e) The regulatory environments in which benefits may be provided
- (f) Risks and uncertainties

- (g) Re-insurance as a means of risk management
- (h) Actuarial models to project income and outgo
- (i) Principles of financing, including asset and liability relationships
- (j) Determining assumptions for valuing future benefits and contributions
- (k) Placing values on assets, future benefits and future contributions for the purpose of
 - financing
 - the establishment of provisions and reserves for the accounts
 - the estimation of solvency
 - the determination of benefits including guarantees and options
- (l) Monitoring and analysing experience
- (m) Calculation and distribution of surplus

Suggested reading:

Aitken, W. H. (1996) *A problem-solving approach to pension funding and valuation*. 2nd ed. Winsted, CT: Actex. 405 pages. ISBN: 1566982006.

Allen, E. T.; Melone, J. J.; Rosenbloom, J. S. et al (2003) *Pension planning: pension, profit-sharing and other deferred compensation plans*. 9th ed. Boston, MA: McGraw-Hill. 580 pages. ISBN: 0072530839.

Anderson, A. W. (1990) *Pension mathematics for actuaries*. 2nd ed. Winsted, CT: Actex. 217 pages. ISBN: 0936031107.

Bennett, P. (1994) *Pension fund surpluses*. 2nd ed. London: Longman. 148 pages. ISBN: 0752000128.

Berin, B. N. (1989) *The fundamentals of pension mathematics*. Schaumburg, IL: Society of Actuaries. 139 pages.

Bleakney, T. P.; Pacelli, J. (1994) *Benefit design in public employee retirement systems*. Government Finance Officers Association.

Booth, P. M.; Chadburn, R. G.; Cooper, D. R. et al (1999) *Modern actuarial theory and practice*. Boca Raton, FL: Chapman & Hall. 716 pages. ISBN: 0849303885.

Brown, H. (2004) *Defined contribution arrangements in Europe*. Oxford: Groupe Consultatif. (pdf. file 120Kb downloadable from www.gcactuaries.org)

Carne, S. A.; Ward, G. (1987) *The work of a pension scheme actuary*. London: Auditing Practices Committee, of the Consultative Committee of Accountancy Bodies. 94 pages. ISBN: 0852918801.

Chapman, R.J., Gordon, T.J. and Speed, C.A. (2001) Pensions, Funding and Risk. *British Actuarial Journal*, **7(4)**, 605-686.

Collinson, D. A. (ed) (2001) *Actuarial methods and assumptions used in the valuation of retirement benefits in the EU and other European countries*. Oxford: Groupe Consultatif. 162 pages (pdf. file 2,469Kb downloadable from www.gcactuaries.org)

Cowling, C.A., Gordon, T.J. and Speed, C.A. (2004) *Funding defined benefit schemes*. To be published in *British Actuarial Journal*, **11**.

Daykin, C. D.; Lewis, D. (1999) A crisis of longer life: reforming pension systems. *British Actuarial Journal*, **5(1)**, 55-113.

Daykin, C. D. (2005) An Ageing Population - Pension Reform Developments in the UK and internationally. *Manchester Statistical Society*. ISBN: 0853361754.

De Smet, B. (2002) *Professional responsibilities of pensions actuaries in the countries of the EU and other European countries*. Oxford: Groupe Consultatif. (pdf. file 247Kb downloadable from www.gcactuaries.org)

- Exley, J.; Mehta, S. J. B.; Smith, A. D. (1997) The financial theory of defined benefit pension schemes. *British Actuarial Journal*, **3(4)**, 835-966.
- Faculty and Institute of Actuaries. *Core reading for Subjects CA1 and SA4*.
- Farrimond, W.; Mayer, D. L. (eds) (1994) *Actuarial cost methods: a review*. Arlington, VA: American Society of Pension Actuaries. 413 pages.
- Head, S.J., Adkins, D.R., Cairns, A.J.G. et al (2000) *Pension Fund valuations and market values*. *British Actuarial Journal*, **6(1)**, 55-141 and **7(1)**, 103-122.
- Lecina Gracia, J. M. (1990) *Los planes de prevision: un tratamiento actuarial*. Barcelona: Caja de Cataluña. 276 pages. ISBN: 8487135110.
- Long, C. A. (1989) *The actuary in practice*. Croydon: Tolley. 86 pages. ISBN: 0854593861.
- MacDonald, J. B. (1997) *Differences in valuation methods and assumptions between social insurance and occupational pension plans (Course P-567 Study Note)* Schaumburg, IL: Society of Actuaries.
- Mansfield, C. B.; Cunningham, T. W. (1993) *Pension funds: a common-sense guide to a common goal*. Homewood, IL: Business One Irwin. 194 pages. ISBN: 155623810X.
- McGill, D. M.; Brown, K. N.; Haley, J. J. et al (2004) *Fundamentals of private pensions*. 8th ed. Oxford: Oxford University Press. 878 pages. ISBN: 0199269505.
- Niklewicz, K (2004) *Pensions aspects of corporate transactions*. Oxford: Groupe Consultatif. (pdf. file 29Kb downloadable from www.gcactuaries.org)
- Patel, C. (2004) *Taxation of occupational pensions in the EU countries*. Oxford: Groupe Consultatif. (pdf. file 107Kb downloadable from www.gcactuaries.org)
- Peña Esteban, J.I. de la (2000) *Planes de Previsión Social*. Madrid: Pirámide.
- Pensions Management Institute. (2002) *Pensions terminology: a glossary for pension schemes*. 6th ed. London: PMI. 120 pages. ISBN: 1904120059.
- Rejda, G. E. (1998) *Social insurance and economic security*. 6th ed. Upper Saddle River, NJ: Prentice-Hall. 416 pages. ISBN: 0130204412.
- Rosenbloom, J. S.; Hallman, G. V. (1991) *Employee benefit planning*. 3rd ed. Englewood Cliffs, NJ: Prentice-Hall. 500 pages. ISBN: 0137544967.
- Steuerle, C. E.; Bakija, J. M. (1994) *Retooling social security for the 21st century*. Washington, D.C.: Urban Institute Press. 354 pages. ISBN: 0877666024.
- Thornton, P. N.; Wilson, A. F. (1992) A realistic approach to pension funding. *Journal of the Institute of Actuaries*, **119**, 229-312.
- Towers Perrin. (1995) *Handbook of executive benefits*. Homewood, IL: Irwin. 372 pages. ISBN: 0786301856.
- Trowbridge, C.L. and Farr, C.E. (1976) *The theory and practice of pension funding*. Irwin
- Turner, J. A.; Watanabe, N. (1995) *Private pension policies in industrialized countries: a comparative analysis*. Kalamazoo, MI: Upjohn Institute for Employment Research. 171 pages. ISBN: 088099150X.
- William M. Mercer International. (annual) *Worldwide Benefit & Employment Guidelines (combines the Statutory Benefits and Employment Conditions Handbook series and the International Benefit Guidelines)* London: William M Mercer International.
- Winklevoss, H.E. (1977) *Pension mathematics with numerical illustrations*. Pension Research Council (The Wharton School)
- World Bank. (1994) *Averting the old age crisis: policies to protect the old and promote growth*. New York: Oxford University Press. 402 pages. ISBN: 0195209966.
- World Bank (2005) *Old-age income support in the 21st century: an international perspective on pension systems and reform*. ISBN 082136040X
- Relevant Actuarial Guidance Notes should also be read by specialists.

18. Living Benefits

Aim: To instil the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation on sound financial lines of providers of health insurance/living benefits.

- (a) Principal terms.
- (b) Different models for financing health care.
- (c) The main features of mixed public/private financial health care systems.
- (d) Main features of the major types of health insurance product, including
 - sickness insurance
 - critical illness insurance
 - long-term care insurance
 - medical expenses insurance
 - disability insurance
- (e) The principles of health insurance markets.
- (f) Principles of accounting for health insurance.
- (g) Major areas of risk and uncertainty in health insurance.
- (h) Principles of investment for health insurers' assets.
- (i) Valuation data and verification procedures.
- (j) Analysis of the experience of a health insurer.
- (k) Pricing of health insurance products.
- (l) Valuation of the liabilities for the purposes of
 - the establishment of reserves for the accounts
 - the determination of solvency.
- (m) Interpretation of the accounts of a health insurer.
- (n) Establishing the impact of the liabilities of a health insurer on the choice and management of assets.
- (o) Modelling of the uncertainty in claim frequency and amount.
- (p) Experience rating for health insurance
- (q) Evaluation of the capital requirements of a health insurer for the purpose of determining the strategy for growth in business.

Suggested reading:

Bohn, K. (1980) *Die Mathematik der deutschen Privaten Krankenversicherung. Schriftenreihe Angewandte Versicherungsmathematik, 11.*

Crenca, G. (1991) *Le assicurazioni malattia.* Rome: Edizioni Buffetti. 78 pages. ISBN: 8819194015.

Dienst, H.-R. (1995) *Zur aktuariellen Problematik der Invaliditaetsversicherung: unter Verwertung internationaler Erfahrungen.* Karlsruhe: Verlag Versicherungswirtschaft. 160 pages. ISBN: 3884874837.

Faculty and Institute of Actuaries. *Core reading for Subjects CA1 and SA1.*

Haberman, S.; Pitacco, E. (1999) *Actuarial models for disability insurance.* Boca Raton, FL: CLC Press. 280 pages. ISBN: 0849303893.

O'Grady, F. T. (ed) (1988) *Individual health insurance.* Schaumburg, IL: Society of Actuaries. ISBN: 093895900X.

Pitacco, E. (1995) *Modelli attuariali per le assicurazioni sulla salute.* Milan: Edizioni Egea Universita Bocconi. 365 pages. ISBN: 8823802865.

Soule, C. E. (1994) *Disability income insurance: the unique risk*. 3rd ed. Homewood, IL: Business One Irwin. 300 pages. ISBN: 1556239580.

STAGE 3: COUNTRY SPECIFIC AND SPECIALIST STAGE

In many countries candidates will be required to study at least one of the applications areas in greater depth to gain the full qualification for their association. Student actuaries will need to understand the detailed regulatory, legislative, cultural and administrative framework of the country in which they intend to work. In each subject taken at this level the following additional objectives will apply beyond those set for the subject in the generalised applications stage:

- (a) Country specific terms
- (b) Country specific commercial and legislative environment
- (c) Practical application of principles within the context of (b)

Student actuaries also need to develop higher order skills of analysis, synthesis and judgement. During the study of the country specific and specialist aspects in their training these are likely to be developed. Practical work experience, study for an individual dissertation, and study for problem solving assessments are ways in which these skills might be gained.

PART THREE: MORE DETAILED SYLLABUSES

For some subjects more detailed versions have been prepared to illustrate possible implementations. These are attached purely as an illustration.

10(a) Financial Mathematics

Aim: To provide a grounding in financial mathematics and their applications to actuarial science.

- (a) Traditional compound interest, including:
 - accumulating and discounting;
 - interest payable p times per time period;
 - the force of interest:
 - nominal and effective rates;
 - standard functions;
 - equations of value;
 - loan schedules;
 - flat and annual effective rates;
 - interest and capital components of annuity payments;
 - running and redemption yields;
 - simple applications (e.g. investing a sum of money over a period).
- (b) Cash flow techniques, including:
 - generalised cash-flow models describing financial transactions;
 - net present value;
 - accumulated profit;
 - internal rate of return;
 - payback period;
 - discounted payback period;
 - money-weighted, time-weighted and linked internal rates of return
 - simple applications (e.g. investment project appraisal).
- (c) Term structure of interest rates, including:
 - factors influencing the term structure;
 - par yield and yield to maturity;
 - discrete and continuous spot rates;
 - forward rates;
 - duration and convexity;
 - (Redington) immunisation;
 - delivery price;
 - valuing and pricing forward contracts;
 - arbitrage;
 - hedging.
- (d) Simple stochastic interest rate models, including:
 - the mean and the variance of an accumulation;
 - distribution functions for accumulated and present values.
- (e) Introduction to contingent claims analysis
 - definition of derivative securities and classes of derivatives
 - market assumptions and the no arbitrage principle
- (f) Stochastic calculus for finance
 - probability space: space of events, sigma-algebra, probability measure,
 - stochastic process, filtrations
 - conditional expectation and properties, martingales
 - Brownian motion
 - Stochastic integrals
 - Ito's Lemma and stochastic differential equations
 - Girsanov theorem: change of measures and the martingale problem

- (g) Pricing and hedging for derivatives
 - The one-period CRR model: pricing via replication and via risk-neutral valuation, extension to multi-period models: extensions to dividend-paying underlying assets
 - Fundamental theorems of asset pricing
 - Continuous time models: no arbitrage valuation; martingale pricing and the risk-neutral valuation principle, Black-Scholes-Merton option pricing formula
 - Extensions: dividends (Merton model) and the FX options (Garman and Kohlagen formula)
 - Limitations of the Black-Scholes paradigm; the Brownian motion assumption and incomplete markets; implied volatility
 - Greeks and risk management
- (h) Term structure of interest rates
 - Spot interest rates

11(a) Survival Models

Aim: To provide a grounding in survival models

- (a) Survival models, including
 - survival distributions
 - random lifetimes
 - censored data
 - estimation of distributions of complete and partial lifetimes
 - product-limit (Kaplan-Meier) estimator of the survival function.
 - The Nelson-Aalen estimator
- (b) Statistical models of transfers between multiple states, including processes with single or multiple decrements and/or increments relationships between probabilities of transfer and transition intensities.
- (c) State-space and Markov models for life insurance.
- (d) Maximum likelihood estimators for transition intensities
- (e) Construction of a multiple decrement table.
- (f) Binomial model of mortality, including derivation of a maximum likelihood estimator for the probability of death comparison of the Binomial model with the multiple state model.
- (g) Methods available for graduating experience rates and the principal tests for establishing the suitability of a graduation.
- (h) Comparison of actual against expected experience.
- (i) The use of single figure indices for describing the variation of mortality and sickness with regard to social, economic and regional factors.
- (j) The principal forms of heterogeneity within a population with regard to mortality and sickness.

15(a) Life Insurance

Aim: To instil the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation on sound financial lines of providers of life insurance.

This detailed syllabus contains some mathematics of contingencies.

- (a) Principal terms.
- (b) The main contract types, including
 - savings, protection and income products
 - individual and group products.

- (c) Premiums, including
 - concept of gross premium
 - calculation using equation of value
 - calculation using profit testing
 - 1st order basis vs realistic basis.
- (d) Reserving, including
 - principles of
 - premium basis vs valuation basis
 - net premium vs gross premium
 - allowance for initial expenses
 - first order basis vs realistic basis.
- (e) Surrender values - methods of calculation
- (f) Policy alterations - methods of calculation
- (g) Derivation of actuarial assumptions in relation to
 - pricing
 - reserving
 - surrender values
 - alteration terms.
- (h) Measurement and analysis of surplus, including use of 2nd order basis.
- (i) Methods of distributing surplus to policyholders.
- (j) Principles of investment for life insurers, including asset-liability modelling.
- (k) Accounting and reporting, including
 - valuation of the assets and liabilities for demonstrating supervisory solvency
 - validation of the valuation data
 - presentation in published accounts and internal reporting
 - approaches to the recognition of profit for presentation in published accounts.
- (l) Risk management, including
 - reinsurance
 - underwriting
 - design of bonus system
 - design of contracts.
- (m) Life insurance regulations, including
 - taxation
 - supervisory regulation
 - accounting
 - EU requirements.
- (n) Group life, including experience rating.
- (o) Future financial requirements including dynamic financial analysis.
- (p) Value of a life company, including
 - method of calculation
 - basis for calculation
 - analysis of change in value.

Specialists

As above with the addition of:

- (q) Country specific terms
- (r) Country specific commercial and legislative environment
- (s) Practical application of principles within the context set out in (r).

17(a) Pensions

Aim: To instil the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation on sound financial lines of providers of pensions.

- (a) Principal terms.
- (b) The possible roles of various parties in pension provision, including:
 - the State;
 - employers or groups of employers;
 - individuals or groups of individuals.
- (c) The needs of the various parties, including:
 - encouragement of provision;
 - security of provision;
 - suitability of provision;
 - adequacy of provision;
 - financing;
 - non-finance related sponsor needs.
- (d) The effects of the environment in which benefits are provided, including:
 - types of tax controls;
 - legal frameworks for pension provision;
 - regulation relating to the presentation and reporting of pension provision;
 - professional guidance for actuaries and other professionals.
- (e) Financing of provision, including:
 - timing of contributions relative to benefit payments;
 - forms and characteristics of any investments.
- (f) Scheme design, including:
 - the level and form of benefits;
 - the level and form of any advance contributions;
 - options for beneficiaries;
 - occupational, personal and State provision.
- (g) Risks and uncertainties, including:
 - the level and incidence of benefits;
 - the level and incidence of contributions;
 - the level and incidence of return on capital;
 - the overall security of benefits
- (h) Actuarial models, including
 - stationary and stable populations;
 - computational tools;
 - funding methods;
 - projection of income and outgo;
 - setting contributions and assessing the return on capital;
 - population projections;
 - stochastic approaches;
 - sensitivity analysis.
- (i) Assumptions for valuing future benefits and contributions, including:
 - the relevance of management of risk and return on capital;
 - the information that may be available;
 - the usefulness of the information;
 - the objectives of the various parties.
- (j) Possible approaches to benefits on discontinuance.
- (k) Placing values on assets, future benefits and future contributions, including:
 - material data verification;
 - risk management;
 - valuation circumstances/purposes;
 - guarantees and options;
 - sensitivity analysis;

calculation method.

- (l) Principles of financing, including:
 - advance funding and pay-as-you-go;
 - investment principles;
 - investment contract suitability;
 - asset-liability matching.
- (m) Re-insurance as a means of risk management.
- (n) Communication of actuarial values, including:
 - presentation on results as a balance sheet;
 - purpose of the valuation.
- (o) Monitoring of experience, including:
 - sources of surplus/deficit;
 - factors affecting the application of surplus/deficit;
 - reasons for monitoring;
 - data requirements;
 - the process of analysis of the experience;
 - the use of the results of an analysis of experience.

Specialists

As above with the addition of:

- (p) Country specific terms
- (q) Country specific commercial and legislative environment
- (r) Practical application of principles within the context set out in (q).