

# ACTUARIAL SCIENCE (ACT SCI)

## ACT SCI 300 – PROBABILITY FOR ACTUARIES

1 credit.

Develop a knowledge of fundamental mathematical tools for quantitatively assessing risk. Emphasize the applications of these tools to problems encountered in actuarial science.

**Requisites:** (STAT/MATH 309, MATH 331, STAT 333, 340, or concurrent enrollment), or declared in undergraduate Business Exchange program. Not open to graduate/professional students.

**Repeatable for Credit:** Yes, for 2 number of completions

**Last Taught:** Fall 2024

**Learning Outcomes:** 1. Mathematically represent common single variable discrete and continuous probability functions that are relevant in actuarial applications such as Poisson, binomial, negative binomial, and geometric, uniform, exponential, and normal.

Audience: Undergraduate

2. Calculate measures related to the characteristics of single variable probability functions such as moments, mean, variance, median, mode, percentiles, etc., and interpret them in an actuarial context.

Audience: Undergraduate

3. Derive joint, marginal and conditional probabilities and densities from multivariate distributions and calculate covariance and correlation coefficients, and interpret them in an actuarial context.

Audience: Undergraduate

## ACT SCI 301 – ACTUARIAL SCIENCE METHODS II

1 credit.

Develop a knowledge of mathematical tools for quantitatively assessing financial risk. Emphasize the applications to problems encountered in actuarial science.

**Requisites:** (ACT SCI 303 or concurrent enrollment), declared in Capstone Certificate in Actuarial Science, or declared in undergraduate Business Exchange program. Not open to graduate students.

**Repeatable for Credit:** Yes, for 2 number of completions

**Last Taught:** Spring 2024

**Learning Outcomes:** 1. Illustrate the impact of the time value of money on decisions both in their professional and personal life.

Audience: Undergraduate

2. Compare and contrast the dynamics of key financial instruments including annuities, bonds and loans as well as calculate the price and other significant values of these instruments.

Audience: Undergraduate

3. Demonstrate the importance of immunizing asset and liability portfolios against changes in interest rates and describe methods of immunization.

Audience: Undergraduate

4. Explain the determinants of interest rates.

Audience: Undergraduate

5. Differentiate between the different types of measures of rate of return and return on investment and calculate those rates given a set of cash flow assumptions.

Audience: Undergraduate

6. Calculate the value of interest rate swaps.

Audience: Undergraduate

### **ACT SCI 303 – THEORY OF INTEREST**

3 credits.

Time value of money; interest compounded discretely and continuously; accumulated and present value of payments; loans and sinking funds; annuity and bond valuation; interest rate term structure; duration, immunization and interest rate swaps.

**Requisites:** MATH 213, 222, or declared in the Business Exchange program

**Repeatable for Credit:** No

**Last Taught:** Fall 2024

**Learning Outcomes:** 1. Understand and illustrate the impact of the time value of money on decisions both in their professional and personal life.

Audience: Undergraduate

2. Differentiate between the different types of measures of rate of return and return on investment and calculate those rates given a set of cash flow assumptions.

Audience: Undergraduate

3. Compare and contrast the dynamics of key financial instruments including annuities, bonds and loans as well as calculate the price and other significant values of these instruments.

Audience: Undergraduate

4. Demonstrate the importance of immunizing asset and liability portfolios against changes in interest rates and describe methods of immunization.

Audience: Undergraduate

### **ACT SCI 365 – CONTEMPORARY TOPICS**

1-3 credits.

Exploration of subject areas possibly to be introduced into the business curriculum.

**Requisites:** None

**Repeatable for Credit:** Yes, unlimited number of completions

**Last Taught:** Fall 2023

### **ACT SCI 399 – READING AND RESEARCH-ACTUARIAL SCIENCE**

1-3 credits.

Directed study in various areas of actuarial science that provides the opportunity to participate in more in-depth study (intermediate level) under the direct guidance of actuarial science faculty.

**Requisites:** Consent of instructor

**Course Designation:** Level - Intermediate

L&S Credit - Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** Yes, for 4 number of completions

**Last Taught:** Spring 2024

**Learning Outcomes:** 1. Students will be able to communicate basic knowledge of content, analyze related data and apply knowledge in a variety of academic settings.

Audience: Undergraduate

### **ACT SCI 640 – ACTUARIAL STATISTICS FOR RISK MODELING**

4 credits.

Introduction to statistical learning theory and methods for analyzing and modeling risks in actuarial applications. Topics include linear and nonlinear models; diagnostics and assessment of predictive models; variable and model selection; and non-supervised learning techniques.

**Requisites:** (GEN BUS 317, ECON 410, STAT/MATH 310, STAT 312, 333, or 340), graduate/professional standing, or declared in Capstone Certificate in Actuarial Science

**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Fall 2024

**Learning Outcomes:** 1. Articulate key assumptions pertinent to various statistical methods for risk modeling in insurance.

Audience: Both Grad & Undergrad

2. Evaluate actuarial models for risk analysis using graphical procedures, hypothesis tests, and score-based approaches.

Audience: Both Grad & Undergrad

3. Demonstrate an understanding of the bias-variance trade-off within the actuarial and risk modeling context and its impact on model selection.

Audience: Both Grad & Undergrad

4. Employ resampling techniques for validating models used in risk assessment and management.

Audience: Both Grad & Undergrad

5. Explain and interpret statistical package outputs to risk managers and other stakeholders.

Audience: Both Grad & Undergrad

6. Apply supervised and unsupervised learning methods to address challenges in insurance applications.

Audience: Graduate

**ACT SCI 650 – FUNDAMENTALS OF LONG-TERM ACTUARIAL MODELING**

3 credits.

Advanced problems in the mathematical theory of life contingencies; force of mortality, laws of mortality; premiums and reserves for insurance and annuities based on a single life.

**Requisites:** ACT SCI 303 and (MATH 331, STAT/MATH 309, 431, STAT 333, or 340), declared in undergraduate Business Exchange program, or Capstone Certificate in Actuarial Science

**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Fall 2024

**Learning Outcomes:** 1. Describe the key features of life and annuity insurance.

Audience: Both Grad & Undergrad

2. Apply key concepts concerning parametric and non-parametric mortality models for individual lives.

Audience: Both Grad & Undergrad

3. Estimate parameters for parametric and nonparametric survival models for actuarial applications.

Audience: Both Grad & Undergrad

4. Describe and evaluate present value random variables associated with benefits and expenses for life and annuity insurance

Audience: Both Grad & Undergrad

5. Describe and use the premium and policy value calculation processes for life and annuity insurance

Audience: Both Grad & Undergrad

6. Apply long-term actuarial modeling tools in conjunction with other techniques to address challenges in insurance applications.

Audience: Graduate

**ACT SCI 651 – ADVANCED LONG-TERM ACTUARIAL MODELING**

3 credits.

Joint life probabilities, annuities and insurances; multiple-decrement theory; pension fund mathematics.

**Requisites:** ACT SCI 650

**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Fall 2024

**Learning Outcomes:** 1. Develop and utilize multiple state models in actuarial applications and calculate premiums and reserves for policies associated with multiple state models.

Audience: Undergraduate

2. Apply special cases of multiple state model in actuarial practice, including the multiple decrement and multiple life models.

Audience: Undergraduate

3. Understand liabilities and required contributions for pension plans and post retirement health plans.

Audience: Undergraduate

4. Evaluate premiums and liabilities for Universal Life insurance policies.

Audience: Undergraduate

5. Apply profit testing methodology to price and evaluate insurance policies.

Audience: Undergraduate

**ACT SCI 652 – FUNDAMENTALS OF SHORT-TERM ACTUARIAL MODELING**

3 credits.

Definition and selection of probability distributions appropriate for insurance data that are heavily tailed and skewed.

**Requisites:** (GEN BUS 317, STAT/MATH 310, STAT 333, 340, or concurrent enrollment), declared in undergraduate Business Exchange program, or Capstone Certificate in Actuarial Science

**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** No

**Last Taught:** Fall 2024

**Learning Outcomes:** 1. Demonstrate the appropriateness of alternative probability models, for both frequency and severity, when applied to short-term insurance loss data.

Audience: Both Grad & Undergrad

2. Evaluate the effects of coverage modifications on severity models and adjust the models to accommodate the coverage change.

Audience: Both Grad & Undergrad

3. Explain the model building process, and estimation, for the analysis of short-term insurance loss data.

Audience: Both Grad & Undergrad

4. Build aggregate loss models that quantify the risks of an insurance system, and utilize these models in applications such as reinsurance.

Audience: Both Grad & Undergrad

5. Interpret the concepts of ratemaking and reserving, and prepare data for short-term insurance ratemaking and reserving analyses.

Audience: Both Grad & Undergrad

6. Apply short-term actuarial modeling tools in conjunction with other techniques to address challenges in insurance applications.

Audience: Graduate

**ACT SCI 653 – ADVANCED SHORT-TERM ACTUARIAL MODELING**

3 credits.

Estimation of parameters of probability distributions appropriate for insurance data that are heavy tailed and skewed; assessment of credibility of data for ratemaking.

**Requisites:** ACT SCI 652 or declared in undergraduate Business Exchange program

**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Fall 2024

**Learning Outcomes:** 1. Create new severity distributions through techniques including random variable transformation, mixtures, and splicing.

Audience: Undergraduate

2. Apply extreme value distributions to the estimation of tail measures and probabilities in short-term insurance applications.

Audience: Undergraduate

3. Perform model selection using graphical procedures, hypothesis tests, and score-based approaches with a focus on short-term insurance applications.

Audience: Undergraduate

4. Estimate losses for short-term insurance coverages using credibility procedures including greatest accuracy credibility and empirical Bayesian estimation.

Audience: Undergraduate

5. Apply advanced techniques for estimating outstanding claims associated with short-term insurance coverages, and understand the underlying statistical models and assumptions.

Audience: Undergraduate

6. Apply advanced techniques to calculate premiums for short-term insurance coverages, such as calculating risk classification differential changes.

Audience: Undergraduate

**ACT SCI 654 – REGRESSION AND TIME SERIES FOR ACTUARIES**

2-3 credits.

Foundation of multiple regression and time series analysis with focus on business. Introduction to skills needed to become critical consumers of reports that are based on regression and time series analysis.

**Requisites:** (ACT SCI 640, GEN BUS 656, STAT 333, or 340), or declared in undergraduate Business Exchange program

**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Spring 2024

**Learning Outcomes:** 1. Complete hands-on tutorials and exercises using linear regression and time series models relevant for actuarial practice.

Audience: Undergraduate

2. Utilize statistical software to estimate model parameters for regression models in business applications.

Audience: Undergraduate

3. Explain the importance of checking model assumptions and conducting residual analyses in business applications.

Audience: Undergraduate

4. Explain the impact of choices of explanatory variables and incorporate these variables in the model.

Audience: Undergraduate

5. Integrate regression concepts to other actuarial science courses including loss models, actuarial mathematics, and use of simulation.

Audience: Undergraduate

**ACT SCI 655 – HEALTH ANALYTICS**

3 credits.

Introduction to the broad area of health, integrating how researchers from multiple perspectives have investigated various aspects of health, along with the hands-on practice of learning and using statistical tools to analyze these topics.

**Requisites:** (ACT SCI 640, GEN BUS 656, STAT 333, or 340), or declared in undergraduate Business Exchange program

**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Fall 2024

**Learning Outcomes:** 1. Discuss an assortment of issues in the health area to gain knowledge of the interaction of health, health care and health insurance.

Audience: Undergraduate

2. Synthesize research in assigned articles and critically discuss health-related peer-reviewed articles in a small, interactive group setting.

Audience: Undergraduate

3. Apply and extend knowledge in statistics and statistical modeling as related to health topics.

Audience: Undergraduate

4. Apply statistical methods to data from the Medical Expenditure Panel Survey (MEPS).

Audience: Undergraduate

5. Develop presentation and writing skills by critically discussing and analyzing a health analytics paper using MEPS data.

Audience: Undergraduate

### **ACT SCI 657 – RISK ANALYTICS**

3 credits.

Develop a toolbox for modeling, communicating, and managing risk and uncertainty in business applications. Emphasis on the notation of probabilistic forecasting and introduces a predictive modeling framework that integrate modern machine learning methods with distribution-based regression models. Topics include heavy-tailed regression, count data regression, survival data analysis, feature engineering using neural networks and natural language processing, among others.

**Requisites:** (ACT SCI 640, GEN BUS 656, STAT 333, or 340), or declared in undergraduate Business Exchange program

**Course Designation:** Level - Advanced

L&S Credit - Counts as Liberal Arts and Science credit in L&S

**Repeatable for Credit:** No

**Last Taught:** Spring 2024

**Learning Outcomes:** 1. Articulate the difference between point prediction and probabilistic prediction in a business context.

Audience: Undergraduate

2. Build predictive models for the purpose of probabilistic forecasting in business applications.

Audience: Undergraduate

3. Select appropriate modeling strategy and evaluate performance of the models in a given business context.

Audience: Undergraduate

4. Perform feature engineering to incorporate complex pattern and unstructured data into the predictive model development for business applications.

Audience: Undergraduate

5. Interpret the prediction outcome and communicate results to non-technical business audiences

Audience: Undergraduate

### **ACT SCI 765 – CONTEMPORARY TOPICS**

1-3 credits.

Exploration of subject areas possibly to be introduced into the business curriculum.

**Requisites:** Graduate/professional standing or declared in graduate Business Exchange program

**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement

**Repeatable for Credit:** Yes, unlimited number of completions

**Last Taught:** Spring 2020