

# QUANTITATIVE FINANCE (QFGB)

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## **QFGB 8900. Greenpoint/Finastra Project. (0 Credits)**

The goal of this program is conceptual learning and hands-on research with real-life portfolios and enterprise systems, including the Finastra Capital Markets Fusion Platform. At the end of the program students are expected to have enriched their learning—and their CVs—with projects that have direct industry applicability and through achievements that will enhance their employment prospects and career growth. The research will include FRTB QIS on a portfolio, model sensitivity of PLA tests, impact of specific portfolio features, and risk parameters on FRTB SA and IMA charges.

## **QFGB 8901. Basics of Accounting. (1 to 3 Credits)**

This course provides students with a basic understanding of the preparation and analysis of corporate financial statements. It also introduces generally accepted accounting principles (GAAP) and the standard-setting process, and students discuss current issues in the reporting process, such as the benefits and problems of the Sarbanes-Oxley Act.

## **QFGB 8902. Basics of Economics. (1 to 3 Credits)**

Covers both microeconomics and macroeconomics. Microeconomics topics include theory of demand and the nature of profit and utility-maximizing market equilibrium that constitute the economic basis of finance theory and applications. The macroeconomics segment defines the major components of the economy, outlines a simple model of long-run, real economic behavior with competitive, market clearing prices, then establishes a companion model of short-run adjustments without flexible pricing.

## **QFGB 8903. Basics of Finance. (1 to 3 Credits)**

Provides a conceptual framework for decision-making processes in many diverse areas of finance. Concepts including time value of money, stock and bond valuation, project and firm valuations, risk and return measures, portfolio management, basic CAPM and APT, diversification and hedging are reviewed. Basic theoretical aspects of corporate finance, such as dividend policy and capital structure, are also introduced.

## **QFGB 8905. Math for Quantitative Finance. (1.5 Credits)**

Reviews the basics of mathematics in preparation for advanced courses in the MSQF program. Topics include: Special functions, Multivariate calculus, Optimization, Integration, Differential equations (ODE and PDEs), and Linear algebra.

## **QFGB 8906. Probability and Statistics. (1.5 Credits)**

Reviews the basics of probability and statistics in preparation for advanced courses in the MSQF program. Topics include special distributions like binomial, poisson, normal, lognormal, gamma, beta, and fat-tailed distributions.

## **QFGB 8907. Introduction to Web Technology: Blockchain. (0 Credits)**

Blockchain technology is affecting the financial services industry and considered to be the biggest disruption in payments, financial contracts, and almost all other aspects of the financial services industry. The goal of this course is to give students a basic understanding of and hands-on experience with the web technology tools necessary for blockchain technology. This 0-credit course will be offered in the fall and must be taken prior to Blockchain Application Development course offered in the spring, which will involve development of a real blockchain application via various hands-on projects. Second-year M.S. in quantitative finance students are encouraged to take this introductory course in the second half of the fall term. The instructor will be a top industry expert in blockchain technology and its applications in the financial services industry.

## **QFGB 890A. Fund Strategies and Performance. (3 Credits)**

This course examines how money is managed by organizations through such things as university endowments, pension funds, mutual funds, hedge funds, and private equity funds. It provides an advanced treatment of asset allocation and equity portfolio strategies, and a performance evaluation of U.S. mutual funds and hedge funds. The course provides a deeper understanding of the measurement of risk and its relationship to return, as well as of multifactor models. Implementation issues, including statistical estimation, back-testing, portfolio construction, and performance evaluation, are covered. Some programming skill (likely Python/SAS) will be important, and partly taught.

## **QFGB 890B. ESG & Portfolio Management. (3 Credits)**

This course will introduce students to the management of investment portfolios with an awareness of Environmental, Social, and Governance (ESG) risks and objectives. We'll start with an introduction to ESG and everything that means today. We'll then examine a variety of approaches to ESG-aware portfolio management, including security screening & exclusion, ESG integration, best-in-class investing, thematic investing, portfolio tilting, active ownership, and impact investing. We'll initially focus on public equity, but other asset classes will be introduced over the semester. The emphasis will be on developing a practical understanding of the subject, with both active and index-based approaches to portfolio management considered. ESG quantitative data and third-party ratings widely used by portfolio managers will be reviewed, and students will complete computational exercises involving that content. We'll use Python for that, and students will be assumed to have a basic working knowledge of that language.

## **QFGB 890C. Cloud Computing and Finance Uses. (1.5 Credits)**

This course introduces the core concepts of cloud computing, including networking, storage, database, access control, security, compliance, and pricing. Cases will be drawn from the finance industry. The course does not require prior programming or cloud computing experience. Students will create their own account on a cloud platform and gain some hands-on experience by provisioning a cloud service and working with it.

**QFGB 890D. Introduction to ESG and Finance. (1.5 to 3 Credits)**

In this course, students will learn about the history of ESG and impact investing, as well as the evolution of key social, environmental, and economic challenges. They will examine the use of ESG Value Reporting Foundation (Sustainability Accounting Standards Board) standards in the United States, Europe, and China, and they will review regulatory factors in relation to the ability of an institution to drive value for its multiple stakeholders. Students will also evaluate social tensions relating to climate change and the exponential growth of investor interest in transformative climate tech solutions. We will look at how policies and market environments, including in each student's native country, support ESG development. The course will leverage Fordham's relationship with the United Nations PRME (Principles of Responsible Management Education) program, and students will examine in detail the UN's 17 Sustainable Development Goals and the Business Roundtable pledge.

**QFGB 890E. Introduction to Climate Finance. (3 Credits)**

In this course, students explore the science of climate change and its related economic and environmental impacts. They study changing global policies and examine financial tools and techniques to fight climate change in its context. Specific areas covered include the use of capital markets to create market-based emission trading systems, project finance to build renewable energy projects, venture capital to fund innovative low emission technologies, etc. The course will feature a large number of readings and a few cases to introduce students to climate finance.

**QFGB 890F. Finance Primer. (1 Credit)**

Finance Primer.

**QFGB 890G. Finance Prep. (0 Credits)**

Finance Prep.

**QFGB 890H. Advanced Machine Learning. (3 Credits)**

The primary focus of this course is on developing computational models to identify/forecast economic regimes, factor-based smart beta, strategic risk budgeting, and trading decisions. The topics covered in this course will help students gain theoretical knowledge and practical skills to work with global financial firms across different asset classes. Students are required to be proficient in Python programming and have knowledge of basic data mining algorithms and techniques.

**QFGB 890J. Managing Business Climate Change Risk Exposure. (3 Credits)**

This course will introduce you to the effects that climate change is having on business organizations across the globe and how businesses are responding to these risks. We will explore the short-term impact on businesses of extreme weather events and the long-term impact of chronic changes in weather patterns due to global warming. The course will explain the full range of potentially severe physical risks and transition risks of climate change facing businesses today and how these risks are changing due to global warming. You will learn the strategies that business utilize to manage these risks, including risk avoidance, risk mitigation, and risk transfer. We will study how businesses use such important climate risk transfer mechanisms as buying insurance, including general business, flood, and business interruption insurance, and issuing catastrophe bonds. You will also learn how businesses can use derivatives, such as specialized weather derivatives and certain traditional derivatives like forwards, futures, and swaps, to hedge their climate change risk exposure. The course will explain how climate change can also give rise to opportunities for businesses to develop innovative products, services, and strategies to help other businesses. You will learn how successful businesses that recognize these opportunities can turn climate change into an advantage for their stakeholders and society.

**Prerequisite:** QFGB 890E.

**QFGB 890K. Python Bootcamp. (0 Credits)**

The goal of this bootcamp and workshop is for the students to learn basic Python. The coverage includes Python programming environment, Python shell, Python IDE, Jupyter notebook, Python data types and complex type operations, Pandas data structure, I/O, and visualization.

**QFGB 890L. Equity Factor Investment Strategy. (2 to 3 Credits)**

This quantitative course is designed to teach students how to backtest a quantitative strategy using the programming language Python. Equity factor investing is a systematic approach to evaluating companies. Companies are assessed on how attractive they are based on one or more factors and then ranked against other firms. Higher-ranked companies may indicate a greater opportunity for alpha. Students will learn about risk exposures and alpha generation. Students will be exposed to long-only and long-short quantitative strategies.

**QFGB 8911. Financial Markets and Modeling. (2 Credits)**

This course provides the foundation for developing skills in the quantitative analysis of financial decisions, primarily using R and Python. Topics include business planning, forecasting, sensitivity and scenario analyses, risk and return measures, portfolio analysis, binomial option pricing, and value-at-risk (VAR) analysis. It emphasizes practical skills to produce computer models that are useful for a variety of decision-making purposes.

**Attribute:** BUAN.

**QFGB 8914. Derivatives. (2 Credits)**

This course introduces deferred delivery (i.e., exchange-traded futures and OTC-traded forward) markets and option markets. The course covers the following: (1) briefly examines the institutional features of these markets; (2) discusses hedger, arbitrageur, and speculator strategies; (3) provides an analytical foundation for the pricing of these contracts; (4) reviews some of the available empirical evidence concerning these markets; and (5) uses the data to perform small-scale, suggestive tests of the theories and strategies.

**QFGB 8915. Introduction to Stochastic Calculus. (2 Credits)**

Focuses on the practical applications of stochastic differential equations subject to appropriate boundary conditions, solving valuation problems, and using measure-transformations as required in advanced financial engineering practice to value assets within a risk-neutral framework. Builds a theoretical foundation for continuous-time models that are essential for the pricing and hedging of financial derivatives.

**QFGB 8923. Machine Learn & Econometrics. (2 Credits)**

Covers estimation of parametric and non-parametric techniques commonly used in finance, applying high-frequency financial databases. Discusses properties of financial data, linear time series data analysis, basic theory of statistical inference with linear models, general linear models, conditional Heteroskedasticity models, nonlinear models and Bayesian inference and estimation.

**Attribute:** BUAN.

**QFGB 8924. Advanced Derivatives. (2 Credits)**

Designed to complement and extend the topics discussed in QFGB 8914, this course includes all types of derivatives for which a commodity, equity, or currency is the underlying asset. Hull's software and a Bloomberg/Reuters terminal are used for pricing options and gathering data. The data to perform small-scale, suggestive tests of theories and strategies is used.

**QFGB 8925. Simulation Applications. (2 Credits)**

Introduces state-of-the-art computational techniques essential for implementing financial models, pricing derivatives, obtaining numerical solutions to estimation problems, and simulating stochastic systems in risk management. Provides conceptual framework for gaining experience on simulation design and implementation using METLAB. This course builds a skill set that combines financial modeling, data analysis, and computation.

**Attributes:** ASDM, BUAN.

**QFGB 8926. Finance Theory. (2 Credits)**

This course introduces financial theory with a particular emphasis on portfolio choice and the fundamentals of asset pricing. Focuses on both the partial equilibrium theory (CAPM) and the general equilibrium theory (Arrow-Debreu Pricing Theory), with brief introductions on the arbitrage-based theories. The course introduces the basics of asymmetric information and how the problems it imposes can be mitigated via security design. It also emphasizes an understanding of the theories of Discrete-Time Asset Pricing, studies the application of the theory of stock options to real options and complex corporate liabilities, and explores the basic foundation of the GMM tests of asset-pricing theories.

**QFGB 8927. Introduction to C++. (2 Credits)**

This course will introduce quantitative finance students to programming in C++.

**QFGB 8928. Auto Trading Systems - Intro. (2 to 3 Credits)**

This course discusses key issues involved in the design of an Auto (Algorithmic) Trading Systems, and provides hands-on experience. The end product is a prototype Auto Trading System designed by students that successfully trades in the real market (stock, futures, option) using live data feeds from exchanges. Issues covered include: typical structures of trading systems; efficient processing of live information; minimizing trade slippages; handling large number of securities; asynchronous information processing; GUI interfaces; etc. Industry experts are invited to discuss new developments. Key programming techniques will be reviewed at the beginning, very briefly. The course is suitable for students in MSGF, MSQF, and other master level students with programming skills equivalent to one formal course (e.g, R, Matlab, VBA, etc). Students with less programming skill may take the course if approved by instructor.

**QFGB 8930. Advanced Fund Strategy and Evaluation. (2 Credits)**

This course is designed to help students gain a better understanding of the asset management industry in the U.S. The course covers some of the most important topics in the fund industry, including developments and implementations of fund trading strategies and performance evaluation models, fund trading costs, and the behavior patterns of fund investors and fund managers.

**QFGB 8931. Fixed Income Securities. (2 Credits)**

Introduces fixed-income securities, basic fixed-income concepts, the different sectors of the fixed-income market, and basic bond mathematics. Studies quantitative fixed-income analysis and its use in valuing bonds and quantifying risk-return characteristics. Involves extensive training in the mathematical formulation of bond valuation problems and in the use of the existing models and software to solve these problems.

**QFGB 8933. Time Series Econometrics. (2 Credits)**

This course introduces modern financial econometric techniques with a special focus on applications to finance. Both the theoretical framework for making statistical inference and exemplary applications using data in modern finance are emphasized. The course involves extensive use of commercial software packages, as well as implements new financial econometric techniques using high-level programming language, such as MATLAB.

**QFGB 8934. Interest Rate Derivatives. (2 Credits)**

Studies continuous time no-arbitrage models of yield curves and pricing of fixed-income securities and derivatives. In particular, treasury bonds as well as more complicated instruments, such as options on bonds, interest rate swaps, option on interest rate swaps, caps, floors, and Mortgage Backed Securities are priced and analyzed.

**QFGB 8935. Risk Management. (2 Credits)**

Builds strong understanding of the risks of individual products and methods of hedging and/or replication those products. Also examines firm-wide risk issues from a financial perspective which requires aggregation of multiple positions and consideration of interrelationships among asset price fluctuations. Regulatory and other non-market risk issues are considered and simulation techniques for modeling risk are practiced.

**Attribute:** ASDM.

**QFGB 8936. Financial Markets and Major Players. (3 Credits)**

This course will provide an overview of a broad range of financial markets from practitioner standpoints. It will discuss how secondary market prices, ranging from equity and fixed income to commodities and complex derivatives, are established in listed exchanges, OTC markets, and dealer platforms. We will examine the roles of both market-maker ("sell-side") and price takers ("buy-side"), with the latter further divided into two major groups: institutional or retail. We will survey sell-side businesses, including market-makers vs. agents in listed markets and OTC markets, institutional block trading, securities lending, and prime-brokerage. On the retail clientele side, we will discuss the whole-sale market making business. On the risk management of the sell-side business, we will cover market risk, credit risk, and counterparty credit risk. At the end of the course, students should have a thorough understanding of how various businesses fit together. Hopefully, the course will help students better understand the area in which they might pursue their career path in financial markets.

**QFGB 8942. Advanced Finance Theory. (2 Credits)**

This course build upon Financial Theory I (QF 8922) and examines cross-sectional and time series properties of asset returns. Offers an in-depth statistical review of several theoretical models of inter-temporal asset pricing. Microstructure effects on short-term asset returns as well as tests of returns predictability are covered.

**QFGB 8943. Large-Scale Data Modeling. (2 Credits)**

Explores financial modeling topics using large data sets and various econometric techniques applied in a variety of financial problems. Topics include modeling the yield curve in the US and other countries, application of pattern recognition techniques in developing stock-rating systems, factor models in portfolio construction, and portfolio performance evaluation. Emphasis on project analysis using SAS to process large data sets and develop appropriate models for solving real problems in equity and fixed-income research.

**Attribute:** BUAN.

**QFGB 8944. Credit Risk Mgmt. (2 to 3 Credits)**

Introduces modern credit risk models with particular focus on credit derivative instruments. Focuses on derivative market methods, rather than accounting analyses of business risks. Exposes students to institutional practices and commonly used data. Students will be expected to thoroughly understand professional software output, along with the risks and rewards of credit product strategies.

**QFGB 8946. Financial Programming. (2 Credits)**

This course uses C++ to solve finance problems. Two types of students will take this course. One type is the student with a strong computer programming background (perhaps an engineering undergraduate), but who has not taken C++ or applied it to finance problems. The other type may have been a finance undergraduate student who had little computer programming experience before entering the MSQF program. The latter student must take the spring introduction to C++ course offered by the computer science department before taking this course in their second fall term.

**QFGB 8947. Advanced Derivative Pricing. (2 Credits)**

This course covers advanced option pricing.

**QFGB 8948. Quantitative Methods for Portfolio Management. (2 to 3 Credits)**

Introduces the scope of the quantitative concepts used in asset management, with focus on practical application, challenges and limitations in constructing optimal portfolios, evaluating performance and portfolio risk. Involves extensive discussions of case studies and group project. \* \*Subject to NY Approval.

**QFGB 8949. Advanced Financial Econometric. (2 Credits)**

This course takes up Bayesian estimation of small-scale financial sector and macro-econometric models. Counter-factual simulations will also be used, as well as monte-carlo methods for evaluating confidence intervals. In addition to Bayesian estimation, the course will make use of extensive data sets to investigate topics such as contagion effects across countries in financial markets, and neural networks for predictive accuracy. \* \*Subject to NY Approval.

**QFGB 8950. Alternative Investments. (2 to 3 Credits)**

The course is an introduction to the rapidly evolving universe of alternative investments. Delivered in modules, the course covers a broad array of alternative strategy classes (Quantitative/Systematic, Fundamental Long/Short, Global Macro, Private Equity) ranging across all major asset classes (Equities, Fixed Income, Currencies, Commodities, Derivatives). \* \*Subject to NY Approval.

**QFGB 8951. Internship and Project Report. (1 to 4 Credits)**

A professional project report and presentation are the final outputs of this course. Students complete these projects under the supervision of a faculty member. Both individual and group-projects are possible.

**QFGB 8952. Business Comm for Quants A. (0.5 to 1 Credits)**

Covers the basics of professional speaking and writing. Develops oral and written presentation skills essential for successful careers. Coordinated with summer term internship to give students the opportunity to apply their new communication skills in a business setting.

**QFGB 8953. Research Seminar 1. (1 Credit)**

This fall course features a series of lecturers from the finance industry. They discuss research projects that their companies are working on.

**QFGB 8954. Research Seminar 2. (1 to 1.5 Credits)**

This spring course features a series of lecturers from the finance industry. They discuss research projects that their companies are working on.

**QFGB 8955. Computational Finance. (2 Credits)**

This course provides a hands-on in-depth introduction to the Python language as well as surveys tools used in data and computational science, focusing on their application to the field of quantitative finance.

**Attribute:** BUAN.

**QFGB 8957. Applied Capital Markets and Financial Regulations. (3 Credits)**

This course will explore how the market structure has fundamentally changed after the 2008 liquidity and credit crisis, and how this crisis has impacted on liquidity, balance sheets, risk taking, and returns across the entire financial services industry. The new reality is that regulation has changed the landscape of Wall Street and the dynamic of how the sell-side and buy-side will interact in the foreseeable future.

**QFGB 8958. Lectures in Applied Port Mgt. (3 Credits)**

This advanced Portfolio Management course quickly reviews Modern Portfolio Theory (MPT) conceptual underpinnings and builds on MPT 1.0. It delves into contemporary liability driven asset allocation, MPT 2.0 and portfolio management industry practices, issues and concerns. Lectures, problem solving, and self-study along with extensive hands-on tools using Microsoft Excel based models will be used to provide a practitioner's perspective. We will review and demo contemporary asset allocation optimization and forecasting techniques, new asset class pricing and valuation, performance and risk attribution, tail risk measurement and management tools etc. using real time vendor based (third party) solutions. As prerequisites - the student should have class exposure to investment and portfolio analysis, Excel, stats, and basic regressions.

**QFGB 8959. Machine Learning for Finance. (2 Credits)**

This course explores the world of Machine Learning and financial applications. We will investigate how it uses large amounts of structured or unstructured data to discover patterns and hidden topics, transforming raw data into knowledge for decision making. We will investigate real and practical examples from finance, tracing parallels between data science, statistics, and data analytics.

**Attribute:** BUAN.

**QFGB 8960. Advanced C++ for Finance. (2 Credits)**

Advanced C++ for finance.

**QFGB 8961. Business Comm for Quants B. (0.5 to 1 Credits)**

Covers the basics of professional speaking and writing. Develops oral and written presentation skills essential for successful careers.

**QFGB 8962. Dynamics of Banking & Fin Mkts. (3 Credits)**

This course is designed to provide students a well-rounded and hands-on perspective on the practical functioning and decisions in financial markets and banking.

**QFGB 8963. Stress Tests and Cap Adequacy. (3 Credits)**

The financial crisis of 2007 -08 taught us all a lesson: that preparedness is everything. How resilient and prepared will we be, and how fast will we be able to recover? This is the key focus of this course: how to plan for moments of distress so that firms such as yours have capital of a sufficient quality to survive potential storms. We will demonstrate how to create a robust capital plan and test it for moments of hypothetical stress. We will investigate exactly how a bank holding company and an insurance company should conduct their capital plan, highlighting the significant differences between the two industries. By the end of the course, you will be able to create a capital plan for your business on your own.

**QFGB 8964. Arpm Bootcamp-Intensive Quant. (3 Credits)**

Consolidates portfolio and risk manager's expertise into a structured and rigorous quantitative framework. Empowers avid learners with background in hard sciences to gain the deep technical knowledge necessary to operate across the complex world of quantitative trading, asset management, and risk management. Topics include data science and machine learning; classical / Bayesian multivariate statistics, and econometrics; financial analytics; market, credit & liquidity risk management; estimation error and model risk; and much more. ARPM Lab online (theory, case studies, Python & MATLAB code, slides, exercises). Obtain ARPM Certificate of Attendance & 40 GARP CPD.

**QFGB 8965. Trading - Market Making and Algorithms. (3 Credits)**

This course will introduce students to basic market microstructure, algorithmic trading, and quantitative investment strategies. Mathematical and statistical techniques along with their computational implementation in R or Python will be used throughout the course.

**Prerequisites:** QFGB 8911 and QFGB 8923 and QFGB 8926.

**QFGB 8966. Behavioral Finance. (2 Credits)**

Over the past several decades, the field of finance has developed a successful paradigm based on the notions that investors and managers are generally rational and that the prices of securities are generally efficient. In recent years, however, anecdotal evidence as well as theoretical and empirical research has shown this paradigm to be insufficient to describe various features of actual financial markets. In this course we will use psychology and more realistic settings to guide and develop alternative theories of financial markets. We will examine how the insights of behavioral finance complement the traditional paradigm and shed light on investors' trading patterns, the behavior of asset prices, corporate finance, and various financial market practices through lectures, case studies, and our own discussions.

**QFGB 8967. Bank Capital and CCAR. (2 Credits)**

This course will provide an overview of the range of risks that banking institutions undertake to perform their role as credit intermediaries. It will delve into the choices that bank managers make to measure the risks they undertake, and will explore the approaches that a bank can take to translate risk measurement into stress tests of a bank's capital position. Students will have an opportunity to apply methodologies discussed while developing a model to stress test a bank's exposure to market, credit, or operational risk for the purpose of testing the adequacy of a bank's capital position.

**QFGB 8968. Blockchain Technology and Application Development. (3 Credits)**

The main objective of this course is to familiarize you with the ecosystem, technologies, and development skills surrounding Blockchain. The course starts with foundational concepts such as distributed state machine, hash tree, P2P network, GPU processing, cryptocurrency, and cryptography. Using both simulated sandbox and locally installed environments, the course then guides you through the development, front-end integration, and deployment of Blockchain-based smart contracts. Other topics covered include rapid prototyping, design patterns, and agile process to maximize the success likelihood for Blockchain projects. The lab portion of this course involves weekly submissions of programming exercises, assignments, and project deliverables. Prior knowledge required: Proficiency in computer programming; basic knowledge in analysis and linear algebra.

**Attributes:** BUAN, ISEL.

**QFGB 8969. Systematic Investment Strategies. (2 Credits)**

This lecture series will cover a variety of topics on quantitative investment management. We start with an overview of the evolution of the current state of affairs, both with respect to individual strategies as well as topics related to their management within the context of a portfolio. We will first cover the basic set of thematic strategies (e.g., value/reversion, momentum/trend, carry, volatility, etc.) across different asset classes with some representative specific strategies covered in detail. We will then consider extensions and refinements. We will also cover various portfolio construction approaches for baskets of systematic strategies and their consequences. The lecture series will feature readings from "Wall Street" practitioner research series at the major asset managers and investment banks, with guest lecturers from industry on specific topics. Students will be expected to participate via data collection, strategy construction, and back-testing analysis, etc.

**QFGB 8970. Programming with Python. (3 Credits)**

Do you want to be able to solve business problems through programming and coding? This course introduces key programming concepts, techniques, and tools. Students will learn programming and coding using the widely used Python programming language. This section of Programming with Python will include additional finance applications.

**QFGB 8971. Artificial Intelligence. (3 Credits)**

The goal of this course is to acquaint you with the objectives and methods of researchers and practitioners in artificial intelligence. We will explore numerous aspects of computational models of intelligence including search and problem solving, planning, machine learning, logic and reasoning, machine perception and robotics, natural-language processing, speech recognition, vision, and cognitive science. We'll also discuss genetic algorithms, fuzzy logic and deep machine learning including neural networks. The ethics of artificial intelligence is also addressed. The course is organized as a survey, with hands-on assignments in open source artificial intelligence tools.

**QFGB 8972. Deep Machine Learning. (3 Credits)**

The goal of this course is to acquaint you with the objectives and methods of deep machine learning (DML). We will explore and learn the basic types of deep neural networks including convolutional, recurrent, and generative adversarial, and the type of data each is designed for. Key additional topics include learning techniques to improve training, preventing overfitting, and finding best practices for minimizing error. Students will study the major technology trends driving DML. A key takeaway is a working knowledge of the vocabulary of concepts and algorithms in DML. The challenges and issues surrounding the use of DML including design issues, ethics, governance, ownership of data, privacy, and security standards. Quality control and validation are also discussed. Emphasis is on business applications. The course is organized as a seminar-style course, with hands-on assignments in DML tools. Familiarity with basic calculus and linear algebra expected.

**QFGB 8973. Cybersecurity Analytics for Business. (3 Credits)**

Cyber attacks pose an increasing threat to the nation's critical infrastructure, including computer networks, cyber-human systems, business applications, sensor networks, and mobile devices. This course provides an introduction to data analytics for multiple aspects of information security and focuses on using data analytics methods for discovering anomalies pertaining to cyber threats through hands-on exercises in programming, visualization, statistical analysis, machine learning, and big data analytics tools.

**QFGB 8999. Independent Study. (1 to 3 Credits)**

Independent study.