Risk Management Questions for Quantitative Finance, Market Risk, Credit Risk, Operational Risk, and Risk Modeling

Market Risk (10 Questions)

1. What is **Value-at-Risk (VaR)**? How is it calculated?
2. Compare **Historical VaR**, **Parametric VaR**, and **Monte Carlo VaR**.
3. What are the limitations of VaR? How does **Expected Shortfall (CVaR)** improve it?
4. Explain the **Basel III** market risk capital requirements (FRTB).
5. How do you backtest a VaR model? What is a **traffic light approach**?
6. What is **liquidity risk**? How do you measure it?
7. How does **volatility clustering** impact risk models?
8. What is **stress testing**? Give an example of a historical stress scenario.
9. How do you compute **marginal VaR** and **incremental VaR**?
10. What is the difference between **systematic risk** and **idiosyncratic risk**?

Credit Risk (10 Questions)

1. Define **Probability of Default (PD)**, **Loss Given Default (LGD)**, and **Exposure at Default (EAD)**.
2. What is the **Merton Model** for credit risk?
3. How does **Credit VaR** differ from Market VaR?
4. Explain the **CreditMetrics** approach.
5. What are **credit spreads**, and how do they relate to default risk?
6. How do you model **counterparty credit risk (CCR)** in derivatives?

7. What is a **Credit Default Swap (CDS)**? How is its spread determined?
8. Compare **IRB (Internal Ratings-Based)** and **Standardized Approach** under Basel III.
9. What is **wrong-way risk**? Give an example.
10. How does **collateralization** (e.g., CSA agreements) reduce credit risk?

Operational Risk (10 Questions)

1. What are the key categories of **operational risk**?
2. Explain the **Basic Indicator Approach (BIA)** vs. **Advanced Measurement Approach (AMA)** in Basel III.
3. What is **model risk**? How can it be mitigated?
4. How do you quantify **fraud risk** in banking?
5. What is **settlement risk**? How does **CLS Bank** mitigate it?
6. Explain **cybersecurity risk** in financial institutions.
7. What are **Key Risk Indicators (KRIs)**? Give examples.
8. How does **RCSA (Risk Control Self-Assessment)** work?
9. What is **conduct risk**? How is it regulated?
10. How do **operational risk losses** differ from market/credit losses?

Risk Modeling & Quantitative Techniques (10 Questions)

1. How do you simulate correlated random variables using **Cholesky decomposition**?
2. Explain **copulas** in risk modeling (e.g., Gaussian vs. Student-t copula).
3. What is **Extreme Value Theory (EVT)**? How is it used in risk management?
4. How does **GARCH** modeling improve volatility forecasts?
5. What is **principal component analysis (PCA)** in risk factor modeling?
6. How do you compute **risk contributions** in a portfolio?
7. What is **coherent risk measure**? Is VaR coherent?

8. Explain **regime-switching models** in risk management.
9. How do you model **jump risk** in asset prices?
10. What is **Kupiec's POF test** for VaR backtesting?

Regulatory & Enterprise Risk (10 Questions)

1. What is **Basel III**? How does it differ from Basel II?
2. Explain **Economic Capital** vs. **Regulatory Capital**.
3. What is **FRTB (Fundamental Review of the Trading Book)**?
4. How does **Dodd-Frank** impact risk management in the U.S.?
5. What are the **Pillar 1, 2, and 3** requirements under Basel III?
6. How do banks perform **ICAAP (Internal Capital Adequacy Assessment Process)**?
7. What is **enterprise risk management (ERM)**?
8. Explain **liquidity coverage ratio (LCR)** and **net stable funding ratio (NSFR)**.
9. How does **CCAR (Comprehensive Capital Analysis and Review)** work?
10. What are the key challenges in **climate risk modeling** for financial institutions?

Bonus: Scenario-Based Questions

- "A VaR model underestimates tail risk—how would you fix it?"
- "How would you assess risk in a portfolio of crypto assets?"
- "Explain how Lehman Brothers' collapse relates to liquidity risk."

Market Microstructure & Trading Basics (10 Questions)

1. What is **market microstructure**? How does it impact trading strategies?
2. Explain **order types** (limit, market, IOC, FOK, iceberg) and their use cases.

3. What is **latency arbitrage**? How do HFT firms exploit it?
4. Describe the **trade lifecycle** (from order entry to settlement).
5. What are **dark pools**? How do they differ from lit markets?
6. How does **slippage** occur, and how can it be minimized?
7. What is **adverse selection** in trading?
8. Explain **price impact** and how it affects execution strategies.
9. What is **spoofing**? How do regulators detect it?
10. How do exchanges handle **order matching** (price-time priority vs. pro-rata)?

Execution Algorithms & Optimization (10 Questions)

1. Compare **TWAP (Time-Weighted Average Price)** vs. **VWAP (Volume-Weighted Average Price)** strategies.
2. What is **implementation shortfall**? How is it minimized?
3. How does **POV (Percentage of Volume)** execution work?
4. Explain **adaptive execution algorithms** (e.g., reinforcement learning-based).
5. What is **latency sensitivity** in execution? How is it measured?
6. How do you optimize **transaction costs** (fees, spreads, impact)?
7. What is **smart order routing (SOR)**? How does it improve execution?
8. How do **hidden liquidity** and **order book dynamics** affect execution?
9. Explain **arrival price** vs. **participation rate** strategies.
10. How do **fill probabilities** influence order placement?

Statistical Arbitrage & Mean Reversion (10 Questions)

1. What is **pairs trading**? How do you select and hedge pairs?
2. Explain the **Ornstein-Uhlenbeck process** in mean-reverting strategies.
3. How do you test for **cointegration** (Engle-Granger, Johansen test)?

4. What is **Kalman filtering** in dynamic hedge ratio estimation?
5. How does **volatility scaling** improve mean-reversion strategies?
6. What are **z-score thresholds** for entry/exit in stat arb?
7. How do you handle **structural breaks** in cointegrated pairs?
8. What is **index arbitrage**? How does ETF creation/redemption work?
9. Explain **cross-sectional momentum** vs. **time-series momentum**.
10. How do **transaction costs** affect stat arb profitability?

Machine Learning in Trading (10 Questions)

1. How can **supervised learning** predict stock returns? What are the pitfalls?
2. Compare **feature engineering** for trading vs. traditional ML.
3. What is **walk-forward optimization**? Why is it better than backtesting?
4. How do you avoid **overfitting** in trading strategy development?
5. Explain **reinforcement learning (RL)** in execution optimization.
6. What are **alternative data** sources (satellite, credit card, sentiment)?
7. How do you evaluate ML models for trading (Sharpe ratio, drawdowns)?
8. What is **portfolio construction** using ML (hierarchical risk parity)?
9. How does **NLP (natural language processing)** aid trading strategies?
10. What are **latency vs. alpha decay** trade-offs in ML strategies?

Backtesting & Strategy Evaluation (10 Questions)

1. What are **common pitfalls in backtesting**? How to avoid them?
2. Explain **survivorship bias** and how to correct it.
3. What is **slippage modeling** in backtests?
4. How do you calculate **Sharpe ratio, Sortino ratio, and Calmar ratio**?
5. What is **Monte Carlo robustness testing** for strategies?
6. How do you handle **lookahead bias** in strategy development?

7. What is **position sizing** (Kelly criterion, risk parity)?
8. How do you **stress-test** a trading strategy?
9. What is **regime-switching detection** in strategy adaptation?
10. How do you **productionize** a backtested strategy (latency, infrastructure)?

Bonus: Advanced & Behavioral Questions

- "How would you design a market-making algorithm for cryptocurrencies?"
- "Explain how GameStop's short squeeze impacted stat arb strategies."
- "What's the role of psychology in algorithmic trading?"

Math & Statistics (50 Questions)

Probability & Statistics (15 Questions)

1. Define **conditional probability** and **Bayes' Theorem**.
2. What is the **Central Limit Theorem (CLT)**? Why is it important in finance?
3. Explain **moment-generating functions (MGFs)** and their use.
4. What is the difference between **covariance** and **correlation**?
5. How do you compute the **joint probability distribution** of two random variables?
6. Define **skewness** and **kurtosis**. How do they impact financial returns?
7. What is a **Markov process**? Give an example in finance.
8. Explain **stationarity** (strict vs. weak) in time series.
9. What is the **Law of Large Numbers (LLN)**?
10. How do you test for **normality** (Jarque-Bera, QQ plots)?
11. What is a **martingale**? How is it used in derivatives pricing?
12. Explain **fat-tailed distributions** and their implications for risk.
13. What is **copula theory**? How is it used in risk modeling?
14. Define **convergence in probability** vs. **almost sure convergence**.
15. What is the **Hoeffding inequality**?

Linear Algebra (10 Questions)

1. What are **eigenvalues** and **eigenvectors**? How are they used in PCA?
2. Explain **positive definite matrices** and their role in optimization.
3. What is the **Cholesky decomposition**? How is it used in Monte Carlo simulations?
4. Define **matrix rank** and its implications for regression.
5. What is the **Singular Value Decomposition (SVD)**?
6. How do you solve a **system of linear equations** (Ax = b)?
7. What is a **Hessian matrix**? How is it used in optimization?
8. Explain **vector spaces** and **basis transformations**.
9. What is the **Moore-Penrose pseudoinverse**?
10. How is **linear algebra** used in **portfolio optimization**?

Stochastic Calculus (15 Questions)

1. What is a **Wiener process (Brownian motion)**?
2. Define **Itô's Lemma** and its application in finance.
3. What is the **Black-Scholes PDE**? Derive it.
4. Explain **geometric Brownian motion (GBM)** and its use in stock modeling.
5. What is a **martingale measure**? How does it relate to risk-neutral pricing?
6. Define **stopping times** and their role in American options.
7. What is the **Feynman-Kac formula**?
8. Explain **Ornstein-Uhlenbeck process** and its use in mean-reversion.
9. What is **Girsanov's Theorem**?
10. How do you simulate **jump-diffusion processes**?
11. What is **stochastic volatility** (Heston model)?
12. Explain **local vs. stochastic volatility models**.
13. What is the **Radon-Nikodym derivative**?
14. How does **Monte Carlo integration** work for path-dependent options?
15. What is the **Kolmogorov backward equation**?

Optimization (10 Questions)

1. What is **convex optimization**? Why is it important in finance?
2. Explain the **Lagrange multiplier method**.
3. What is **quadratic programming**? How is it used in portfolio optimization?
4. Compare **gradient descent** vs. **Newton's method**.
5. What is **dynamic programming**? How is it used in optimal execution?
6. Explain **constraints in optimization** (equality vs. inequality).
7. What is **stochastic gradient descent (SGD)**?
8. How do you solve a **linear programming** problem?
9. What is the **Kelly criterion** for optimal betting?
10. Explain **robust optimization** in portfolio management.

Financial Knowledge (50 Questions)

Derivatives (20 Questions)

1. What is **no-arbitrage pricing**? Give an example.
2. Explain **put-call parity** and its derivation.
3. What are the **Greeks (Delta, Gamma, Vega, Theta, Rho)**?
4. How do you price **European vs. American options**?
5. What is **implied volatility** and the **volatility smile**?
6. Explain **Black-Scholes assumptions** and limitations.
7. What is **delta hedging**? How does it work?
8. How do you price **barrier options**?
9. What is **Monte Carlo pricing** for exotic options?
10. Explain **binomial option pricing**.
11. What are **variance swaps**? How are they priced?
12. Define **forward measure** and its use in interest rate derivatives.
13. What is **credit valuation adjustment (CVA)**?
14. How do **dividends** affect option pricing?
15. What is **stochastic interest rate modeling** (Vasicek, CIR)?
16. Explain **swaps (IRS, CDS, TRS)**.
17. What is **FX option pricing (Garman-Kohlhagen model)**?
18. How do **futures vs. forwards** differ in pricing?
19. What is **local volatility (Dupire's equation)**?
20. Explain **multi-asset options (basket, quanto, rainbow)**.

Portfolio Theory (15 Questions)

1. Derive the **Capital Asset Pricing Model (CAPM)**.
2. What is the **efficient frontier**? How is it constructed?
3. Explain **Modern Portfolio Theory (MPT)** and its assumptions.
4. What is **mean-variance optimization**?

5. How does **Black-Litterman model** improve MPT?
6. What is **risk parity**? How does it differ from MPT?
7. Explain **factor models (Fama-French, APT)**.
8. What is **maximum Sharpe ratio portfolio**?
9. How do you compute **portfolio beta**?
10. What is **downside risk (VaR, CVaR)** in portfolio management?
11. Explain **Kelly criterion** in portfolio allocation.
12. What is **resampling** in portfolio optimization?
13. How does **leverage** impact portfolio returns?
14. What is **drawdown control** in hedge funds?
15. Explain **cointegration in portfolio construction**.

Market Microstructure (15 Questions)

1. What is **order book dynamics**?
2. Explain **bid-ask spread** and its determinants.
3. What is **latency arbitrage**?
4. How do **market makers** profit?
5. What is **adverse selection** in trading?
6. Explain **volume-weighted average price (VWAP)**.
7. What is **implementation shortfall**?
8. How does **high-frequency trading (HFT)** work?
9. What is **dark pool trading**?
10. Explain **slippage** and its impact on execution.
11. What is **spoofing** and **layering**?
12. How do **exchange matching algorithms** work?
13. What is **price impact** in large trades?
14. Explain **liquidity fragmentation** in modern markets.
15. What is **Reg NMS** and its impact on US equity markets?

Bonus: Advanced & Behavioral Questions

1. "How would you model flash crashes using stochastic processes?"
2. "What's wrong with using normal distributions in risk modeling?"
3. "Explain how GameStop's short squeeze relates to market microstructure."

Python (35 Questions)

Core Python & Data Structures

Q1. What's the difference between **lists and tuples**?

Q2. Explain **list comprehensions** with an example.

Q3. How does Python handle **memory management** (garbage collection)?

Q4. What are **decorators**? Write a simple decorator.

Q5. Explain **generators** vs. **iterators**.

Q6. What is the **Global Interpreter Lock (GIL)**?

Q7. How do ***args** and ****kwargs** work?

Q8. Compare **shallow copy vs. deep copy**.

Q9. What is **duck typing** in Python?

Q10. How do you handle **exceptions** (`try-except-else-finally`)?

Python for Quant Finance & Data Analysis

Q1. How do you **vectorize operations** in Python (NumPy vs. loops)?

Q2. Explain **Pandas DataFrame operations** (merge, groupby, pivot).

Q3. How do you handle **missing data** in Pandas?

Q4. What is `pd.NA` vs. `np.nan`?

Q5. How do you **optimize Pandas performance** (e.g., `eval()`, `apply()` vs. vectorization)?

Q6. Write code to compute **rolling volatility** of a stock.

Q7. How do you **resample time-series data** (OHLC → daily)?

Q8. What is `numba` and how does it speed up Python?

Q9. How do you **parallelize tasks** in Python (`multiprocessing`, `joblib`)?

Q10. Explain `asyncio` for high-frequency trading applications.

Object-Oriented & Advanced Python

Q1. What is `__slots__` and when should you use it?

Q2. Explain **metaclasses** in Python.

Q3. How does `__new__` differ from `__init__`?

Q4. What is **memoization**? Implement it using `functools.lru_cache`.

Q5. How do you **profile Python code** (`cProfile`, `line_profiler`)?

Numerical & Scientific Computing

Q1. How do you compute **eigenvalues** in NumPy?

Q2. Write a **Monte Carlo simulation** for option pricing.

Q3. How do you solve **linear equations** ($Ax = b$) in NumPy?

Q4. What is **broadcasting** in NumPy?

Q5. How do you implement **Cholesky decomposition**?

Python Libraries for Quant Finance

Q1. How do you fetch stock data using `yfinance`?

Q2. What is **statsmodels** used for?

Q3. How do you backtest a strategy using `backtrader` or `zipline`?

Q4. Explain **TA-Lib** for technical indicators.

Q5. How do you use **Dask** for large datasets?

C++ (25 Questions)

Core C++ for High-Performance Computing

Q1. What is the **difference between `new` and `malloc`**?

Q2. Explain **smart pointers** (`unique_ptr`, `shared_ptr`).

Q3. What is **RAII** (Resource Acquisition Is Initialization)?

Q4. How do you **avoid memory leaks** in C++?

Q5. What is **move semantics** (`std::move`)?

Templates & STL

Q1. Write a **generic `max()` function** using templates.

Q2. What is **SFINAE**?

Q3. How do **STL containers** (`vector`, `map`, `unordered_map`) differ in performance?

Q4. What is `constexpr`?

Q5. How do you **sort a `vector` of custom objects**?

C++ in Quant Finance & HFT

Q1. How do you **optimize C++ for low-latency trading**?

Q2. What is `volatile` and when is it used?

Q3. How do you **implement a lock-free queue**?

Q4. What is **cache locality** and why does it matter in HFT?

Q5. How do you **profile C++ code** (`gprof`, `perf`)?

Numerical Methods & Algorithms

Q1. Write C++ code for **Black-Scholes option pricing**.

Q2. How do you **implement a binomial tree**?

Q3. What is **Eigen library** used for?

Q4. How do you **solve ODEs** in C++?

Q5. Write a **fast Monte Carlo simulation** in C++.

Advanced C++

Q1. What is **CRTP (Curiously Recurring Template Pattern)**?

Q2. Explain **virtual functions and vtable**.

Q3. How does **multiple inheritance** work in C++?

Q4. What is `std::async`?

Q5. How do you **handle exceptions** in C++?

SQL (25 Questions)

SQL Basics & Queries

Q1. What's the difference between `WHERE` **and** `HAVING`?

Q2. How do you **join tables** (INNER, LEFT, RIGHT, FULL OUTER)?

Q3. Write a query to find **duplicate records**.

Q4. How do you **optimize a slow SQL query**?

Q5. What are **indexes** and when should you use them?

Advanced SQL for Finance

Q1. How do you compute **moving averages** in SQL?

Q2. Write a query to find **stocks with the highest volatility**.

Q3. How do you **pivot data** in SQL (`CASE`, `PIVOT`)?

Q4. What is a **window function** (`OVER`, `PARTITION BY`)?

Q5. How do you **handle missing data** (`COALESCE`, `NULLIF`)?

SQL Performance & Optimization

Q1. What is **query execution plan**? How do you read it?

Q2. When should you **denormalize** a database?

Q3. What is **database sharding**?

Q4. How do you **prevent SQL injection**?

Q5. What are **materialized views**?

SQL in Quant Applications

Q1. How do you **store and query time-series data** efficiently?

Q2. Write SQL to **backtest a pairs trading strategy**.

Q3. How do you **compute portfolio returns** using SQL?

Q4. What is `ROLLUP` **and** `CUBE`?

Q5. How do you **handle large-scale financial datasets** in SQL?

NoSQL & Alternatives

Q1. When would you use **Redis** over SQL?

Q2. What is `pandasql`?

Q3. How does `DuckDB` differ from traditional SQL?

Q4. What is `SQLAlchemy` used for?

Q5. Compare **PostgreSQL vs. MySQL for financial data**.

Bonus: Scenario-Based Questions

Q1. "How would you design a low-latency order-matching engine in C++?"

Q2. "Write Python code to fetch real-time stock data and compute EMA."

Q3. "Optimize a SQL query for a 10-year backtest on 1B rows."

Time-Series Analysis (20 Questions)

Foundations & Stationarity

1. What is **stationarity**? Why is it important in time-series modeling?
2. How do you test for stationarity (ADF, KPSS tests)?
3. Explain **differencing** and **integrated series (I(d))**.
4. What is **seasonality**? How do you remove it (e.g., **STL decomposition**)?

Autocorrelation & ARIMA Models

1. Define **autocorrelation (ACF)** and **partial autocorrelation (PACF)**.
2. How do you select **p, d, q** parameters in ARIMA?
3. What are the limitations of **ARIMA** for financial time series?
4. Explain **ARCH/GARCH** models for volatility clustering.

Advanced Time-Series Models

1. How does **Hurst exponent** detect market regimes (mean-reverting vs. trending)?
2. What is **cointegration**? How is it tested (**Engle-Granger, Johansen**)?
3. Explain **Kalman filtering** for dynamic regression.
4. How do **state-space models** (e.g., **SARIMA**) improve forecasting?
5. What is **wavelet analysis** in financial time series?

High-Frequency & Market Microstructure

1. How do you model **order book dynamics** as a time series?
2. What is **realized volatility** vs. **implied volatility**?
3. How do you handle **irregularly spaced tick data**?
4. Explain **Hawkes processes** for trade arrival modeling.

Applications

1. How do you forecast **VaR** using time-series models?
2. Design a **pairs trading strategy** using cointegration.
3. How do you **backtest a momentum strategy** on time-series data?

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Machine Learning in Finance (20 Questions)

Supervised Learning

1. How do you **feature engineer** financial data for ML?
2. What are **good target variables** for predicting stock returns?
3. Why is **labeling data** challenging in finance (e.g., **triple-barrier method**)?
4. Compare **tree-based models (XGBoost, Random Forest)** vs. **neural nets** for finance.

Unsupervised Learning

1. How does **PCA** reduce dimensionality in factor models?
2. Explain **clustering (k-means, DBSCAN)** for regime detection.
3. What is **t-SNE/UMAP** for visualizing market states?

Deep Learning

1. How do **LSTMs/GRUs** handle sequential financial data?
2. What is **attention mechanism** in trading models?
3. How do you avoid **overfitting** in deep learning for finance?

Reinforcement Learning (RL)

1. How is **RL** used for **optimal execution**?
2. What is **reward shaping** in trading RL agents?
3. Explain **Q-learning vs. Policy Gradients** in portfolio optimization.

Challenges & Evaluation

1. How do you address **non-stationarity** in ML models?
2. What is **walk-forward validation** vs. k-fold cross-validation?
3. How do you **interpret SHAP values** for trading signals?
4. Why is **backtest overfitting** a major risk in ML finance?

Alternative Data

1. How do you process **news sentiment** data for trading?
2. What are **latency-accuracy trade-offs** in live ML systems?
3. How do you validate **alternative data** signals?

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Stochastic Calculus (10 Questions)

Foundations

1. Define **Brownian motion (Wiener process)** and its properties.
2. What is **Itô's Lemma**? Derive it for $dS_t = \mu S_t dt + \sigma S_t dW_t$.
3. Explain **martingales** and their role in risk-neutral pricing.

Stochastic Differential Equations (SDEs)

1. Solve the **Ornstein-Uhlenbeck process** $dX_t = \theta(\mu - X_t)dt + \sigma dW_t$.
2. Compare **geometric Brownian motion (GBM)** vs. **jump-diffusion models**.
3. What is **Heston's stochastic volatility model**?

Numerical Methods

1. How do you **simulate paths** using Euler-Maruyama vs. Milstein schemes?
2. Explain **Monte Carlo for exotic options** (e.g., Asian, barrier).

Applications

1. Derive the **Black-Scholes PDE** from a stochastic process.
2. How does **stochastic control** optimize trading strategies?

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Bonus: Advanced Integrations

1. "Combine GARCH with ML for volatility forecasting."
2. "How would you model Bitcoin's volatility using regime-switching SDEs?"
3. "Design an RL agent for market-making using limit order book data."