MSCF Quantitative Assessment

Study Guide

Use this guide to identify areas for review. Topic coverage may vary by test form.

Calculus

Be prepared to use both computational techniques and the concepts behind them.

- **Limits and continuity:** One-sided and infinite limits, standard limit forms, continuity, and removable discontinuities.
- **Differentiation:** Derivative rules; implicit and parametric differentiation; tangent slopes, extrema, concavity, optimization, related rates, and the Mean Value Theorem.
- **Integration:** Definite and indefinite integrals; the Fundamental Theorem; substitution, integration by parts, partial fractions, and improper integrals; area, average value, arc length, and volumes.
- **Sequences and series:** Convergence, alternating and power series, intervals and radii of convergence, and Taylor series.
- **Multivariable and vector calculus:** Partial derivatives, gradients, directional derivatives, constrained optimization, Jacobians, multiple integrals, line integrals, conservative fields, divergence, curl, and Green's theorem.
- **Differential equations:** Basic first- and second-order equations and initial-value problems.

Linear Algebra

Focus on how matrix operations, linear systems, vector spaces, and transformations connect.

- **Matrices and systems:** Dimensions, multiplication, transpose, inverse, determinants, trace, row operations, pivots, free variables, consistency, and unique solutions.
- **Vector spaces:** Span, subspaces, linear independence, bases, dimension, column space, null space, rank, and rank-nullity.
- **Geometry and orthogonality:** Dot products, norms, projections, cross products, the Cauchy-Schwarz inequality, and Gram-Schmidt.
- **Eigenvalues and diagonalization:** Characteristic equations, eigenvectors, matrix powers, similarity, and properties of singular, symmetric, orthogonal, idempotent, and nilpotent matrices.
- **Advanced tools:** Spectral theorem, quadratic forms and definiteness, least squares, projection matrices, QR decomposition, singular values, change of basis, and steady-state eigenvectors.

Probability

Coverage ranges from foundational event rules through random variables, conditioning, and asymptotic results.

- **Counting and events:** Probability based on combinatorics (permutations and combinations), set theoretic notions of probability, independent events, and conditional probability.
- **Random variables:** PMFs, PDFs, CDFs, expectation, moments, variance, covariance, and correlation.
- **Joint and conditional distributions:** Marginal distributions, independent random variables, conditional densities and expectations, Bayes' theorem, and multivariate distributions.
- **Common distributions:** Bernoulli, binomial, geometric, Poisson, uniform, exponential, and normal distributions.
- **Distributional tools:** Moment-generating functions, transformations, sums and convolution, order statistics, symmetry, and expectation or probability computed by summation or integration.
- **Theorems and inequalities:** Laws of total expectation and variance, Law of Large Numbers, Central Limit Theorem, Markov, Chebyshev, Jensen, and the Delta method.

Computer Science

No single programming language is the focus. Be comfortable reading structured pseudocode and reasoning precisely about it.

- **Pseudocode and control flow:** Variables, assignment, arithmetic, Boolean logic, functions, return values, for and while loops, nested loops, conditionals, break, continue, and short-circuit evaluation.

- **Data handling:** Integers and digit operations, strings, lists, zero-based indexing, slicing, concatenation, insertion, append and pop, and simple character-code operations.
- **Tracing and edge cases:** Determine outputs, describe what a function computes, compare implementations, and track initialization, boundaries, empty inputs, and early returns.
- **Mutation and references:** Recognize when variables share the same list and when an operation creates a new one.
- **Recursion and debugging:** Base cases, recursive and mutual-recursive calls, iterative equivalents, off-by-one errors, invalid indexing, incorrect conditions, variable shadowing, and mutation during iteration.
- **Efficiency:** Identify constant, logarithmic, linear, linearithmic, and quadratic growth; analyze loops; and recognize a more efficient equivalent algorithm.

How to prepare

- **Refresh:** Review definitions, standard identities, major theorems, and notation across all four areas.
- **Practice:** Work short, mixed problems by hand and choose the method before calculating.
- **Trace:** Follow pseudocode on paper, recording variable values, indices, updates, and returned values.
- **Check:** Test edge cases and review errors as conceptual, algebraic, notational, logical, or time-management issues.
- **Time:** Once the material is familiar, practice mixed sets under a fixed time limit.

Scope note. The guide is intended to make the academic scope transparent while preserving assessment integrity. It is not an exhaustive guarantee of the content on any test form. The emphasis is on quantitative and computational foundations rather than finance-specific knowledge.