

# Quantitative Finance: Technical Interviews & Exams

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# Outline

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1. Interviews & Exams
2. Quant Topics
3. Useful References

# 1. Interviews & Exams

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SOME GENERAL POINTERS

# Interviews

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Interviewers in general are looking for the following things in an interview:

1. Technical Knowledge
2. Fit (Personality as well as passion for finance)
3. Market Knowledge (Views and intuition)
4. Company Knowledge (Why us?)

In this presentation we will focus on the first item on the list: **The Technical Knowledge**

# Interviews

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If you are an MSCF Student then you should expect **quantitative** and **highly technical** interviews. As you start your recruitment remember:

- Interviewers are looking for intuition, make sure you don't just have a shallow understanding of the concepts involved, or a mere procedural knowledge of the coursework.
- Sell-side firms will tend to ask more math questions, Buy-side will have more statistics questions for you to tackle. Both may ask you programming questions.
- You should expect to **write down answers** with a paper and pen during the interview – some candidates are surprised to learn that! For coding questions you are expected to write pseudo-code.

# Exams

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Another integral part of recruitment **is written examination**. Several Companies have been relying on written exams recently as a first step of their recruitment process for internships and full time openings.

Exams are of varying difficulty, in general there is no clear cut score for 'passing'. Successful candidates are chosen depending on their **relative performance within their peer group**, i.e. if you are a Ph.D. student gunning for a full time position you will not be compared to a Masters Student seeking an internship.

# Exams

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The following are some firms known to give written exams as part of recruitment:

- Morgan Stanley Strats and Modeling (MSSM)  
One Hour Multiple Choice Exam with around 60 questions
- Credit Suisse Quantitative Summer Institute (QSI)  
One Hour Multiple Choice Exam with around 30 questions
- Deutsche Bank Analytics  
Take home Exam encompassing around 10 word problems
- Trans-Market Group  
Take home exam (they ask you to complete it in 8 hours) on Algorithms and Coding

# 2. Quant Topics

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FOR INTERVIEWS AND EXAMS



# Exam & Interview Topics

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Quant Exams & Interviews cover a wide range of topics, most of which you will see at varying stages of the MSCF curriculum.

The most Popular Topics Covered:

- Calculus
- Differential Equations
- Linear Algebra
- Probability & Statistics
- Mathematical Finance
- Programming (Java or C++)

Let's jump right in!

# Calculus

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## Differentiation

- Trigonometric Functions
- Exponential and Logarithms
- Chain Rule
- Leibnitz Rule – Differentiation under the integral sign

## Integration

- All the functions above
- Integration by parts
- Normal Distribution pdf, the erf() function

## Other

- Taylor Expansion
- Lagrange Multipliers (don't worry about if you haven't seen it before)

# Differential Equations

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## Ordinary Differential Equations

- Solving by direct integration for 1<sup>st</sup> order ODEs
- General 1<sup>st</sup> order Linear ODEs
- Constant Coefficient 1<sup>st</sup> order and 2<sup>nd</sup> order equations
- Reduction of Order (from 2<sup>nd</sup> or higher to 1<sup>st</sup>)
- Exact Differential

## Partial Differential Equations

- Heat Equation (at least a 'knowing look' is enough at an early stage)

# Linear Algebra

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## Matrix Algebra

- Solving 2 equations in 2 unknowns
- Finding Determinants
- Matrix Multiplication
- Matrix Inversion for  $2 \times 2$  and  $3 \times 3$
- Dot Product
- Eigenvalues and Eigenvectors

## Theory

- Rank-Nullity Theorem (more advanced)

# Probability & Statistics

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## Counting

- Combinations and Permutations
- Finding odds of Poker hands and Dice Throws

## Popular Distributions

- PDF / CDF
- Moment Generating Function
- Central Limit Theorem
- Normal and logNormal Distributions

## Iterative Problems

- Expected number of coin tosses to get N heads in a row
- Amoeba Problem (google this!)

# Probability & Statistics

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## More Probability

- Jensen's Inequality
- Change of Probability Measure (more advanced)

## Linear Models

- Least squares estimation
- Covariance – Correlation – Beta
- Applications to CAPM

## Time Series

- Mean Reversion and Stationarity (at least a high level view)
- ARMA and GARCH models (you'll learn this in mini4)

# Mathematical Finance

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## Fixed Income

- DV01, Duration, Convexity and applications to hedging
- Implications of negative Convexity
- Pricing Floating Rate Notes, Swaps

## Options

- Black-Scholes Assumptions (derivation of PDE is covered in mini3)
- Basic Option Strategies (Straddles, Strangle, Spreads)
- Greeks (Delta, Vega, Gamma, Theta)

## Stochastic Calculus

- Brownian Motion 'acrobatics' (differentiation, integration, Itô's Lemma)

# Programming

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## Algorithms

- Sorting and Searching Algorithms
- Order of Complexity (Big-O Notation)
- Numerical Integration and Differentiation

## Object Oriented Programming

- Classes (why do we need them)
- Polymorphism, Inheritance, and Virtual Functions
- Constructor and Destructor 'gimmicks'



# 3. Useful References

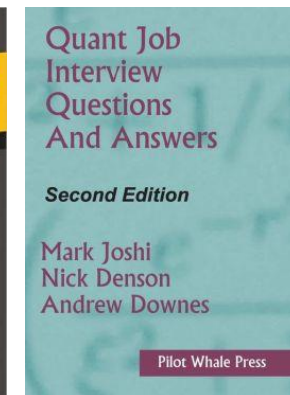
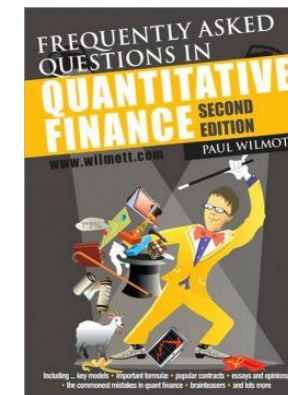
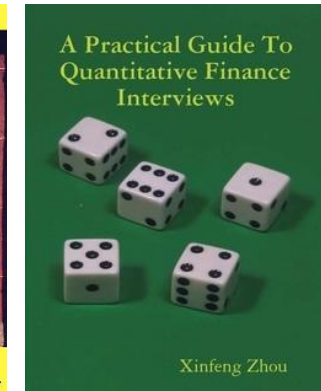
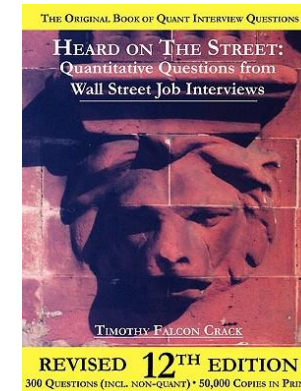
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INTERVIEW PREP MATERIAL

# Useful Books

The following are standard books for interview prep, they contain a lot of the questions you would see on an exam or during an interview:

1. Heard on the Street
2. A Practical Guide to Quantitative Finance Interviews
3. Frequently Asked Questions in Quantitative Finance
4. Quant Job Interview Questions and Answers



# QFC Interview Database

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This is an accumulation of interview questions that your past peers in the CMU MSCF program have encountered during their recruiting. It is a student maintained database.

- 387 Questions in total
- Broken down by:
  - School: Tepper, Math, Dietrich, Heinz
  - Course
  - Question Type: Behavioral, Brain Teaser, Markets, Technical
  - Job: Equities, Fixed Income, Options, Portfolio Management, Quant
- Ability to filter the questions most relevant to your recruiting
- **Help us and your future classmates by contributing to it!!**

# QFC Interview Database

The database is currently in the form of an Excel Document that can be downloaded from the QFC CampusGroups Website.

This is a snapshot of how the document looks like.

The next slide explains how to access it.

You need a CMU login and password to access this.

Tepper MSCF Interview Questions.xlsx - Excel

Akram Ayyash

	A	B	C	D	E	F	G
	NUM	Question	School	Class	Question Type	Job	Notes
1	1	Suppose one has 50 ropes, and one were to try to tie them together, find the expected number of loops in the end.	Math	Math Prep	Brain Teaser	Any	
2	2	Write a program to find the maximum draw down of a portfolio. (PS. See <a href="http://en.wikipedia.org/wiki/Drawdown_(economics)">http://en.wikipedia.org/wiki/Drawdown_(economics)</a> )	Heinz	FC I	Technical	Quant	
3	3	A portfolio has 3 assets X, Y, Z, suppose we know volatility of all three and correlation between X, Y and Y, Z to be $\rho_{X,Y}$ , $\rho_{X,Z}$ , and $\rho_{Y,Z}$ , what is the range of correlation $\rho_{X,Z}$ can be?	Dietrich	Probability	Technical	Portfolio Mgmt	
4	4	Suppose X is normal with mean $\mu_1$ , $\sigma_1$ , and Y is lognormal $\mu_2$ , $\sigma_2$ , what is distribution of $Z = XY$ ?	Dietrich	Probability	Technical	Quant	
5	5	When can the delta of a call option be negative?	Tepper	MSCF Options	Technical	Options	
6	6	What is the price of option with payoff $\max(S^2 - K)$ ?	Math	Stochastic Calc I	Technical	Quant	
7	7	Plot the price of deeply out of money put option as function of volatility $\sigma$	Tepper	MSCF Options	Technical	Options	
8	8	What is the relationship between the fair strike price of a variance swap versus a volatility swap?	Math	Fixed Income	Technical	Fixed Income	
9	9	Given a fair coin, suppose X is the number of throws to get 2 consecutive heads and Y is the number of throws to get 3 consecutive heads, find the probability $P(X > Y)$	Dietrich	Probability	Brain Teaser	Any	
10	10	Tell me about BGM (Libor Market Model) model.	Math	Stochastic Calc I	Technical	Quant	
11	11	A cooler can hold 10 bottles, you can choose from 6 different color of bottles to fill the cooler, assume we have 10 of each color of bottle, how many different ways of combination of bottles can a cooler hold. (Assume the all bottle with same color are the same)	Math	Math Prep	Brain Teaser	Any	
12	12	For Vasicek model, how does the mean reversion speed impact the fitted slope of yield curve?	Math	Stochastic Calc II	Technical	Quant	
13	13	How do investors earn profit from a structured product?	Tepper	Financial Prdcts	Technical	Fixed Income	
14	14	Derive put-call parity.	Tepper	MSCF Options	Technical	Options	
15	15	Draw the gamma/delta against strike curve.	Tepper	MSCF Options	Technical	Options	
16	16	How do you increase the portfolio duration	Math	Fixed Income	Technical	Fixed Income	
17	17	Gold is 100 today, interest rate 1%. Given a call and a put, both with strike prices 100 and maturity of 1 year, which one would you choose	Tepper	MSCF Options	Technical	Options	
18	18	Gold is traded at \$100/ounce. You long a call option on gold with strike \$100 and short a call option on gold with strike \$105. The two options are with the same maturity. What happens to the value of your portfolio if suddenly volatility doubles?	Tepper	MSCF Options	Technical	Fixed Income	Nomura Fixed Income - Structuring
19	19	What are some of the benefits for each counterparty entering a total return swap?	Math	Fixed Income	Technical	Fixed Income	It is called Total Returns Swap not Total Interest Swap
20	20	Put Call Parity: Given $S$ , $K$ , $C = P$ , would you long call or put?	Tepper	MSCF Options	Technical	Any	
21	21	How would you construct binary search without multiplication and division?	Heinz	FC II	Technical	Quant	
22	22	What is CDS? / CDO?	Tepper	Financial Prdcts	Technical	Fixed Income	UBS Fixed Income - Sales
23	23	How do you price a forward contract?	Math	Fixed Income	Technical	Any	UBS Fixed Income - Sales
24	24	Question on Total Return Swap: Interviewer first explained the product to me and then asked me to re-explain it to him. After that, interviewer asked further questions about the product: What benefits can the client get from entering such a contract? What benefits can a bank get from entering such a contract?	Math	Fixed Income	Technical	Fixed Income	UBS Fixed Income - Structuring

Questions\_List Statistics Advice

READY 90%

# QFC Interview Database

1 Visit the QFC website: [https://tepper.campusgroups.com/student\\_community?club\\_id=11638](https://tepper.campusgroups.com/student_community?club_id=11638)

The image displays two screenshots of the Quantitative Finance Club website, illustrating the steps to access the MSCF Interview Questions Database.

**Left Screenshot (Main Page):**

- 3** The blog post titled "MSCF Interview Questions Database" by Niles Moodley is highlighted.
- 2** The "Blog" link in the "Group Links" sidebar is highlighted.

**Right Screenshot (Blog Post Details):**

- 4** The link "Download the spreadsheet by clicking here" is highlighted.
- 5** The link "Add a question to the database by clicking here" is highlighted.