Probability Exam—January 2021

The Probability Exam is a three-hour exam that consists of 30 multiple-choice questions and is administered as a computer-based test (CBT).

The purpose of the syllabus for this examination is to develop knowledge of the fundamental probability tools for quantitatively assessing risk. The application of these tools to problems encountered in actuarial science is emphasized. A thorough command of the supporting calculus is assumed. Additionally, a very basic knowledge of insurance and risk management is assumed.

A table of values for the normal distribution is available below for candidates to download and will be included with the examination. Since the table will be included with the examination, candidates will not be allowed to bring copies of the table into the examination room.

Check the Updates section on this exam's home page for any changes to the exam or syllabus.

The ranges of weights shown are intended to apply to the large majority of exams administered. On occasion, the weights of topics on an individual exam may fall outside the published range. Candidates should also recognize that some questions may cover multiple learning outcomes.

Each multiple-choice problem includes five answer choices identified by the letters A, B, C, D, and E, only one of which is correct. Candidates must indicate responses to each question on the computer.

As part of the CBT process, a few pilot questions will be randomly placed in the exam (paper and pencil and computer-based forms). These pilot questions are included to judge their effectiveness for future exams, but they will not be used in the scoring of this exam. All other questions will be considered in the scoring. All unanswered questions are scored incorrect. Therefore, candidates should answer every question on the exam. There is no set requirement for the distribution of correct answers for the multiple-choice preliminary examinations. It is possible that a particular answer choice could appear many times on an examination or not at all. Candidates are advised to answer each question to the best of their ability, independently from how they have answered other questions on the examination.

Since the CBT exam will be offered over a period of a few days, each candidate will receive a test form composed of questions selected from a pool of questions. Statistical scaling methods are used to ensure within reasonable and practical limits that, during the same testing period of a few days, all forms of the test are comparable in content and passing criteria. The methodology that has been adopted is used by many credentialing programs that give multiple forms of an exam.

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LEARNING OUTCOMES

1. **Topic: General Probability (10-17%)**
Learning Objectives
The Candidate will understand basic probability concepts.
Learning Outcomes
The Candidate will be able to: a) Define set functions, Venn diagrams, sample space, and events. Define probability as a set function on a collection of events and state the basic axioms of probability.   b) Calculate probabilities using addition and multiplication rules.   c) Define independence and calculate probabilities of independent events.   d) Calculate probabilities of mutually exclusive events.   e) Define and calculate conditional probabilities.   f) Calculate probabilities using combinatorics, such as combinations and permutations.   g) State Bayes Theorem and the law of total probability and use them to calculate conditional probabilities.

2. **Topic: Univariate Random Variables (40-47%)**
Learning Objectives
The Candidate will understand key concepts concerning discrete and continuous univariate random variables (including binomial, negative binomial, geometric, hypergeometric, Poisson, uniform, exponential, gamma, normal, and mixed) and their applications.
Learning Outcomes
The Candidate will be able to: a) Explain and apply the concepts of random variables, probability and probability density functions, cumulative distribution functions. b) Calculate conditional probabilities. c) Explain and calculate expected value, mode, median, percentile, and higher moments. d) Explain and calculate variance, standard deviation, and coefficient of variation. e) Define probability generating functions and moment generating functions and use them to calculate probabilities and moments. f) Determine the sum of independent random variables (Poisson and normal). g) Apply transformations.

3. **Topic: Multivariate Random Variables (40-47%)**

Learning Objectives

The Candidate will understand key concepts concerning multivariate random variables (including the bivariate normal) and their applications.

Learning Outcomes

The Candidate will be able to:

a) Explain and perform calculations concerning joint probability functions, probability density functions, and cumulative distribution functions.

b) Determine conditional and marginal probability functions, probability density functions, and cumulative distribution functions.

c) Calculate moments for joint, conditional, and marginal random variables.

d) Explain and apply joint moment generating functions.

e) Calculate variance, standard deviation for conditional and marginal probability distributions.

f) Calculate joint moments, such as the covariance and the correlation coefficient.

g) Determine the distribution of a transformation of jointly distributed random variables. Determine the distribution of order statistics from a set of independent random variables.

h) Calculate probabilities and moments for linear combinations of independent random variables.

i) State and apply the Central Limit Theorem.

REFERENCES

Suggested Texts

There is no single required text for this exam. The texts listed below may be considered as representative of the many texts available to cover material on which the candidate may be examined. Texts are added and deleted as part of a regular process to keep the list up-to-date. The addition or deletion of a textbook does not change the bank of questions available for examinations. There is no advantage to selecting a text recently added or not using a text recently removed.

Not all the topics may be covered adequately by just one text. Candidates may wish to use more than one of the following or other texts of their choosing in their preparation. Earlier or later editions may also be adequate for review.

- A First Course in Probability (Ninth Edition), 2012, by Ross, S.M., Pearson/Prentice Hall, ISBN: 978-0321794772, Chapters 1–8
- Mathematical Statistics with Applications (Seventh Edition), 2008, by Wackerly, D., Mendenhall III, W., Scheaffer, R., Thomson Brooks/Cole ISBN: 978-0495110811, Chapters 1-7.
- Probability for Risk Management, (Second Edition), 2006, by Hassett, M. and Stewart, D., ACTEX, ISBN: 978-156698-2, Chapters 1–11.
- Probability and Statistical Inference (Tenth Edition), 2019, by Hogg, R.V., Tanis, E.A., and D. Zimmerman, Prentice Hall, ISBN: 978-0135189399, Chapters 1–5. **[Candidates may also use: Probability and Statistical Inference (Ninth Edition), 2014, by Hogg, R.V., Tanis, E.A., and D. Zimmerman, Prentice Hall, ISBN: 978-0321923271, Chapters 1–5].**
- Probability and Statistics with Applications: A Problem Solving Text, (Second Edition) 2015, by Asimow, L. and Maxwell, M., ACTEX, ISBN: 978-1-62542-472-3, Chapters 1–8 (excluding section 8.5)

Other Resources

The candidate is expected to be familiar with the concepts introduced in "Risk and Insurance".

Tables for Exam P

Exam P Sample Questions and Solutions

Online Sample Exam P

The Society of Actuaries (SOA) is interested in supporting candidates as they prepare for the preliminary exams. To that end the SOA has launched an online sample exam for Exam P (Probability). Available at no cost the sample exam selects questions and solutions in an online exam experience that resembles the computer-based testing employed for most of the SOA's preliminary exams. Questions have been coded to meet the Exam P learning objectives and ensure candidates receive a balanced yet randomized set of questions each time they repeat the sample exam. The current set of questions is drawn from the existing set of sample questions.