Certificate in Quantitative Investing

Module 1: Foundations of Quantitative Investing

- Meaning, purpose and scope of quantitative investing.
- Quantitative, discretionary and hybrid investment approaches.
- Systematic investing versus algorithmic execution.
- Rules-based strategies, factor investing and statistical models.
- Sources of investment returns: market exposure, risk premia and potential alpha.
- Investment objectives, constraints and time horizons.
- The quantitative investment research lifecycle.
- Economic intuition and testable investment hypotheses.
- Roles of researchers, portfolio managers, risk teams and technology specialists.
- Strengths, limitations and failure modes of model-driven investing.

Module 2: Financial Markets, Instruments and Investment Data

- Equity, fixed-income, currency, commodity and multi-asset markets.
- Stocks, bonds, ETFs, indices, futures and options.
- Prices, returns, volumes and market-capitalisation data.
- Fundamental, macroeconomic and alternative data.
- Trading calendars, timestamps and market conventions.
- Corporate actions, dividends and adjusted prices.
- Total-return versus price-return series.
- Security identifiers and changes in investment universes.
- Data frequency and investment horizon.
- Data availability, licensing and permitted use.

Module 3: Mathematical Foundations for Investment Analysis

- Simple and compounded returns.
- Arithmetic and logarithmic returns.
- Annualisation and compounding conventions.

- Present value and time value of money.
- Weighted averages and portfolio returns.
- Algebraic relationships in investment models.
- Vectors, matrices and their portfolio applications.
- Covariance matrices and diversification.
- Optimisation objectives and constraints.
- Numerical precision, rounding and calculation checks.

Module 4: Probability and Descriptive Statistics

- Populations, samples and sampling methods.
- Mean, median, percentiles and dispersion.
- Variance, standard deviation and downside measures.
- Probability, conditional probability and dependence.
- Common probability distributions.
- Skewness, kurtosis and extreme observations.
- Correlation and covariance.
- Sampling error and estimation uncertainty.
- Normal-distribution assumptions and their limitations.
- Describing investment-return distributions.

Module 5: Statistical Inference and Research Judgement

- Hypotheses, test statistics and confidence intervals.
- Statistical significance versus economic significance.
- Type I and Type II errors.
- Sample size, statistical power and effect size.
- Multiple testing and false discoveries.
- Data snooping and selective reporting.
- Correlation, prediction and causation.
- Confounding variables and omitted-variable bias.
- Robustness checks and sensitivity analysis.
- Communicating uncertainty in research conclusions.

Module 6: Data Preparation and Research Integrity

- Data acquisition and documentation.
- Missing values, duplicates and inconsistent observations.

- Outlier identification and treatment.
- Scaling, standardisation and winsorisation.
- Point-in-time data and publication lags.
- Restated versus originally available financial information.
- Delistings, failed companies and incomplete histories.
- Data alignment across securities, dates and markets.
- Training, validation and test datasets.
- Reproducibility, version control and audit trails.
- Preventing leakage during feature preparation.
- Recording data limitations and research decisions.

Module 7: Regression and Investment Models

- Simple and multiple linear regression.
- Interpretation of coefficients and residuals.
- Explanatory versus predictive modelling.
- Model fit and out-of-sample performance.
- Multicollinearity and unstable estimates.
- Heteroskedasticity and serial correlation.
- Non-linear relationships and transformations.
- Dummy variables and interaction effects.
- Regularisation: introductory concepts.
- Model assumptions, diagnostics and limitations.
- Applications to returns, factor exposures and risk.

Module 8: Time-Series Analysis

- Time-series characteristics of financial data.
- Trends, seasonality and structural breaks.
- Stationarity and non-stationarity.
- Autocorrelation and lagged relationships.
- Rolling and expanding windows.
- Mean reversion and persistence.
- Introductory autoregressive models.
- Volatility clustering.
- Forecast horizons and forecast uncertainty.
- Regime changes and model instability.
- Avoiding spurious relationships in trending series.

Module 9: Factor Investing and Return Drivers

- Market, size, value, momentum, quality and low-volatility factors.
- Profitability, investment and carry-related signals.
- Risk-based and behavioural explanations.
- Cross-sectional versus time-series approaches.
- Factor definitions and implementation choices.
- Factor exposures versus investment alpha.
- Long-only and long–short factor portfolios.
- Factor cyclicality and drawdowns.
- Crowding, capacity and changing effectiveness.
- Factor diversification and unintended exposures.
- Evaluating evidence for an investment premium.

Module 10: Signal Design and Evaluation

- Converting investment hypotheses into measurable signals.
- Fundamental, price-based and macroeconomic signals.
- Ranking, scoring and standardisation.
- Sector and market neutralisation.
- Signal combinations and weighting.
- Information coefficient and rank correlation.
- Hit rates and return spreads.
- Signal persistence, decay and turnover.
- Incremental value relative to existing signals.
- Stability across markets, periods and subgroups.
- Distinguishing robust signals from research artefacts.

Module 11: Systematic Equity Strategies

- Value, quality, momentum and defensive strategies.
- Earnings, profitability and balance-sheet indicators.
- Price trends and reversal signals.
- Multifactor stock-selection models.
- Universe definition and investability filters.
- Sector, size and liquidity controls.
- Ranking-based portfolio formation.
- Benchmark-relative and absolute-return mandates.
- Rebalancing rules and turnover.

- Long-only versus long–short implementation.
- Borrow availability and short-selling constraints.

Module 12: Systematic Fixed-Income and Credit Strategies

- Bond prices, yields, duration and convexity.
- Yield curves and term-structure exposures.
- Carry and roll-down.
- Credit spreads and spread changes.
- Credit quality, default and recovery considerations.
- Systematic issuer and bond selection.
- Liquidity and pricing-data limitations.
- Duration, sector and issuer constraints.
- Credit-factor exposures and concentration.
- Evaluating returns after defaults, trading costs and financing.
- Differences between equity and fixed-income backtesting.

Module 13: Multi-Asset and Trend-Following Strategies

- Strategic and tactical asset allocation.
- Cross-asset momentum and trend following.
- Time-series versus cross-sectional momentum.
- Carry strategies across asset classes.
- Defensive allocation and risk balancing.
- Volatility targeting.
- Futures-based implementation.
- Contract rolls and continuous price series.
- Currency exposure and hedging.
- Correlation changes during stress.
- Diversification benefits and limitations.

Module 14: Portfolio Construction and Optimisation

- Translating signals into portfolio weights.
- Equal weighting and score-based weighting.
- Mean–variance optimisation.
- Minimum-variance portfolios.
- Risk budgeting and risk-parity concepts.

- Expected-return and covariance estimation.
- Estimation error and unstable allocations.
- Position, sector and exposure limits.
- Turnover, liquidity and transaction-cost constraints.
- Long-only, leverage and short-exposure constraints.
- Robustness and simplicity in portfolio design.
- Rebalancing policies and exception handling.

Module 15: Backtesting and Validation

- Purpose, scope and limitations of backtesting.
- Investment-universe and benchmark selection.
- Formation dates, holding periods and rebalance schedules.
- In-sample versus out-of-sample evaluation.
- Rolling-window and walk-forward testing.
- Survivorship and look-ahead biases.
- Selection bias, backfill bias and data snooping.
- Overfitting and excessive parameter searches.
- Realistic execution and information-availability assumptions.
- Sensitivity to start dates, periods and parameters.
- Recording unsuccessful research trials.
- Paper trading and live validation.

Module 16: Transaction Costs, Execution and Capacity

- Explicit and implicit trading costs.
- Bid–ask spreads, slippage and market impact.
- Turnover and implementation drag.
- Liquidity, trade size and participation.
- Timing between signal generation and execution.
- Order types and execution assumptions.
- Financing, margin and securities-borrow costs.
- Taxes, duties and market-specific charges.
- Capacity constraints and strategy scalability.
- Gross versus net performance.
- Implementation shortfall.
- Research assumptions versus live execution.

Module 17: Risk Management and Stress Testing

- Market, factor, liquidity and concentration risk.
- Leverage and counterparty exposure.
- Volatility and downside risk.
- Value at Risk and Expected Shortfall: introductory applications.
- Drawdowns and recovery periods.
- Historical and hypothetical stress scenarios.
- Correlation breakdown and crowded exits.
- Tail risk and non-normal returns.
- Position limits and exposure monitoring.
- Risk-based scaling and escalation.
- Model failure and operational disruption.
- Limitations of historical risk estimates.

Module 18: Performance Measurement and Attribution

- Time-weighted and money-weighted returns.
- Cumulative and annualised performance.
- Benchmark selection and excess returns.
- Volatility, tracking error and beta.
- Sharpe, Sortino and information ratios.
- Maximum drawdown and Calmar ratio.
- Alpha estimation and interpretation.
- Factor and sector attribution.
- Stock-selection and allocation effects.
- Gross, net and investable performance.
- Performance consistency and uncertainty.
- Distinguishing skill, exposure and luck.

Module 19: Machine Learning and AI in Investing

- Supervised and unsupervised learning.
- Regression, classification and clustering applications.
- Feature selection and engineering.
- Decision trees and ensemble methods: introductory concepts.
- Regularisation and model complexity.
- Time-aware validation and leakage prevention.
- Prediction accuracy versus investment usefulness.

- Interpretability and explainability.
- Non-stationarity, drift and changing relationships.
- Natural-language processing and text-based signals.
- Generative AI for research support and code assistance.
- Human verification, confidentiality and accountability.

Module 20: Tools and Reproducible Research

- Spreadsheet-based investment analysis.
- Introductory Python workflows for financial data.
- Data tables, joins, grouping and date handling.
- Return, signal and portfolio calculations.
- Charts and diagnostic visualisations.
- Reading and interpreting simple analytical code.
- Testing calculations against independent checks.
- Separating data preparation, research and reporting.
- Reproducible notebooks and documented assumptions.
- Dataset and model versioning.
- Secure storage of credentials and licensed data.
- Responsible use of AI-generated code.

Module 21: Investment Products and Manager Due Diligence

- Quantitative mutual funds, ETFs and systematic mandates.
- Smart beta versus active quantitative strategies.
- Index construction and reconstitution rules.
- Product mandate, benchmark and implementation.
- Live records versus simulated histories.
- Team, process and research governance.
- Data sourcing and model ownership.
- Risk controls, capacity and operational infrastructure.
- Fees, turnover and investor outcomes.
- Questions to ask quantitative managers.
- Warning signs in performance presentations.
- Suitability within a broader investment portfolio.

Module 22: Model Governance, Ethics and Professional Standards

- Model ownership, approval and independent review.
- Research documentation and change control.
- Monitoring live performance and exposures.
- Model drift, retirement and revalidation.
- Handling exceptions and manual overrides.
- Conflicts of interest and personal trading.
- Material non-public information and alternative-data risks.
- Data licensing, privacy and confidentiality.
- Fair presentation of backtests and live results.
- Disclosure of assumptions, costs and limitations.
- Avoiding misleading claims of predictive certainty.
- Professional boundaries and specialist escalation.