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SYLLABUS OF BASIC EDUCATION  
2022

Estimation of Policy Liabilities, Insurance Company  
Valuation, and Enterprise Risk Management  
Exam 7

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The syllabus for this four-hour exam is defined in the form of learning objectives, knowledge statements, and readings.

**LEARNING OBJECTIVES** set forth, usually in broad terms, what the candidate should be able to do in actual practice. Included in these learning objectives are certain methodologies that may not be possible to perform on an examination, such as complex simulations, but that the candidate would still be expected to explain conceptually in the context of an examination.

**KNOWLEDGE STATEMENTS** identify some of the key terms, concepts, and methods that are associated with each learning objective. These knowledge statements are not intended to represent an exhaustive list of topics that may be tested, but they are illustrative of the scope of each learning objective.

**READINGS** support the learning objectives. It is intended that the readings, in conjunction with the material on earlier examinations, provide sufficient resources to allow the candidate to perform the learning objectives. Some readings are cited for more than one learning objective. The CAS Syllabus & Examination Committee emphasizes that candidates are expected to use the readings cited in this *Syllabus* as their primary study materials.

Thus, the learning objectives, knowledge statements, and readings complement each other. The learning objectives define the behaviors, the knowledge statements illustrate more fully the intended scope of the learning objectives, and the readings provide the source material to achieve the learning objectives. Learning objectives should not be seen as independent units, but as building blocks for the understanding and integration of important competencies that the candidate will be able to demonstrate.

Note that the range of weights shown should be viewed as a guideline only. There is no intent that they be strictly adhered to on any given examination—the actual weight may fall outside the published range on any particular examination.

The overall section weights should be viewed as having more significance than the weights for the individual learning objectives. Over a number of years of examinations, absent changes, it is likely that the average of the weights for each individual overall section will be in the vicinity of the guideline weight. For the weights of individual learning objectives, such convergence is less likely. On a given examination, in which it is very possible that not every individual learning objective will be tested, there will be more divergence of guideline weights and actual weights. Questions on a given learning objective may be drawn from any of the listed readings, or a combination of the readings. There may be no questions from one or more readings on a particular exam.

After each set of learning objectives, the readings are listed in abbreviated form. Complete text references are provided at the end of this exam syllabus.

Items marked with a bold **SK** or **SKU** constitute the 2022 Exam 7 Study Kit that may be purchased from the CAS Online Store. The 2022 Update to the 2021 Study Kit includes only the new items marked with a bold **SKU**; the Update may be purchased from the CAS Online Store. Items marked with a bold **OP** (Online Publication) are available at no charge and may be downloaded from the CAS website.

Please check the “*Syllabus Updates*” section of the CAS Web Site for any changes to the *Syllabus*.

## A. Estimation of Policy Liabilities

Range of weight for Section A: 65-75 percent

This section focuses on advanced techniques that the actuary may need to estimate reserves for unpaid claims. The candidate is expected to be well versed in the basic Principles and Standards of Practice for unpaid claim estimation. This section addresses how actuarial concepts are adapted to evaluate liabilities arising in complex risk transfer agreements common in excess insurance and reinsurance contracts. Emphasis is placed on developing ranges around a best estimate.

LEARNING OBJECTIVES	KNOWLEDGE STATEMENTS
<p>1. Calculate unpaid claim estimates using credibility models.</p> <p>Range of weight: 10-14 percent</p>	<p>a. Application of credibility</p> <p>b. Mechanics of the methods (including loss ratio based payout factors)</p> <p>c. Strengths and weaknesses</p> <p>d. Testing results for reasonableness</p>
<p><b>READINGS</b></p>	
<ul style="list-style-type: none"> <li>• Brosius</li> <li>• Hürlimann</li> <li>• Mack (2000)</li> </ul>	



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LEARNING OBJECTIVES	KNOWLEDGE STATEMENTS
<p>2. Estimate parameters and unpaid claims using claims development models related to loss reserving methods such as:</p> <ul style="list-style-type: none"> <li>• Chain ladder</li> <li>• Cape Cod</li> <li>• Chain ladder plus calendar-year effects</li> <li>• Bornhuetter-Ferguson</li> </ul> <p>3. Calculate the moments and percentiles of unpaid claim distributions implied by the models.</p> <p>Range of weight for Learning Objectives A.2 and A.3 collectively: 16-18 percent</p>	<ul style="list-style-type: none"> <li>a. Key assumptions of the models and testing of assumptions</li> <li>b. Original Mack chain ladder assumptions</li> <li>c. Relationship of variance assumptions to methods of calculating development factors</li> <li>d. Row-factor, column-factor, and combined row- times column-factor models</li> <li>e. Calendar-year effects in development factor models and in row-column factor models</li> <li>f. Effect of trends and their interrelationship (e.g., calendar year, accident year, and development year trends)</li> <li>g. Testing for and eliminating insignificant parameters</li> <li>h. Testing whether the methods work and how well the models fit (including both one-tail and two-tail tests)</li> <li>i. Moments of the chain ladder unpaid claim estimate when factors are calculated based on different variance assumptions</li> <li>j. Simulation of parameter percentiles and unpaid claims percentiles when models assume a distribution of residuals fit by MLE</li> </ul>
<p><b>READINGS</b></p>	
<ul style="list-style-type: none"> <li>• Clark</li> <li>• Mack (1994)</li> <li>• Venter Factors</li> </ul>	



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LEARNING OBJECTIVES	KNOWLEDGE STATEMENTS
<p>4. Estimate unpaid claims for various layers of claims.</p> <p>Range of weight: 5-7 percent</p>	<p>a. Methods for estimating unpaid claims in a deductible layer, excess of a threshold, and excess of a retention but bounded by a limit</p> <p>b. Interrelationships between parameters and development patterns for forecasting deductible, unlimited excess, layer excess and total claims</p>
<b>READINGS</b>	
<ul style="list-style-type: none"> <li>Sahasrabuddhe</li> <li>Siewert</li> </ul>	

LEARNING OBJECTIVES	KNOWLEDGE STATEMENTS
<p>5. Describe the various sources of risk and uncertainty that are associated with the determination of reserves. Calculate risk margins that consider these sources of risk and uncertainty.</p>	<p>a. Systemic risks and independent risks</p> <p>b. Limitations of quantitative risk assessment</p> <p>c. Risk correlations</p> <p>d. Testing and evaluation of risk models</p>
<p>6. Calculate the mean and prediction error of a reserve given an underlying statistical model.</p>	<p>a. Distributions and distribution-free models</p> <p>b. Comparison of Chain Ladder stochastic models</p>
<p>7. Derive predictive distributions using bootstrapping, simulation techniques, and generalized linear models.</p>	<p>a. Comparison of methods</p> <p>b. Simulation using bootstrapping</p> <p>c. Simulation from parameters</p> <p>d. Bayesian methods</p> <p>e. Generalized linear models</p>
<p>8. Identify data issues and related model adjustments for reserving models.</p> <p>9. Test assumptions underlying reserve models.</p> <p>10. Develop a distribution of reserves using weights and multiple stochastic models.</p> <p>Range of weight for Learning Objectives A.5 through A.10 collectively: 22-24 percent</p>	<p>a. Bayesian methods</p> <p>b. Adjustments to various reserving techniques</p> <p>c. Comparison of ODP Bootstrap and GLM Bootstrap models</p>
<b>READINGS</b>	
<ul style="list-style-type: none"> <li>Marshall et al.</li> <li>Shapland</li> <li>Taylor</li> <li>Verrall</li> <li>Meyers (2015)</li> </ul>	



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LEARNING OBJECTIVES	KNOWLEDGE STATEMENTS
11. Compare and contrast reinsurance and primary reserving procedures. 12. Adjust primary methods and data to be used for reinsurance reserving. 13. Calculate ceded loss reserves using appropriate methods.  Range of weight for Learning Objectives A.11 through A.13 collectively: 6-9 percent	a. Reinsurance and primary reserving methods b. Effect on assumptions from differences in information available to reinsurers c. Standard-Buhlmann (Cape Cod) method d. Underlying business characteristics of reinsurance contracts, e.g., concentration of exposures e. Data structures, e.g., Ground up versus Excess loss, Accident Year versus Treaty Year
<b>READINGS</b>	
<ul style="list-style-type: none"> <li>Patrik</li> </ul>	

LEARNING OBJECTIVES	KNOWLEDGE STATEMENTS
14. Forecast Premium Reserves. Range of weight: 4-5 percent	a. Reserves for retrospective premiums
<b>READINGS</b>	
<ul style="list-style-type: none"> <li>Teng and Perkins</li> </ul>	

## B. Insurance Company Valuation

Range of weight for Section B: 8-12 percent

This section focuses on methods used to determine the theoretical value of equity securities and extending the methodology to value property and casualty insurance companies. The candidate is expected to be proficient with the basic tools and techniques commonly used in the financial analysis of corporations as described in the knowledge requirements set forth for VEE–Accounting and Finance (previously VEE-Corporate Finance).

LEARNING OBJECTIVES	KNOWLEDGE STATEMENTS
1. Calculate the effect of loss and expense reserve requirements and regulatory or rating agency capital requirements on the free cash flow to equity for a P&C insurer.	a. Calculate the effect of loss and expense reserve requirements and regulatory or rating agency capital requirements on the free cash flow to equity for a P&C insurer.
2. Value the equity of a P&C insurer based on its expected future dividends, its free cash flow to equity, or its expected abnormal earnings	a. Dividend Discount Model (DDM) b. Free cash flow to equity for a P&C insurer c. Discounted Cash Flow (DCF) Valuation using free cash flow to equity (FCFE), including effect of alternative methods of estimating terminal values and reasons why this method is preferred over the free cash flow to the firm (FCFF) method for P&C insurers d. Abnormal Earnings (AE) Valuation, including effect of alternative methods of estimating terminal values e. Option Pricing
3. Value the equity of a firm using comparative or relative valuation methods based on multiples of selected financial variables obtained from either peer companies or from underlying fundamentals.  Range of weight for Learning Objectives B.1 through B.3 collectively: 8-12 percent	a. Comparative valuation ratios including price-earnings, price-sales, price-book, price-cash flow b. Relationship between the dividend discount model and the price-earnings (P-E) ratio c. Relationship between the abnormal earnings valuation model and the price-book value (P-BV) ratio
<b>READINGS</b>	
<ul style="list-style-type: none"> <li>Goldfarb</li> </ul>	

## C. Enterprise Risk Management

Range of weight for Section C: 15-25 percent

This section introduces the candidate to the concepts and basic techniques of Enterprise Risk Management (ERM). ERM seeks to integrate the entire landscape of risk that confronts a business. Topics include value of risk management and basic modeling concepts.

LEARNING OBJECTIVES	KNOWLEDGE STATEMENTS
1. Demonstrate how insurance and financial risk can be analyzed quantitatively.	a. Definition of ERM and key elements of consideration b. ERM process and risk management c. ERM risk models evaluation d. Sources of risks and modeling of dependencies e. ERM in setting capital requirements
2. Describe the rationale for, methods for, and effect of managing insurance and financial risks.	a. IRM and other capital adequacy models b. An asset-liability modeling approach c. Reinsurance and Risk optimization
3. Demonstrate the properties of various risk measures and their limitations. 4. Describe how risk measures and risk modeling, including allocation, can affect strategic management.	a. VaR, TVaR, and XTVaR b. Expected policyholder deficit c. Probability transforms d. Generalized moments
5. Describe the use of enterprise-wide risk modeling and aggregation techniques. 6. Evaluate and select appropriate models to handle diverse risks, including stochastic approaches.  Range of weight for Learning Objectives C.1 through C.6 collectively: 13-17 percent	a. Incorporating the use of correlation b. Evaluation and selection of appropriate copulas as part of the process of modeling multi-variate risks c. Tail dependence and tail correlations d. Low frequency/high severity events e. Parameter, projection, estimation, and model risk
<b>READINGS</b>	
<ul style="list-style-type: none"> <li>Brehm et al., Chapter 1, Chapter 2 (Sections 2.1-2.5), Chapter 3 (Sections 3.1-3.3)</li> </ul>	



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LEARNING OBJECTIVES	KNOWLEDGE STATEMENTS
7. Describe operational risk and demonstrate possible mitigation and quantification methodology.	a. Types of operational risk b. Key risk indicators and operational risk modeling c. Types of strategic risks d. Examples of strategic risks e. Scenario planning
8. Describe approaches to modeling the underwriting cycle.  Range of weight for Learning Objectives C.7 and C.8 collectively: 4-6 percent	a. Definition, characteristics, and drivers of the underwriting cycle b. Soft, behavioral, and technical modeling approaches c. Modeling components: supply and demand, capital flows
<b>READINGS</b>	
• Brehm et al., Chapter 4 and Chapter 5, Section 5.4	





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## Complete Text References for Exam 7

Text references are alphabetized by the citation column.

Citation	Abbreviation	Learning Objective	Source
Brehm, P.; Gluck, S.; Kreps, R.; Major, J.; Mango, D.; Shaw, R.; Venter, G.; White, S.; and Witcraft, S., Guy Carpenter, "Enterprise Risk Analysis for Property & Liability Insurance Companies," Chapter 1, 2 (excluding Section 2.6), 3 (excluding Section 3.4), 4, and 5 (Section 5.4 only).	Brehm et al.	C1-C8	SK
Brosius, E., " <a href="#">Loss Development Using Credibility</a> ," CAS Study Note, March 1993.	Brosius	A1	OP
Clark, D.R., " <a href="#">LDF Curve Fitting and Stochastic Reserving: A Maximum Likelihood Approach</a> ," Casualty Actuarial Society <i>Forum</i> , Fall 2003.	Clark	A2-A3	OP
Goldfarb, R., " <a href="#">P&amp;C Insurance Company Valuation</a> ," CAS Study Note, October 2010.	Goldfarb	B1-B3	OP
Hürlimann, W., " <a href="#">Credible Loss Ratio Claims Reserves: The Benktander, Neuhaus and Mack Methods Revisited</a> ," <i>ASTIN Bulletin</i> 39(1), 2009, pp. 81-99. Including <a href="#">errata</a> .  Candidates are not responsible for mathematical proofs.	Hürlimann	A1	OP
Mack, T., " <a href="#">Measuring the Variability of Chain Ladder Reserve Estimates</a> ," Casualty Actuarial Society <i>Forum</i> , Spring 1994.	Mack (1994)	A2-A3	OP
Mack, T., " <a href="#">Credible Claims Reserve: The Benktander Method</a> ," <i>ASTIN Bulletin</i> , 2000, pp. 333-337.	Mack (2000)	A1	OP
Marshall, K.; Collings, S.; Hodson, M.; and O'Dowd, C., " <a href="#">A Framework for Assessing Risk Margins</a> ," Institute of Actuaries of Australia 16th General Insurance Seminar, 9-12 November 2008, Coolumb, Australia.	Marshall et al.	A5-A10	OP
Meyers, G., " <a href="#">Stochastic Loss Reserving Using Bayesian MCMC Models</a> ," CAS Monograph #1.	Meyers (2015)	A5-A10	OP
Patrik, G.S., " <a href="#">Reinsurance</a> ," <i>Foundations of Casualty Actuarial Science</i> , Fourth Edition, Casualty Actuarial Society, 2001, Chapter 7, pp. 434-464 (section on Reinsurance Loss Reserving).	Patrik	A11-A13	OP
Sahasrabudde, R., " <a href="#">Claims Development by Layer: The Relationship between Claims Development Patterns, Trend and Claim Size Models</a> ," Casualty Actuarial Society <i>E-Forum</i> , Fall 2010, Volume 1 (revised January 2, 2013). Including <a href="#">errata</a> .	Sahasrabudde	A4	OP
Shapland, M., " <a href="#">Using the ODP Bootstrap Model: A Practitioner's Guide</a> ," CAS Monograph #4. Supplementary modeling files linked on pages 61-62 will aid in understanding of the method's application.	Shapland	A5-A10	OP



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Citation	Abbreviation	Learning Objective	Source
Siewert, J.J., " <a href="#">A Model for Reserving Workers Compensation High Deductibles</a> ," <i>Casualty Actuarial Society Forum</i> , Summer 1996, pp. 217-244.	Siewert	A4	OP
Taylor, G. and McGuire G., " <a href="#">Stochastic Loss Reserving Using Generalized Linear Models</a> ," CAS Monograph #3, Chapters 1-3. Including <a href="#">errata</a> .	Taylor	A5-A10	OP
Teng, M.T.S. and Perkins, M.E., " <a href="#">Estimating the Premium Asset on Retrospectively Rated Policies</a> ," <i>PCAS LXXXIII</i> , 1996, pp. 611-647, excluding Section 5. <a href="#">Including discussion of paper</a> : Feldblum, S., <i>PCAS LXXXV</i> , 1998, pp. 274-315, Sections 1 and 2 only. Candidates will not be held responsible for specific Annual Statement notation but will be responsible for concepts presented.	Teng and Perkins	A14	OP
Venter, G.G., " <a href="#">Testing the Assumptions of Age-to-Age Factors</a> ," <i>PCAS LXXXV</i> , 1998, pp. 807-847. Including <a href="#">errata</a> .	Venter Factors	A2-A3	OP
Verrall, R.J., " <a href="#">Obtaining Predictive Distributions for Reserves Which Incorporate Expert Opinion</a> ," <i>Variance</i> , Vol. 1, Issue 1, 2007, Casualty Actuarial Society. Including <a href="#">errata</a> .	Verrall	A5-A10	OP

## Source Key

<b>B</b>	Book—may be purchased from the publisher or bookstore.
<b>DSK</b>	Material included in the 2022 Digital Study Kit.
<b>NEW</b>	Indicates new or updated material.
<b>OP</b>	All text references marked as Online Publications will be available on a web page titled Complete Online Text References.
<b>SK</b>	Material included in the 2022 Study Kit.
<b>SKU</b>	Material included in both the 2022 CAS Study Kit and the 2022 Update to the 2021 Study Kit.

Items printed in **red** indicate an update, clarification, or change.