

Exam P — Learning Objectives

All 23 learning objectives are covered.

General Probability

- STAT2400 1. Set functions including set notation and basic elements of probability
- STAT2400 2. Mutually exclusive events
- STAT2400 3. Addition and multiplication rules
- STAT2400 4. Independence of events
- STAT2400 5. Combinatorial probability
- STAT2400 6. Conditional probability
- STAT2400 7. Bayes Theorem / Law of total probability

Univariate probability distributions (including binomial, negative binomial, geometric, hypergeometric, Poisson, uniform, exponential, chi-square, beta, Pareto, lognormal, gamma, Weibull, and normal)

- STAT2400&3400 8. Probability functions and probability density functions
- STAT2400&3400 9. Cumulative distribution functions
- STAT2400&3400 10. Mode, median, percentiles, and moments
- STAT2400&3400 11. Variance and measures of dispersion
- STAT3400 12. Moment generating functions
- STAT3400 13. Transformations

Multivariate probability distributions (including the bivariate normal)

- STAT3400&3800 14. Joint probability functions and joint probability density functions
- STAT3400 15. Joint cumulative distribution functions
- STAT3400&3800 16. Central Limit Theorem
- STAT3400 17. Conditional and marginal probability distributions
- STAT3400 18. Moments for joint, conditional, and marginal probability distributions
- STAT3800 19. Joint moment generating functions
- STAT3400 20. Variance and measures of dispersion for conditional and marginal probability distributions
- STAT3400 21. Covariance and correlation coefficients
- STAT3400&3800 22. Transformations and order statistics
- STAT2400&3400&3800 23. Probabilities and moments for linear combinations of independent random variables

Exam FM — Learning Objectives

All 22 learning objectives are covered.

Time Value of Money (Interest Theory)

1. *The candidate will be able to define and recognize the definitions of the following terms:*

- ACT2120 a. Interest rate (rate of interest)
- ACT2120 b. Simple interest
- ACT2120 c. Compound interest
- ACT2120 d. Accumulation function
- ACT2120 e. Future value
- ACT2120 f. Present value/net present value
- ACT2120 g. Discount factor
- ACT2120 h. Discount rate (rate of discount)
- ACT2120 i. Convertible m-thly
- ACT2120 j. Nominal rate
- ACT2120 k. Effective rate
- ACT2120 l. Force of interest
- ACT2120 m. Equation of value

2. *The candidate will be able to:*

- ACT2120 a. Given any two of interest rate, present value, or future value, calculate the third based on simple or compound interest.
- ACT2120 b. Given any one of the effective interest rate, the nominal interest rate convertible m-thly, the effective discount rate, the nominal discount rate convertible m-thly, or the force of interest, calculate all of the other items.
- ACT2120 c. Write the equation of value given a set of cash flows and an interest rate.

Annuities with payments that are not contingent (Interest Theory)

3. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2120 a. Annuity-immediate
- ACT2120 b. Annuity-due
- ACT2120 c. Perpetuity
- ACT2120 d. Payable m-thly
- ACT2120 e. Level payment annuity
- ACT2120 f. Arithmetic increasing/ decreasing payment annuity
- ACT2120 g. Geometric increasing/ decreasing payment annuity
- ACT2120 h. Term of annuity

4. The candidate will be able to:

- ACT2120 a. Given an annuity with level payments, immediate (or due), payable m-thly, and any three of present value, future value, interest rate, payment, and term calculate the remaining two items.
- ACT2120 b. Given an annuity with non-level payments, immediate (or due), payable m-thly, the pattern of payment amounts, and any three of present value, future value, interest rate, payment amounts, and term of annuity calculate the remaining two items.

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Loan (Interest Theory)

5. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2120 a. Principal
- ACT2120 b. Interest
- ACT2120 c. Term of loan
- ACT2120 d. Outstanding balance
- ACT2120 e. Final payment (drop payment, balloon payment)
- ACT2120 f. Amortization
- ACT2120 g. Sinking fund

6. The candidate will be able to:

- ACT2120 a. Given any four of term of loan, interest rate, payment amount, payment period, principal, calculate the remaining items.
- ACT2120 b. Calculate the outstanding balance at any point in time.
- ACT2120 c. Calculate the amount of interest and principal repayment in a given payment.
- ACT2120 d. Given the quantities, except one, in a sinking fund arrangement calculate the missing quantity.

Bonds (Interest Theory)

7. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2120 a. Price
- ACT2120 b. Redemption value
- ACT2120 c. Par Value/Face value
- ACT2120 d. Coupon, Coupon rate
- ACT2120 e. Term of bond
- ACT2120 f. Yield rate
- ACT2120 g. Callable/non-callable
- ACT2120 h. Book value
- ACT2120 i. Accumulation of discount

8. The candidate will be able to:

- ACT2120 a. Given any four of price, redemption value, yield rate, coupon rate, and term of bond, calculate the remaining item.

General Cash Flows and Portfolios (Interest Theory)

9. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2120 a. Yield rate/rate of return
- ACT2120 b. Dollar-weighted rate of return/Timeweighted rate of return
- ACT2120 c. Current value
- ACT2120 d. Duration (Macaulay and modified)
- ACT2120 e. Convexity
- ACT2120 f. Portfolio
- ACT2120 g. Spot rate
- ACT2120 h. Forward rate
- ACT2120 i. Yield curve
- ACT2120 j. Stock price, stock dividend

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10. The candidate will be able to:

- ACT2120 a. Calculate the current value of a set of cash flows.
- ACT2120 b. Calculate the portfolio yield rate.
- ACT2120 c. Calculate the dollar-weighted and time-weighted rate of return.
- ACT2120 d. Calculate the duration and convexity of a set of cash flows.
- ACT2120 e. Calculate either Macaulay or modified duration given the other.
- ACT2120 f. Use duration and convexity to approximate the change in present value due to a change in interest rate.
- ACT2120 g. Calculate the price of a stock using the dividend discount model.

Immunization (Interest Theory)

11. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2120 a. Cash-flow matching
- ACT2120 b. Immunization (including full immunization)
- ACT2120 c. Redington immunization.

12. The candidate will be able to:

- ACT2120 a. Construct an investment portfolio to fully immunize a set of liability cash flows.
- ACT2120 b. Construct an investment portfolio to match present value and duration of a set of liability cash flows.
- ACT2120 c. Construct an investment portfolio to exactly match a set of liability cash flows.

Exam FM — Learning Objectives

General Derivatives (Financial Economics)

13. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2020 a. Derivative, Underlying asset, Over-the-counter market
- ACT2020 b. Ask price, Bid price, Bid-ask spread
- ACT2020 c. Short selling, Short position, Long position
- ACT2020 d. Stock index
- ACT2020 e. Spot price
- ACT2020 f. Net profit/payoff
- ACT2020 g. Credit risk
- ACT2020 h. Marking-to-market
- ACT2020 i. Margin, Maintenance margin, Margin call

ACT2020 14. The candidate will be able to evaluate an investor's margin position based on changes in asset values.

Options (Financial Economics)

15. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2020 a. Call option, Put option
- ACT2020 b. Expiration, Expiration date
- ACT2020 c. Strike price/Exercise price
- ACT2020 d. European option, American option, Bermudan option
- ACT2020 e. In-the-money, At-the-money, Out-of-the-money
- ACT2020 f. Covered call, Naked writing
- ACT2020 g. Dividends
- ACT2020 h. Put-call parity

ACT2020 16. The candidate will be able to evaluate the payoff and profit of basic derivative contracts.

Hedging and Investment Strategies (Financial Economics)

17. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2020 a. Hedging, Arbitrage
- ACT2020 b. Diversifiable risk, Nondiversifiable risk
- ACT2020 c. Synthetic forwards
- ACT2020 d. Spreads (including bull, bear, box, and ratio spreads)
- ACT2020 e. Collars (including zero-cost collars), Paylater strategy
- ACT2020 f. Straddles (including strangles, written straddles and butterfly spreads)
- ACT2020 g. Convertible bond, Mandatorily convertible bond

18. The candidate will be able to:

- ACT2020 a. Explain how derivative securities can be used as tools to manage financial risk.
- ACT2020 b. Explain the reasons to hedge and not to hedge.
- ACT2020 c. Evaluate the payoff and profit of hedging strategies.

Exam FM — Learning Objectives

Forwards and Futures (Financial Economics)

19. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2020 a. Forward contract, Prepaid forward contract
- ACT2020 b. Outright purchase, Fully leveraged purchase
- ACT2020 c. Implied repo rate
- ACT2020 d. Cost of carry
- ACT2020 e. Lease rate
- ACT2020 f. Futures contract

20. The candidate will be able to:

- ACT2020 a. Determine forward price from prepaid forward price.
- ACT2020 b. Explain the relationship between forward price and futures price.
- ACT2020 c. Explain the relationship between forward price and future stock price.
- ACT2020 d. Use the concept of no-arbitrage to determine the theoretical value of futures and forwards.
- ACT2020 e. Given any four of call premium, put premium, forward price, strike price and interest rate, calculate the remaining item using the put-call parity formula.

Swaps (Financial Economics)

21. The candidate will be able to define and recognize the definitions of the following terms:

- ACT2020 a. Swap, Prepaid swap
- ACT2020 b. Swap term, Swap spread, Notional Amount
- ACT2020 c. Simple commodity swap, Interest rate swap
- ACT2020 d. Deferred swap

- ACT2020 22. The candidate will be able to use the concept of no-arbitrage to determine the theoretical values of swaps.

Exam MFE — Learning Objectives

All 15 learning objectives are covered.

Interest rate models

ACT4000 1. Evaluate features of the Vasicek and Cox-Ingersoll-Ross bond price models.

ACT4000 2. Explain why the time-zero yield curve in the Vasicek and Cox-Ingersoll-Ross bond price models cannot be exogenously prescribed.

ACT4000 3. Construct a Black-Derman-Toy binomial model matching a given time-zero yield curve and a set of volatilities.

Rational valuation of derivative securities

ACT4000 4. Use put-call parity to determine the relationship between prices of European put and call options and to identify arbitrage opportunities.

ACT4000 5. Calculate the value of European and American options using the binomial model.

ACT4000 6. Calculate the value of European and American options using the Black-Scholes option-pricing model.

ACT4000 7. Interpret the option Greeks.

ACT4000 8. Explain the cash flow characteristics of the following exotic options: Asian, barrier, compound, gap, and exchange.

ACT4000 9. Explain the properties of a lognormal distribution and explain the Black-Scholes formula as a limited expected value for a lognormal distribution.

ACT4000 10. Explain what it means to say that stock prices follow a diffusion process.

ACT4000 11. Apply Itô's lemma in the one-dimensional case.

ACT4000 12. Apply option pricing concepts to actuarial problems such as equity-linked insurance.

Simulation

ACT4000 13. Simulate lognormal stock prices.

ACT4000 14. Use variance reduction techniques to accelerate convergence.

Risk management techniques

ACT4000 15. Explain and demonstrate how to control risk using the method of delta-hedging.

Exam MLC — Learning Objectives

All 13 learning objectives are covered.

Survival models

1. Define survival-time random variables

- ACT3130&3530 a. for one life, both in the single- and multiple-decrement models
ACT3230 b. for two lives, where the lives are independent or dependent (including the common shock model).

- ACT3130&3530 2. Calculate the expected values, variances, probabilities, and percentiles for survival-time random variables.

3. Define the continuous survival-time random variable that arises from the discrete survival-time random variable using

- ACT3130 a: a. uniform distribution
ACT3130 b. constant force of mortality
ACT3130 c. hyperbolic assumption

Markov Chain Models

4. Define non-homogeneous and homogeneous discrete-time Markov Chain models and calculate the probabilities of

- ACT3530 a. being in a particular state
ACT3530 b. transitioning between particular states.

Life insurances and annuities

5. Define present-value-of-benefit random variables defined on survival-time random variables:

- ACT3130&3530 a. for one life, both in the single- and multiple-decrement models
ACT3230 b. for two lives, where the lives are independent or dependent (including the common shock model).

6. Define and calculate the expected values, variances and probabilities for:

- ACT3130&3530 a. present-value-of-benefit random variables
ACT3230 b. present-value-of-loss-at-issue random variables, as a function of the considerations (premiums)
ACT3230 c. present-value-of-loss random variables, as a function of the considerations (premiums).

7. Calculate considerations (premiums) for life insurances and annuities,

- ACT3230&3530 a. using the Equivalence Principle
ACT3230 b. using percentiles.

8. Calculate liabilities, analyzing the present-value-of-future-loss random variables:

- ACT3230&3530 a. using the prospective method
ACT3230 b. using the retrospective method
ACT3230 c. using special formulas.

Exam MLC — Learning Objectives

9. Calculate

ACT3530 a. gross considerations (expense-loaded premiums)

ACT3530 b. expense-loaded liabilities (reserves)

ACT3530 c. asset shares.

ACT3230 10. Using recursion, calculate expected values (reserves) and variances of present-value-of-future-loss random variables for general fully-discrete life insurances written on a single life.

11. Extend the present-value-of-benefit, present-value-of-loss-at-issue, present-value-of-future-loss random variables and liabilities to discrete-time Markov Chain models, to calculate

ACT3530 a. actuarial present values of cash flows at transitions between states

ACT3530 b. actuarial present values of cash flows while in a state

ACT3530 c. considerations (premiums) using the Equivalence Principle

ACT3530 d. liabilities (reserves) using the prospective method.

Poisson processes

ACT3530 12. Define Poisson process and compound Poisson process.

13. Define and calculate expected values, variances, and probabilities for Poisson processes,

ACT3530 a. using increments in the homogeneous case

ACT3530 b. using interevent times in the homogeneous case

ACT3530 c. using increments in the non-homogeneous case.

Exam C — Learning Objectives

All 33 learning objectives are covered.

Severity Models

1. Calculate the basic distributional quantities:

- ACT4140 a. Moments
- ACT4140 b. Percentiles
- ACT4140 c. Generating functions

ACT4140 2. Describe how changes in parameters affect the distribution.

ACT4140 3. Recognize classes of distributions and their relationships.

4. Apply the following techniques for creating new families of distributions:

- ACT4140 a. Multiplication by a constant
- ACT4140 b. Raising to a power
- ACT4140 c. Exponentiation,
- ACT4140 d. Mixing

ACT4140 5. Identify the applications in which each distribution is used and reasons why.

ACT4140 6. Apply the distribution to an application, given the parameters.

ACT4140 7. Calculate various measures of tail weight and interpret the results to compare the tail weights.

Frequency Models

8. For the Poisson, Mixed Poisson, Binomial, Negative Binomial, Geometric distribution and mixtures thereof:

- ACT4140 a. Describe how changes in parameters affect the distribution,
- ACT4140 b. Calculate moments,
- ACT4140 c. Identify the applications for which each distribution is used and reasons why,
- ACT4140 d. Apply the distribution to an application given the parameters.
- ACT4140 e. Apply the zero-truncated or zero-modified distribution to an application given the parameters

Aggregate Models

ACT4140 9. Compute relevant parameters and statistics for collective risk models.

ACT4140 10. Evaluate compound models for aggregate claims.

ACT4140 11. Compute aggregate claims distributions.

For severity, frequency and aggregate models

12. Evaluate the impacts of coverage modifications:

ACT4140 a. Deductibles

ACT4140 b. Limits

ACT4140 c. Coinsurance

ACT4140 13. Calculate Loss Elimination Ratios.

ACT4140 14. Evaluate effects of inflation on losses.

Risk Measures

ACT4340 15. Calculate VaR, and TVaR and explain their use and limitations.

Construction of Empirical Models

16. Estimate failure time and loss distributions using:

- ACT4240 a. Kaplan-Meier estimator, including approximations for large data sets
- ACT4240 b. Nelson-Åalen estimator
- ACT4240 c. Kernel density estimators

ACT4240 17. Estimate the variance of estimators and confidence intervals for failure time and loss distributions.

18. Apply the following concepts in estimating failure time and loss distribution:

- ACT4240 a. Unbiasedness
- ACT4240 b. Consistency
- ACT4240 c. Mean squared error

Construction and Selection of Parametric Models

19. Estimate the parameters of failure time and loss distributions using:

- ACT4240 a. Maximum likelihood
- ACT4240 b. Method of moments
- ACT4240 c. Percentile matching
- ACT4340 d. Bayesian procedures

ACT4240 20. Estimate the parameters of failure time and loss distributions with censored and/or truncated data using maximum likelihood.

ACT4240 21. Estimate the variance of estimators and the confidence intervals for the parameters and functions of parameters of failure time and loss distributions.

22. Apply the following concepts in estimating failure time and loss distributions:

- ACT4240 a. Unbiasedness
- ACT4240 b. Asymptotic unbiasedness
- ACT4240 c. Consistency
- ACT4240 d. Mean squared error
- ACT4240 e. Uniform minimum variance estimator

23. Determine the acceptability of a fitted model and/or compare models using:

- ACT4240 a. Graphical procedures
- ACT4240 b. Kolmogorov-Smirnov test
- ACT4240 c. Anderson-Darling test
- ACT4240 d. Chi-square goodness-of-fit test
- ACT4240 e. Likelihood ratio test
- ACT4240 f. Schwarz Bayesian Criterion

Credibility

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| ACT4340 | 24. Apply limited fluctuation (classical) credibility including criteria for both full and partial credibility. |
| ACT4340 | 25. Perform Bayesian analysis using both discrete and continuous models. |
| ACT4340 | 26. Apply Bühlmann and Bühlmann-Straub models and understand the relationship of these to the Bayesian model. |
| ACT4340 | 27. Apply conjugate priors in Bayesian analysis and in particular the Poisson-gamma model. |
| ACT4340 | 28. Apply empirical Bayesian methods in the nonparametric and semiparametric cases |

Simulation

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| ACT4340 | 29. Simulate both discrete and continuous random variables using the inversion method. |
| ACT4340 | 30. Estimate the number of simulations needed to obtain an estimate with a given error and a given degree of confidence. |
| ACT4340 | 31. Use simulation to determine the p-value for a hypothesis test. |
| ACT4340 | 32. Use the bootstrap method to estimate the mean squared error of an estimator. |
| ACT4340 | 33. Apply simulation methods within the context of actuarial models. |