Course Specification

(Postgraduate Programs)

Course Title:	**Probability Models with Actuarial Applications**
Course Code:	**STA 6103**
Program:	**Executive Master of Science in Actuaries and Financial Mathematics**
Department:	**Mathematics and Statistics**
College:	**Science**
Institution:	**Imam Mohammad Ibn Saud Islamic University**
Version:	**2025 – V1**
Last Revision Date:	**None**

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A. General information about the course:

1. Course Identification

1. Credit hours:					
3 (2 Lectures, 2 Lab, 0 Tutorial)					
2. Course type					
A.	☐University	☐ College	☐ Department	☐Track	☒ Others
B.	☒ Required		☐ Elective		
3. Level/year at which this course is offered: Level 2 / Year 1					
4. Course general Description:					
This course provides a comprehensive understanding of probability concepts and their application in actuarial science. The course delves into random variables, key distributional quantities, and actuarial models, focusing on continuous and discrete distributions, coverage modifications, and aggregate loss models. Students will explore advanced topics such as maximum likelihood estimation, frequentist, and Bayesian estimation methods. Emphasis is placed on the practical application of these models in assessing risks and solving real-world problems in insurance and finance. Through analytical techniques and computational tools, the course equips students with the skills to analyze and interpret data effectively in an actuarial context.					
5. Pre-requirements for this course (if any):					
None.					
6. Co-requisites for this course (if any):					
None.					
7. Course Main Objective(s):					
The main objective of this course is to: • Understand fundamental concepts of probability and their applications in actuarial science. • Analyze and model frequency and severity distributions with modifications like deductibles and limits. • Develop a comprehensive understanding of aggregate loss models and compute claims distributions. • Apply maximum likelihood estimation and other statistical methods to actuarial data, including censored and grouped datasets. • Explore frequentist and Bayesian estimation techniques in actuarial modeling. • Use computational tools and software to implement probability models in real-world insurance and financial contexts. • Cultivate critical thinking and problem-solving skills in actuarial applications. • Foster ethical practices and collaborative teamwork in actuarial modeling and decision-making.					

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning	0	0%
3	Hybrid	0	0%

No	Mode of Instruction	Contact Hours	Percentage
	• Traditional classroom • E-learning		
4	Distance learning	0	0%

3. Contact Hours (based on the academic semester)

No	Activity	Contact Hours
1.	**Lectures**	30
2.	**Laboratory/Studio**	30
3.	**Field**	0
4.	**Tutorial**	0
5.	**Others (specify)**	0
Total		**60**

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
1.0	**Knowledge and understanding**			
1.1	**Demonstrate an understanding of key probability tools and their application to actuarial problems, including distributional quantities and risk measures.**	**K1**	**Interactive lectures with examples; Problem-solving sessions**	**Direct: Quizzes; Mid-term and final exams**
1.2	**Explain the characteristics of actuarial models, including parametric distributions, finite mixtures, and their application to insurance.**	**K1, K2**	**Case studies; Class discussions**	**Direct: Case study-based assignments; Written exams**
2.0	**Skills**			
2.1	**Apply frequency and severity models with coverage modifications to analyze insurance claims.**	**S1, S3**	**Hands-on workshops using real-world datasets; Software-based exercises (e.g., R, Python)**	**Direct: Project work; Lab assignments**
2.2	**Develop aggregate loss models, including compound and individual risk models, and compute aggregate claims distributions.**	**S1, S2**	**Step-by-step tutorials; Group problem-solving sessions**	**Direct: Group projects; Problem sets**

Code	Course Learning Outcomes	Code of CLOs aligned with program	Teaching Strategies	Assessment Methods
2.3	Use maximum likelihood and Bayesian estimation techniques for parameter estimation in actuarial models.	S2, S3	Practical demonstrations of estimation techniques; Guided computational tutorials	Direct: Data-driven assignments; Exams with computational problems
2.4	Analyze the impact of policy modifications such as deductibles and limits on claim frequency and aggregate payments.	S3	Discussion of practical examples; Simulations using actuarial software	Direct: Simulation-based assignments; Scenario-based exams
3.0	**Values, autonomy, and responsibility**			
3.1	Perform effectively in teams to model real-world actuarial problems and communicate results with clarity and professionalism.	V1	Group assignments; Peer-review exercises	Direct: Group presentations; Peer evaluation
3.2	Show and uphold ethical principles and professional behavior while applying predictive and probabilistic modeling techniques in actuarial and financial problems.	V2	Ethical case studies; Role-playing exercises on professional scenarios	Direct: Reflective essays; Ethics-focused components in exams

C. Course Content

No	List of Topics	Contact Hours (Lectures, Tutorials, Labs)
1.	**Random Variables & Basic Distributional Quantities** Key Functions and Four Models, Moments, Percentiles, Generating Functions and Sums of Random Variables, Tails of Distributions, Measures of Risk	2
2.	**Characteristics of Actuarial Models** Parametric and Scale Distributions, Parametric Distribution Families, Finite Mixture Distributions, Data-Dependent Distributions	6
3.	**Continuous Models** Creating New Distributions, Selected Distributions and Their Relationships, The Linear Exponential Family	8
4.	**Discrete Distributions** Poisson Distribution, Negative Binomial Distribution, Binomial Distribution, The $(a, b, 0)$ Class, Truncation and Modification at Zero	8
5.	**Frequency and Severity with Coverage Modifications** Deductibles, The Loss Elimination Ratio and the Effect of Inflation for Ordinary	10

	Deductibles, Policy Limits, Coinsurance, Deductibles, and Limits, The Impact of Deductibles on Claim Frequency	
6.	**Aggregate Loss Models** Model Choices, The Compound Model for Aggregate Claims, Analytic Results, Computing the Aggregate Claims Distribution, The Recursive Method, The Impact of Individual Policy Modifications on Aggregate Payments, The Individual Risk Model	10
7.	**Maximum Likelihood Estimation** Individual Data, Grouped Data, Truncated or Censored Data, Variance and Interval Estimation for Maximum Likelihood Estimators, Functions of Asymptotically Normal Estimators, Nonnormal Confidence Intervals	8
8.	**Frequentist Estimation for Discrete Distributions** Poisson Distribution, Negative Binomial Distribution, Binomial Distribution, The $(a, b, 1)$ Class, Compound Models, The Effect of Exposure on Maximum Likelihood Estimation	4
9.	**Bayesian Estimation** Inference and Prediction, Conjugate Prior Distributions and the Linear Exponential Family, Computational Issues	4
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	Quizzes, Mini projects, Real-life project	During the semester	30%
2.	Midterm	Week 8-9	30%
3.	Final Exam	Week 15	40%

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	1. *Loss Models: From Data to Decisions, (Fourth Edition), 2012, by Klugman, S.A., Panjer, H.H. and Willmot, G.E., ISBN 978-1-118-31532-3.*
Supportive References	None
Electronic Materials	2. LMS – Blackboard
Other Learning Materials	3. Study notes and sample exams: https://www.soa.org/education/exam-req/syllabus-study-materials/edu-multiple-choice-exam#october-2024-pa

2. Educational and Research Facilities and Equipment Required:

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	▪ Each class room should be equipped with a whiteboard and a projector. ▪ Laboratories should be equipped with computers and an internet connection.
Technology equipment (projector, smart board, software)	The rooms should be equipped with data show and Smart Board.
Other equipment (depending on the nature of the specialty)	Scientific calculator

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	Students	During the semester and at the end of the course each student will complete two evaluation forms.
Effectiveness of Students assessment	Instructor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.
Quality of learning resources	Students	During the semester and at the end of the course each student will complete two evaluation forms.
The extent to which CLOs have been achieved	Instructor	At the end of each semester the course instructor should complete the course report, including a summary of student questionnaire responses appraising progress and identifying changes that need to be made if necessary.
Other	None	

Assessors (Students, Faculty, Program Leaders, Peer Reviewer, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	MATHEMATICS AND STATISTICS DEPARTMENT COUNCIL
REFERENCE NO.	20/1446
DATE	11/08/1446 (10/02/2025)