Understanding finance doesn’t prepare you for the realities of how markets and their underlying infrastructure work today. Technology is a key driver of advances in the global markets. Virtually all US trading is done on electronic markets with exchange floors a relic of the past. Trading is done using algorithms, high frequency quant models and by automated market makers. We have now have 16 competing stock exchanges and over 40 Alternative Trading Systems (ATSs) providing the mysterious dark liquidity which executes more than a third of our stock trades. We hear the markets rigged? We examine the issues of market structure and technology interaction that underlie these claims and make our own objective assessment. We study evolving payment systems, such as online transaction security using encryption, hashing, digital signatures, EMV, global mobile payment products, Bitcoin and crypto currencies including CBDCs and Decentralized Finance (DeFi). In examining post trade clearing and settlement, we consider how the blockchain may significantly improve these processes.

The financial services industry is being transformed by globalization, regulation, competition, consolidation and technology. These forces will be explored, focusing on how technology is both a driver of change as well as the vehicle for its implementation. Industry consolidation and convergence will be viewed in light of current events. The course objective is to bring both the business practitioner and technologist closer together. Topics will be covered through a combination of lectures, readings, news and case studies.

**COURSE DESCRIPTION**

The course consists of five primary topics, describing their underlying technology and industry practices:

1. Payment systems, institutional (Fedwire, CHIPS, ACH, SWIFT) and retail credit/debit cards and mobile payments (Zelle, Paypal, Alipay, etc.)
2. Internet transaction security, cryptography, digital signatures, TLS security layer
3. Blockchain, Cryptocurrency, Bitcoin, Ethereum smart contracts, new decentralized finance (DeFi) applications
4. Securities markets, electronic trading, high frequency trading, post trade clearance and settlement
PREREQUISITES

None, however one course in investments, equities, fixed income, etc. or equivalent personal experience would be beneficial. If you have any questions, please contact me with any questions.

TEACHING MATERIALS

- NYU Brightspace website for this course will contain lecture materials, late breaking news and class announcements
- Readings will be posted on Brightspace at least a week early and should be read prior to each class. THERE IS NO TEXT BOOK for this course as most books are not current.
- Students are encouraged to find current materials in the news or on the online for class discussion.

GRADING (Tentative)

<table>
<thead>
<tr>
<th>Item</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Quiz – Intro and payment systems</td>
<td>30%</td>
</tr>
<tr>
<td>Second Quiz – Internet security, blockchain, crypto</td>
<td>30%</td>
</tr>
<tr>
<td>Third Quiz – Financial markets</td>
<td>30%</td>
</tr>
<tr>
<td>Assignments and class participation</td>
<td>10%</td>
</tr>
</tbody>
</table>

Quiz study guides will be posted and quiz dates will be announced in class. Quizzes will be given in class. The final quiz will be given on the last day of class.

YOUR E-MAIL ADDRESS

Be sure your email address in NYU Brightspace is correct. I will use it to communicate timely information about the course.

MY EXPECTED CLASSROOM BEHAVIOUR

Please follow covid protocols in force when the semester begins

Stern rules state that you may not use cell phones, laptops, pads or other ELECTRONIC DEVICES OF ANY KIND during class meetings. You must silence cell phones BEFORE class. If you are on-call for work or family, place your device on vibrate and leave the room before taking the call. If your phone rings, you will be asked to leave. Further I reserve the right to reduce your final grade by reducing points normally awarded for class participation.

Class will start on time. Arriving late interferes with other students' learning and is not acceptable. Subway delays and other problems are unavoidable on occasion, but it is each student's responsibility to plan carefully to arrive on time and well prepared. Repeated latecomers will be penalized. Classes are recorded and will be available for students unable to attend a session. Repeated absences will affect class participation grades.

As a mark of respect, I ask all men to remove their caps or hats while in class, unless worn for a religious reason.

Eating in class is limited to foods/drinks that can be eaten quietly and not so fragrant as to disturb other students in the class. There will be a short dinner break at about 7:30.
ACADEMIC INTEGRITY

We take pride in our well-rounded education and approach our academics with honesty and integrity. Indeed, integrity is critical to all that we do here at NYU Stern. As members of our community, all students agree to abide by the NYU Academic Integrity Policies as well as the NYU Stern Student Code of Conduct, which includes a commitment to:

- Exercise integrity in all aspects of one's academic work including, but not limited to, the preparation and completion of exams, papers and all other course requirements by not engaging in any method or means that provides an unfair advantage.
- Clearly acknowledge the work and efforts of others when submitting written work as one’s own. Ideas, data, direct quotations (which should be designated with quotation marks), paraphrasing, creative expression, or any other incorporation of the work of others should be fully referenced.
- Refrain from behaving in ways that knowingly support, assist, or in any way attempt to enable another person to engage in any violation of the Code of Conduct. Our support also includes reporting any observed violations of this Code of Conduct or other School and University policies that are deemed to adversely affect the NYU Stern community.

STERN CODE OF CONDUCT

The Stern Code of Conduct and Judiciary Process applies to all students enrolled in Stern courses.

For graduate students, information can be found here: https://www.stern.nyu.edu/uc/codeofconduct.

For undergraduates, information can be found here: https://www.stern.nyu.edu/portal-partners/current Students/undergraduate/community/community-expectations

To help ensure the integrity of our learning community, prose assignments you submit to NYU Brightspace will be submitted to Turnitin. Turnitin will compare your submission to a database of prior submissions to Turnitin, current and archived Web pages, periodicals, journals, and publications. Additionally, your document will become part of the Turnitin database.

GENERAL CONDUCT & BEHAVIOR

Students are also expected to maintain and abide by the highest standards of professional conduct and behavior. Please familiarize yourself with Stern's Policy in Regard to In-Class Behavior & Expectations for Graduate and Undergraduate students. (https://www.stern.nyu.edu/portal-partners/registrar/policies-procedures/general-policies/code-conduct) (http://www.stern.nyu.edu/portal-partners/current-students/undergraduate/resources-policies/academic-policies/index.htm) and the NYU Student Conduct Policy (https://www.nyu.edu/about/policies-guidelines-compliance/policies-and-guidelines/university-student-conduct-policy.html).
GRADING INFORMATION FOR STERN ELECTIVE COURSES
At NYU Stern, we strive to create courses that challenge students intellectually and that meet the Stern standards of academic excellence. To ensure fairness and clarity of grading, the Stern faculty have agreed that for elective courses the individual instructor or department is responsible for determining reasonable grading guidelines.

STUDENT ACCESSIBILITY
If you will require academic accommodation of any kind during this course, you must notify me at the beginning of the course and provide a letter from the Moses Center for Student Accessibility (212-998-4980, mosescsa@nyu.edu) verifying your registration and outlining the accommodations they recommend. If you will need to take an exam at the Moses Center for Student Accessibility, you must submit a completed Exam Accommodations Form to them at least one week prior to the scheduled exam time to be guaranteed accommodation. For more information, visit the CSA website: https://www.nyu.edu/students/communities-and-groups/student-accessibility.html

STUDENT WELLNESS
Our aim is for students to be as successful academically as they can, and to help them overcome any impediments to that. Bookmark the NYU Stern Well-being Resource Hub (https://www.stern.nyu.edu/wellbeing) for existing services at NYU and Stern covering a wide variety of topics including financial well-being, relationship well-being, mental well-being, and more. Any student who may be struggling and believes this may affect their performance in this course is urged to contact the Moses Center for Student Accessibility (see also the Student Accessibility section of this syllabus) at 212-998-4980 to discuss academic accommodations. If mental health assistance is needed, call the NYU’s 24/7 Wellness Exchange hotline 212-443-9999. Furthermore, please approach me if you feel comfortable doing so. This will enable me to provide relevant resources or referrals. There are also drop in hours and appointments. Find out more at http://www.nyu.edu/students/health-and-wellness/counseling-services.html Graduate students can also reach out to the Academic Advising team at academicaffairs@stern.nyu.edu if you would like to receive more information or further support.

NAME PRONUNCIATION AND PRONOUNS
NYU Stern students now have the ability to include their pronouns and name pronunciation in Albert. I encourage you to share your name pronunciation and preferred pronouns this way. Please utilize this link for additional information: Pronouns & Name Pronunciation

RELIGIOUS OBSERVANCES AND OTHER ABSENCES
NYU’s Calendar Policy on Religious Holidays states that members of any religious group may, without penalty, absent themselves from classes when required in compliance with their religious obligations. You must notify me in advance of religious holidays or observances that might coincide with exams, assignments, or class times to schedule mutually acceptable alternatives. Students may also contact religiousaccommodations@nyu.edu for assistance.

NYU Stern is committed to ensuring an equitable educational experience for all students regardless of identity or circumstances and strives to recognize the obligations its students have outside of Stern. Please review all class dates at the start of the semester and review all course requirements to identify any foreseeable conflicts with exams, course assignments, projects, or other items required for participation and attendance. If you are aware of a potential conflict,
please contact me as soon as possible to discuss any potential conflicts to determine whether/how they can be accommodated.

**LAPTOPS, CELL PHONES & OTHER ELECTRONIC DEVICES**
Due to the nature of this class and the potential disruptions caused by student use of electronic devices, students are not permitted to use any such devices during class without explicit permission from the instructor.

**INCLUSION STATEMENT**
This course strives to support and cultivate diversity of thought, perspectives, and experiences. The intent is to present materials and activities that will challenge your current perspectives with a goal of understanding how others might see situations differently. By participating in this course, it is the expectation that everyone commits to making this an inclusive learning environment for all.
### Topic Schedule

**Classes Thursdays September 21 - December 14, 2023 (Ex Nov 23)**

All topics, dates are subject to change.  
**Topics do not equate to class meetings.**  
Changes will be posted on NYU Brightspace

<table>
<thead>
<tr>
<th>Date</th>
<th>Topics</th>
<th>Questions</th>
</tr>
</thead>
</table>
|      | Course Logistics | What’s this course about?  
How are the teaching materials organized? What is the grading policy? How should we communicate?  
How is the financial services industry organized?  
Money, and banking history and functions  
Federal Reserve Bank |
| Topic 1 | Introduction Financial Services - Banks |       |
| Topic 2 | Payment Systems I Retail | What is the history and economics of various payment methods?  
Cash, checking, debit cards, credit, prepaid cards  
How are payments processed in the US?  
Smart chip cards, NFC communication  
What has the experience been with emerging payment systems, Paypal, EMV, Square, EZpass, Metrocard, Zelle, Venmo, Alipay, mPesa, etc.  
PCI DSS Standards |
| Topic 3 | Payment Systems II Institutional | Institutional high value payments via ACH, Fedwire, CHIPS and SWIFT.  
CLS for ForEx  
Clearance and Settlement  
Bangladesh Central Bank Hack -- Fedwire  
ISO 20022 standards |
| Topic 4 | Internet Transaction Security – Encryption, hashing, digital signatures | Secret key and public key, symmetric and asymmetric encryption, RSA ECC  
How to secure internet payments.  
SSL/TLS Encryption  
Use of public key infrastructure  
Hashing – securing passwords on a server  
Digital signatures |
| Topic 5 | Blockchain and Bitcoin | Distributed ledgers, peer to peer computing, hash pointers  
How the Blockchain works, transactions, wallets  
Cryptocurrency - Bitcoin  
Mining consensus Proof of Work  
Building an exchange on a blockchain |
| Topic 6 | Smart Contracts and Blockchain Use Cases Cryptocurrencies | Smart contracts Ethereum EMV  
Proof of Stake  
Initial coin offerings (ICO)s and other cryptocurrencies  
Decentralized Financed (DeFi) Exchanges, staking, NFTs  
Proof of concept blockchain use cases  
Central Bank Digital Currency |
| Topic 7 | Introduction to Financial Services - Securities | What are the functions of securities, insurance, markets?  
Differences between retail and institutional, buy side and sell side  
How firms raise capital, The IPO process and Google’s Dutch auction  
How to research a firm and Homework Assignment |
| Topic 8 | Introduction to Markets | Markets and Price Discovery  
Market Data and the SIP  
Market Indices  
Order and Execution Management Systems (OMS/EMS) |
| Topic 9A | US Equity Markets | What was the history of the NYSE  
How is the floor organized in posts and booths?  
What is a seat  
Who are the people on the floor, brokers, (house and $2) and the specialists?  
What is the trading process?  
How did abuses and regulation drive it  
Reg 390, Reg ATS and decimalization, implications of Reg NMS  
What happened in 2005 – the new NYSE Group  
Merger with Arca Exchange  
DMMs, SLPs – the new trading process  
Future of the NYSE |
|---|---|---|
| Topic 9B | US Equity Markets | What is the history of NASDAQ  
How does its multi-dealer model work; What is its trading process and rules  
How does an order book work?  
What was the impact of ECNs  
Maker taker model  
Acquisitions of INET and BRUT by NASDAQ  
What happened when NASDAQ became an “exchange”  
the Trade Reporting Facility (TRF)  
What are NASDAQ’s future plans?  
OTC Markets Microcap and Pinksheets |
| Topic 10 | Institutional Trading | The institutional search for liquidity  
Transaction Cost Accounting (TCA)  
Benchmarks, VWAP, implementation shortfall etc. and post trade analytics  
Algorithmic trading by institutions  
Alternative Trading Systems e.g., Liquidnet, BIDS, LEVEL, etc.  
Dark liquidity, dark pools  
Market Structure 24 Exchanges and 40+Dark Pools  
Electronic Fixed Income and FX markets |
| Topic 11 | Low latency Trading and the Flash Crash | Automated Market Making, Payment for Order Flow  
The May 2010 Flash Crash  
Quant Trading (Stat Arb, Pairs, etc.) Trading Strategies  
Wholesalers (Internalizers), Payment for Order Flow  
HFT, Colocation, Latency Arbitrage, Front Running  
Market Structure, Fragmentation, Spreads, Volatility  
*Flash Boys – Are Markets Rigged?* |
| Topic 12 | After the Trade | What is clearance and settlement  
What are CUSIPs, LEI  
What are T+1 and T+3 processes  
What are the functions of a prime broker and custodian  
ISO 20022 |