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Exam Content Outline

Modern Actuarial Statistics II (MAS-II)

Delivery Format

APPOINTMENT TIME: 4.5 HOURS		
Exam Duration	**Scheduled Break**	**Exam Tutorial, Confidentiality Agreement, End of Exam Survey**
4 hours	**15 min**	**15 min**

Exam Item Types

Candidates may see the following item types in the CAS examinations. Candidates should become familiar with these item types. Item type samples are available on the Pearson Vue CAS webpage.

Multiple Choice

Multiple answer choices are presented after a problem with only one correct answer.

Multiple Selection

Multiple answer choices are presented after a problem with more than one correct answer.

Point and Click

An image is presented after a problem where the candidate must identify the correct area of the image by clicking on the correct location in the image.

Fill in the Blank

One or more blank sections are presented after the problem or within a statement where the candidate must input the correct response(s).

Matching

Content columns presented after a problem where the candidate must correctly match content from one column to another.

Exam Cognitive Level

Each task is tied to a certain type of mental operation or thinking skill, which is called the cognitive level. ACAS and FCAS use four cognitive levels, and every examination item is authored to address both the task and one of the following cognitive levels paired with that task.

Remember: 5-10%

Tests the ability of the candidate to recall or remember knowledge or facts.

Understand and Apply: 55-60%

Measures the candidate's ability to understand and apply ideas and concepts to new situations.

Analyze and Evaluate: 35-40%

Requires the candidate analyze information, combine concepts/ideas, and justify a position resulting from that combination.

Create: 0-5%

Requires the candidate to synthesize conclusions by evaluating the validity of ideas and concepts.

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Exam Section Details

DOMAINS	DOMAIN WEIGHT
A. Introduction to Credibility	15-25%
B. Linear Mixed Models	10-20%
C. Statistical Learning	40-50%
D. Time Series with Constant Variance	15-25%

A. Introduction to Credibility

Candidates should understand and be able to calculate credibility weighted estimates.

TASKS
1. Calculate classical (limited fluctuation), Bühlmann, Bühlmann-Straub, and Bayesian credibility-weighted estimates for frequency, severity, and aggregate loss
2. Understand the framework used for the classical (limited fluctuation), Bühlmann, Bühlmann-Straub, and Bayesian credibility procedures
Readings: - Tse

B. Linear Mixed Models

Candidates should understand the structure of linear mixed models, including how to accommodate models with correlated observations or models where the variance is either not assumed to be constant or a function of the mean.

TASKS
1. Understand the assumptions behind the linear mixed model design
2. Understand how to use a hierarchical model
3. Interpret output from a linear mixed model and make appropriate choices when evaluating modeling options
4. Interpret linear mixed model diagnostics and summary statistics to evaluate the linear mixed model structure and variable selection
Readings: - West

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C. Statistical Learning

Candidates should understand the mechanics of the algorithms identified in the tasks below and recognize their inherent strengths and weaknesses to be able to select the most appropriate procedure for the learning task at hand.

TASKS
1. Compute K-nearest neighbors (KNN)
2. Prune decision trees
3. Calculate the summary statistics for a set decision of trees (e.g., Gini index, entropy, residual sum of squares)
4. Understand the assumptions underlying different tree ensemble methods and the improvements they can make to decision trees
5. Compute elements of principal components analysis (PCA) (e.g., loading vectors, variance explained)
6. Interpret principal components analysis (PCA) software outputs
7. Perform the computations behind clustering procedures (e.g., K-means, hierarchical)
8. Interpret clustering procedures outputs
9. Interpret neural network results
10.Calculate measures of model predictive accuracy (e.g., Lift, Gini index, AUROC)
11. Compare models via predictive performance measures (e.g., double lift chart)
Readings: - James et al. - GLM - Salis

D. Time Series with Constant Variance

Candidates should understand the basic applications of the Auto Regressive Integrated Moving Average (ARIMA) time series model.

TASKS
1. Model relationships of current and past values of a statistic/metric
2. Understand the framework of ARIMA models (e.g., trends and seasonality)
3. Calculate trends and seasonality using time series with regression (e.g., deterministic vs. stochastic trend)
4. Interpret time series output to make forecasts
Readings: - Cowpertwait

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Complete Text References for Exam MAS-II

Text references are alphabetized by the citation column.

Citation	Abbreviation	Domains/ Tasks	Source
Cowpertwait, P., and Metcalfe, A., *Introductory Time Series with R*, Springer, 2009. - Chapters 1-5 (excluding Sections 3.3 and 3.4), 6, 7 (Sections 7.1, 7.2 and 7.3)	Cowpertwait	D1-D4	**B**
Goldburd, M., et al., "Generalized Linear Models for Insurance Rating," CAS Monograph #5, 2nd edition, 2020. - Chapter 7	GLM	C10-11	**OP**
James, G., et al., *An Introduction to Statistical Learning, with Application in R*, 2nd ed., Springer, 2021. - Chapters 1 (Background reading only), 2.2, 4.4.2 (Confusion Matrix Only), 8, 10, 12. Exam questions will not be sourced directly from Chapter 1.	James et al.	C1-C9	**OP**
Salis, A., "Measures of Predictive Accuracy," CAS Study Note, November 2025.	Salis	C3 & C10	**OP**
Tse, Y., *Nonlife Actuarial Models, Theory Methods and Evaluation*, Cambridge University Press, 2009. - Chapters 6.1-6.3, 7.1-7.4, 8.1-8.2, and 9.1-9.2	Tse	A1-A2	**B**
West, B. T.; Welsh, K. B.; and Galecki, A. T., *Linear Mixed Models: A Practical Guide Using Statistical Software*, 3rd Edition, CRC Press, 2022. - All chapters, excluding coding examples - Additional Notes on Shrinkage Means (http://www-personal.umich.edu/~bwest/shrinkage.doc)	West	B1-B4	**B**

Source Key

B	Book – may be purchased from the publisher or bookstore.
OP	All text references marked as Online Publications will be available by clicking the hyperlink within the syllabus.

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Supplemental Study Materials

The readings cited above are the expected readings that candidates should incorporate into their study plans and represent the minimum study needed for this exam. The expected readings are also exclusively used by CAS Subject Matter Experts who create the examination content.

In addition to the expected readings, candidates may consider the recommended information and readings below to incorporate into their study plans. The recommended materials below will provide candidates with helpful knowledge to perform the exam tasks.

Assumed Knowledge

Thorough knowledge of calculus and probability is assumed. Given the material covered on this exam, we assume that the candidate has knowledge of linear algebra concepts at the level commonly assumed as a prerequisite to taking an undergraduate level course in regression analysis. Candidates are expected to have mastered the concepts in Exam MAS-I. For those candidates who have obtained a waiver for Exam MAS-I through the transition rule that granted credit for Exam MAS-I by having credit for Exam S - Statistics and Probabilistic Models or through examinations administered by the Institute and Faculty of Actuaries (United Kingdom), Actuaries Institute (Australia), Actuarial Society of South Africa (ASSA), or the Institute of Actuaries of India, it is recommended to review and master the concepts in the paper "Generalized Linear Models" by Larsen[1] and the following Sections in *An Introduction to Statistical Learning, with Applications in R*: 2.1.4, 2.2.1, 2.2.2, 5.1, and 5.2. See Waivers of Examination page of the CAS website for a complete waiver explanation. While some problems may have an insurance or risk management theme, no prior knowledge of insurance terminology is expected.

Tables Provided on Exam Day

A variety of tables along with standard notation for the mixed models will be provided to the candidate with the examination's reference materials. The tables include values for the standard normal distribution, chi-square distribution, *t*-distribution, and *F*-distribution. Abridged inventories of discrete and continuous probability distributions will also be provided. Since they will be included with the examination, candidates will not be allowed to bring copies of the tables into the examination room.

Additional Problems and Examples, Domains B, C, D

Domain B

In Domain B, Chapters 1, 2, and 9 of West contain an introduction to the modeling concepts underlying linear mixed effect models. Chapters 3 through 8 contain examples that illustrate how to build a linear mixed effect model to accommodate different circumstances. Adapting the general formulas for a Mixed Model to accommodate the specific nature of the problem at hand is a skill that the candidate should master. The excluded sections from Chapters 3-8 go into details on software that are outside of the scope of the exam. Sections are included that demonstrate coding the models in R (*.4.3 in Chapters 3 through 8) and there are case studies on the exam that use R to generate the modeling results. However, candidates are not expected to master the details of coding linear mixed effect models in R.

[1] See Content Outline for Exam MAS-I for complete text reference.

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Candidates should focus on understanding the design choices made in modeling, the output from those packages, and how that output was interpreted rather than on the details of coding for the purpose of this exam. Comments in Chapters 3-8 on design choices and the type of hypothesis test to be employed at a given point in the modeling process expand on the introduction to modeling concepts covered in Chapters 1, 2, and 9. These comments are a vital part of the reading from West.

The matrix notations employed in the readings for specifying linear model forms will be adopted for exam questions from Domain B and will be provided in the Exam MAS-II Tables packet that accompanies the examination's reference materials.

Similarly, exam questions in Domain B may contain parameter tables and diagnostic tables or plots of the type shown in the text. Candidates should understand how to interpret these tables. Candidates who become familiar with a statistical language capable of generating this type of output, such as R, will have an easier time understanding and applying the concepts covered in the exam material. In particular, candidates that work with the R code examples in the West textbook, along with the datasets provided, will have a better grasp of the material than that obtained by simply reading the textbook. However, for exam questions from Domain B, candidates will not be explicitly tested on software code.

The book's website has made available the datasets and code introduced in the chapters. It can be found at http://www-personal.umich.edu/~bwest/almmussp.html.

Domain C

For Domain C, Programming labs found in sections 2.3, 8.3, 10.9, and 12.5 of the James et al. reference demonstrate the implementation of topics covered in the sections above with R, but no new concepts are introduced here. These labs show how to load and work with datasets made available in the ISLR package in R. For information on how to install and load R packages, please refer to section 3.6.1. Examination questions will not explicitly test software code, but a careful review of these sections will greatly help the candidates understand and apply these concepts.

Domain D

Exam questions from Domain D may contain snippets of simple R code and illustrative output of the type shown in the text. Candidates should understand the general functionality of the R commands listed in the "Summary of commands used in examples" sections at the end of Chapters 1-5 and 6 in Cowpertwait. Candidates will not be asked to write R code, nor will they be required to interpret complex applications or complete R programs.