Fundamentals of Actuarial Mathematics Exam – Draft Syllabus – December 2021 Draft

The following is a draft syllabus for the new Exam FAM, to be first offered in October 2022. This 3.5-hour exam consists of 40 multiple-choice questions and is administered as a computer-based test (CBT). For additional details on CBT, please refer to Exam Rules. It is possible that there will be small changes to this syllabus when the final version is released, which will be at least six months in advance of the exam. In particular, there may be adjustments to the percentage weights and the assigned readings.

LEARNING OUTCOMES – SHORT-TERM (FAM-S)

1. Topic: Insurance and Reinsurance Coverages (5-7.5%)
Learning Objectives
The Candidate will understand the key features of insurance and reinsurance coverages.
Learning Outcomes
The Candidate will be able to: a) Define and apply the concept of insurable risk. b) Identify different types of short-term insurance coverage including auto, homeowners, liability, health, disability, and workers compensation. c) Identify the types and determine the impact of policy limits and coverage modifications for short-term insurance. d) Identify the different forms of individual risk rating plans. e) Identify the operation of basic forms of proportional and excess of loss reinsurance and understand their impact on reserving and pricing. f) Determine the allocation of claim amounts paid by the insurer and reinsurer under various forms of reinsurance.

2. Topic: Severity, Frequency, and Aggregate Models (10-17.5%)

Learning Objectives

The Candidate will understand the characteristics of and uses for commonly used severity, frequency, and aggregate models.

Learning Outcomes

The Candidate will be able to:

a) For severity models:
- Calculate moments and percentiles.
- Identify the role of scale and shape parameters in continuous models.
- Recognize classes of distributions and their relationships.
- Characterize distributions by existence of moments.

b) For frequency models:
- Identify the role of parameters for the (a,b,0) class of distributions.
- Recognize the (a,b,0) class of distributions and their relationships.
- Perform calculations for the (a,b,0) class of distributions.
- Identify appropriate distributions for a given application.

c) For aggregate models:
- Define collective and individual risk models and calculate their mean and variance.
- Use the log-normal or normal approximation to approximate the aggregate distribution.

d) For risk measures:
- Calculate Value at Risk and Tail Value at Risk.
- Determine whether a given risk measure has certain desirable properties.

3. Topic: Parametric Estimation (10-15%)
Learning Objectives
The Candidate will understand and be able to estimate parameters for parametric models.
Learning Outcomes
The Candidate will be able to: a) Estimate the parameters for severity, frequency, and aggregate distributions using Maximum Likelihood Estimation for: • Complete, individual data • Complete, grouped data • Truncated or censored data

4. Topic: Introduction to Credibility (5-7.5%)
Learning Objectives
The Candidate will understand the concepts of credibility and be able to apply certain types of credibility in some practical settings.
Learning Outcomes
The Candidate will be able to: a) Understand the concept of credibility. b) Perform calculations using limited fluctuation (classical) credibility.

5. Topic: Pricing and Reserving for Short-Term Insurance Coverages (10-12.5%)

Learning Objectives

The Candidate will be able to use basic methods to calculate premiums and reserves for short-term insurance coverages.

Learning Outcomes

The Candidate will be able to:

a) Describe and apply techniques for estimating outstanding claims, using the following methods:
   - Expected Loss Ratio
   - Chain-Ladder
   - Bornhuetter-Ferguson

b) Understand the objectives of ratemaking and the data used for ratemaking.

c) Calculate the adjustments to ratemaking data, including development, trend and adjusting premium to current rate levels.

d) Understand how expenses and the profit and contingencies loading are used in ratemaking.

e) Calculate overall average rates and rate changes using the loss cost and loss ratio methods.

LEARNING OUTCOMES – LONG-TERM (FAM-L)

6. Topic: Insurance Coverages and Retirement Financial Security Programs (2.5-5%)
Learning Objectives
The Candidate will understand the key features of insurance coverages and retirement financial security programs.
Learning Outcomes
The Candidate will be able to: a) Define and apply the concept of insurable interest. b) Identify the long-term insurance coverages (life, health), annuities, and defined benefit and defined contribution pension plans.

7. Topic: Mortality Models (7.5-10%)
Learning Objectives
The Candidate will understand key concepts concerning parametric and non-parametric mortality models for individual lives.
Learning Outcomes
The Candidate will be able to: a) Understand parametric survival models, life tables, and the relationships between them. b) Given a parametric survival model, calculate survival and mortality probabilities, the force of mortality function, and curtate and complete moments of the future lifetime random variable. c) Identify and apply standard actuarial notation for future lifetime distributions and moments, including select and ultimate functions. d) Given a life table, calculate survival and mortality probabilities, the force of mortality function, and curtate and complete moments of the future lifetime random variable, using appropriate fractional age assumptions where necessary. e) Understand and apply select life tables. f) Identify common features of population mortality curves. g) Apply formula-based and spline-based deterministic mortality improvement factors, allowing for calendar year and cohort year effects.

8. Topic: Survival Estimation (7.5-10%)

Learning Objectives

The Candidate will understand and be able to estimate parameters for parametric and non-parametric survival models.

Learning Outcomes

The Candidate will be able to:

a) Estimate the parameters for survival models using Maximum Likelihood Estimation for:
   - Complete, individual data
   - Complete, grouped data
   - Truncated or censored data

b) Apply Kaplan Meier and Nelson Aalen methods to estimate empirical survival functions using censored and truncated lifetime data.

c) Calculate approximate standard errors of the parameter/probability estimates.

d) Construct linear and non-linear confidence intervals (as appropriate) for parameters/estimates.

9. Topic: Present Value Random Variables for Long-Term Insurance Coverages (5-10%)

Learning Objectives

The Candidate will be able to perform calculations on the present value random variables associated with benefits and expenses for long term insurance coverages.

Learning Outcomes

The Candidate will be able to:

a) Identify the present value random variables associated with life insurance, endowment, and annuity payments for single lives, based on annual, 1/m-thly and continuous payment frequency.

b) Calculate probabilities, means, variances and covariances for the random variables in Topic 9(a), using fractional age or claims acceleration approximations where appropriate.

c) Understand the relationships between the insurance, endowment, and annuity present value random variables in Topic 9(a), and between their expected values.

d) Calculate the effect of changes in underlying assumptions (e.g., mortality and interest).

e) Identify and apply standard actuarial notation for the expected values of the random variables in Topic 9(a).

10. Topic: Premium and Policy Value Calculation for Long-Term Insurance Coverages (10-15%)

Learning Objectives

The Candidate will be able to use and explain the premium and policy value calculation processes for long-term insurance coverages.

Learning Outcomes

The Candidate will be able to:

a) Identify the future loss random variables associated with whole life, term life, and endowment insurance, and with term and whole life annuities, on single lives.

b) Calculate premiums based on the equivalence principle, the portfolio percentile principle, and for a given expected present value of profit, for the policies in Topic 10(a).

c) Calculate and interpret gross premium, net premium and modified net premium policy values for the policies in Topic 10(a).

d) Identify and apply Thiele's differential equation, as applied to the policies in Topic 10(a).

e) Calculate the effect of changes in underlying assumptions (e.g., mortality and interest).

f) Apply the following methods for modelling extra risk: age rating; constant addition to the force of mortality, constant multiple of the rate of mortality.

11. Topic: Option Pricing Fundamentals (7.5-10%)

Learning Objectives

The Candidate will be able to value simple options and derivatives using risk neutral expected present values, under the binomial and Black-Scholes models.

Learning Outcomes

The Candidate will be able to:

a) Identify the cash flows and characteristics of puts and calls.

b) Apply the binomial option pricing model to calculate the price of a simple European-style derivative on a single non-dividend paying asset.

c) Apply the Black-Scholes formula to calculate the price and delta hedge of a simple European-style derivative on a single non-dividend paying asset.

d) Apply put-call parity.

Readings - Short-Term (FAM-S):
Loss Models:
Chapter 3 (Sections 1, 2, 4.1, 5)
Chapter 4
Chapter 5 (Sections 3, 4)
Chapter 6 (Section 5)
Chapter 9 (Sections 1-3, 8.1, 8.2)
Chapter 11 (Sections 1-4)
Chapter 12 (Sections 1-3)
Chapter 16

Introduction to Ratemaking and Loss Reserving for Property and Casualty Insurance:
Chapter 1
Chapter 2
Chapter 3 (Sections 1-6.4)
Chapter 4 (Sections 1-8.1)
Chapter 5 (Sections 2, 5)

Individual Health Insurance (IHI):
Chapter 2 (Sections 1, 9)

Readings - Long-Term (FAM-L):
Actuarial Mathematics for Life Contingent Risks:
Chapter 1
Chapter 2
Chapter 3
Chapter 4
Chapter 5
Chapter 6
Chapter 7 (Sections 1-4 [except 2.4, 2.5], 7, 8)
Chapter 16
Chapter 18 (Sections 1-5)