DEPARTMENT OF MATHEMATICS
UNIVERSITYOFKARACHI

M.S (Financial Mathematics)
Two Years Degree Program

Program Overview:

The M.S/M.Phil.in Financial Mathematics is a comprehensive two-year degree program offered in Department of Mathematics, University of Karachi, designed to provide students with advanced knowledge and skills in quantitative finance and mathematical modeling for financial applications. The program covers a wide range of topics including Advanced Financial Mathematics, **Computing for Finance in Python**, Financial Risk Management, Stochastic Volatility and Machine Learning in Finance. Students will gain hands-on experience in using mathematical and statistical tools, programming languages such as Pythonand financial software packages to analyze financial data, develop pricing models, design trading strategies, and evaluate risk factors. The program also emphasizes the integration of theory with real-world financial problems, preparing students for careers in investment banking, asset management, risk analysis, financial engineering, and related fields. Through coursework, research projects, and internships, students will develop a deep understanding of financial markets, quantitative techniques, and computational methods essential for success in the rapidly evolving financial industry.

UNIVERSITY OF KARACHI

Course Structure of M.S in Financial Mathematics

M.S (First Year) ***Financial Mathematics***

SEMESTER I			SEMESTER II		
Course Code	**Course Title**	**Cr.Hr.**	**Course Code**	**Course Title**	**Cr.Hr.**
FM-700.1	Programming Fundamentals in Python	Non-Credit			
FM-701	Research Methodology	3+0	FM-702	**Computing for Finance in Python**	2+1
FM-703	Advanced Financial Mathematics	3+0		Elective-I	3+0
FM-705	Modern Applied Optimization	3+0		Elective-II	3+0
FM-707	Black-Scholes Theory	3+0		Elective-III	3+0

M.S (Second Year) ***Financial Mathematics***

Semester III & IV		
Course code	**Course Title**	**Credit hours**
FM-	M.S Thesis	06

Electives/ Optional Courses

Course code	Course Title	Credit Hours
FM-711	Financial Risk Management and Measurement	3+0
FM-712	Fixed Income Markets	3+0
FM-713	Asset Pricing	3+0
FM-714	Nonlife Actuarial Model	3+0
FM-715	Mathematics of Bond Market	3+0
FM-716	Stochastic Volatility	3+0
FM-717	Monte Carlo Methods	3+0
FM-718	Time Series Modeling	3+0
FM-719	Decision Sciences	3+0
FM-720	Machine Learning for Finance	3+0

First Semester

FM-700.1 Programming Fundamentals in Python (N.C)

Introduction to Python Programming: Overview of Python programming language, Setting up Python environment and IDE, Basic syntax, data types, and variables in Python.

Control Structures and Functions: Conditional statements: if-else, nested if-else, Loops: for loop, while loop, nested loops, Functions and parameter passing, Lists, tuples, and dictionaries, Operations on lists: slicing, appending, extending, Accessing and modifying elements in data structures.

File Handling and Input/Output: Reading and writing data to files, Handling text and CSV files, Working with structured data: JSON, XML.

Numerical Computing with NumPy: Introduction to Num Pylibrary for numerical computing, Arrays and matrices in NumPy, Basic operations and functions: element-wise operations, linear algebra.

Python Data Frames: Introduction to Pandas library for data manipulation and analysis, Data frames and series: indexing, selection, filtering, Data visualization using Matplotlib: line plots, scatter plots, histograms.

Recommended books:

1. Charles R. Severance. (2016). Python for Everybody, 1st edition, University of Michigan.
2. Dawson. M. (2010).Python Programming for the Absolute Beginner, 3rd edition, Course Technology.
3. Goldwasser, M. H., &Letscher, D. (2008). Object-oriented Programming in Python, Pearson Prentice Hall.
4. John V. Guttag. (2016). Introduction to Computation and Programming Using Python, 2nd edition, The MIT Press.
5. Lott, S. F., & Phillips, D. (2021). Python Object-Oriented Programming: Build robust and maintainable object-oriented Python applications and libraries, 4th edition: Packt. Publishing.

FM-701 Research Methodology (3 + 0)

Introduction to Research Methodology: Overview of research methodology in financial mathematics, Understanding the research process: formulation of research questions, objectives, and hypotheses, Types of research: qualitative vs. quantitative, theoretical vs. empirical.

Literature Review: Importance of literature review in research, Searching and reviewing relevant literature in financial mathematics, Critical evaluation of research articles and papers.

Research Design and Planning: Developing a research plan and timeline, Selection of research methods and techniques, Ethical considerations in financial mathematics research.

Quantitative Research Methods: Introduction to quantitative research methods, Data collection techniques: surveys, experiments, archival data, Statistical analysis methods: descriptive statistics, hypothesis testing, regression analysis.

Qualitative Research Methods: Introduction to qualitative research methods, Data collection techniques and interviews, focus groups, case studies, Qualitative data analysis techniques: thematic analysis, content analysis.

Mixed-Methods Research: Understanding mixed-methods research designs, Integration of quantitative and qualitative data, Triangulation and validation in mixed-methods research.

Sampling Techniques: Types of sampling techniques: random sampling stratified sampling, convenience sampling, Sample size determination and sampling errors, Sampling bias and its implications in financial mathematics research.

Data Collection and Analysis: Methods for data collection in financial mathematics research, Data preprocessing and cleaning techniques, Statistical analysis software tools: R, Python, MATLAB.

Writing Research Proposals and Reports: Structure and components of research proposals, Writing literature review, research methodology, and data analysis sections, Guidelines for writing clear and concise research reports, Designing effective research presentations, Communicating research findings to different audiences, Responding to questions and feedback effectively, Ethical principles in financial mathematics research, Informed consent, confidentiality, and data protection, Avoiding plagiarism and maintaining academic integrity.

Recommended books:

1. Aguinis.H. (2024). Research Methodology: Best Practices for Rigorous, Credible, and Impactful Research, 1st edition, SAGE Publications.
2. Kelly.A.D& Richard A. Lesh. (2000). Handbook of Research Design in Mathematics and Science Education,1st edition, Routledge.
3. Mukherjee.S.P. (2019). A Guide to Research Methodology: An Overview of Research Problems, Tasks and Methods, 1st edition, CRC Press.
4. Singh.R.N. (2012). Research Methodology and Techniques in Mathematics, Centrum Press.
5. Uwe Flick. (2015). Introducing Research Methodology: A Beginner′s Guide to Doing a Research Project, 2nd edition, SAGE Publications.

FM-703 Advanced Financial Mathematics (3 + 0)

Deterministic cash flows, Single-period random cash flows, Pricing under multi-period model, Risk-neutral pricing of derivative securities, Financial securities and markets, Itoprocess models for finance, Brownian motion, Stochastic differential equations (SDE's), Stochastic asset models, Stochastic interest rate models, Black-Scholes model, Risk and portfolio management, Arbitrage and hedging, Introduction to actuarial notation, Discounting factor, Annuity certain, Annuity in advance, Deferred annuities, Annuities payable, Simple models for credit risk.

Recommended books:

1. Baxter. M & Rennie. A. (1996). Financial Calculus: An Introduction to Derivative Pricing, Cambridge University Press.
2. Campolieti. G & Roman N. Makarov. (2014). Financial Mathematics: A Comprehensive Treatment, 1st edition, Chapman and Hall.
3. Chan. W.s & Yiu. kuen. T.(2017). Financial Mathematics for Actuaries, 2nd edition, World Scientific.
4. Donald G. Saari. (2019).Mathematics of Finance: An Intuitive Introduction, 1st edition, Springer.
5. Sheldon M. Ross. (1999). An Introduction to Mathematical Finance: Options and Other Topics, 1st edition, Cambridge University Press.

FM-705 Modern Applied Optimization (3 + 0)

Classical algorithms: Univariate optimization, Root finding (Newton, secant, Regulafalsi, etc), Unconstrained optimization (steepest descent, Newton, quasi-Newton, Gauss-Newton, Barzilai-Borwein), Constrained optimization (penalty, barrier, augmented Lagrangian, active set), Proximal algorithms, Stochastic gradient descent and variants, Algorithms that involve moments or momentum or mirror, etc.

Applications to Machine Learning and statistics: Ridge/lasso/logistic regression, Support vector machines with hinge/sigmoid loss, Optimal experimental designs, Maximum entropy, Maximum likelihood, Gaussian covariance estimation, Feedforward neural networks.

Applications in finance: Markowitz classical optimization, Portfolio optimization with diversification or loss risk constraints, Bounding portfolio risks with incomplete covariance information, Log optimal investment strategy.

Recommended books:

1. Bottou.L, Curtis. F, &Nocedal. J. (2016). Optimization Methods for Large-Scale Machine Learning, SIAM publications.
2. Cornuejols G, Pena J &Tütüncü R.(2018). Optimization Methods in Finance.2nd edition, Cambridge: Cambridge University Press.
3. Jeyakumar. V & Rubinov. A.M. (2005). Continuous Optimization: Current Trends and Modern Applications, Springer.
4. Roberto Cominetti, Francisco Facchinei &Jean B. Lasserre. (2012). Modern Optimization Modelling Techniques, Springer.
5. Ross Baldick. (2009). Applied Optimization: Formulation and Algorithms for Engineering Systems, 1st edition, Cambridge University Press.

FM-707 Black-Scholes Theory (3+0)

Credit Derivatives, Exotic Options, Mechanics of Futures Markets, Hedging Strategies Using Futures, Interest Rates, Determination of Forward and Futures Prices, Interest Rate Futures, Swaps, Mechanics of Options Markets, Properties of Stock Options, Trading Strategies Involving Options, Binomial Trees, Wiener Processes and Ito's Lemma, The Black-Scholes-Merton Model, Options on Stock Indices, Currencies, and Futures, Greek Letters, Volatility Smiles, Basic Numerical Procedures, Value at Risk, Estimating Volatilities and Correlations for Risk Management, Credit Risk, Credit Derivatives, Exotic Options, Insurance, Weather, and Energy Derivatives, More on Models and Numerical Procedures, Martingales and Measures, Interest Rate Derivatives, The Standard Market Models, Convexity, Timing, and Quanto Adjustments, Interest Rate Derivatives, Models of the Short Rate, Interest Rate Derivatives.

Recommended books:

1. Jia-An Yan. (2018). Introduction to Stochastic Finance, 1st edition, Springer.
2. John C. Hull. (2014). Options, Futures, and Other Derivatives, 9th edition, Pearson.
3. MarekCapinski& Ekkehard .K. (2012).The Black–Scholes Model (Mastering Mathematical Finance), Cambridge University Press.
4. Neil A. Chriss& Kawaller.I. (1996).Black-Scholes and Beyond: Option Pricing Models, 1st edition, McGraw-Hill.
5. Timothy F.C. (2022). Basic Black-Scholes: Option Pricing and Trading, 6th edition, Crack publications.

Second Semester

FM-702 Computing for Finance in Python (2 + 1)

Introduction to Python for data science: Data types and operators, Building of various types of plots and customizing them to be visually appealing and interpretable, Dictionary, an alternative to the Python list, and the pandas data frame, creating and manipulating datasets, access the information from data structures, Boolean logic, decision-making in Python, different logic operators, Boolean outcomes in control structures, Filtering data in pandas Data Frames using logic. While and for loops.

Extracting and transforming data frames: Cleaning and merging data, Diagnosing issues such as outliers, missing values, and duplicate rows, Advanced indexing, Rearranging and reshaping data.

Importing financial data into Python: The ways to import data into Python: from Pandas, From Quandl, from flat files such as .txt and .csv; from files native to other software such as Excel spreadsheets, Stata, SAS, and MATLAB files; and from relational databases such as SQLite and Postgre SQL.

Financial data analysis: Returns, Volatility Calculation, Ordinary Least-Squares Regression (OLS), Calculation of loan payments and annuities, Time value of money, present value, future value, interest rates, Calculation of loan payments and annuities, Monte Carlo simulation, Simulation of asset prices and portfolio returns, Risk analysis and scenario modeling.

Labs/Practicals:

- Perform data cleaning and preprocessing to handle missing values and outliers.
- Calculate stock returns, moving averages, and volatility measures.
- Visualize the stock price movements using matplotlib or seaborn.
- Fetch historical data for these stocks and calculate their returns and risk measures (e.g., volatility, Sharpe ratio).
- Calculate the theoretical price of call and put options based on the underlying asset's price, strike price, time to maturity, volatility, and interest rate.
- Simulate stock price movements using Monte Carlo simulation.
- Analyze simulation results to understand the distribution of outcomes and assess risk factors.

Recommended books:

1. Chris Kelliher. (2022). Quantitative Finance with Python: A Practical Guide to Investment Management, Trading, and Financial Engineering, 1st edition, Chapman and Hall.
2. Hayden Van Der Post. (2023). Quantitative Finance with Python, 1st edition, Springer.
3. James Ma Weiming.(2015). Mastering Python for Finance, 2nd edition, Packt Pub Ltd.
4. KrishNaik. (2019). Hands-On Python for Finance, Packt Publishing.
5. Yves Hilpisch. (2019). Python for Finance: Mastering Data-Driven Finance, 2nd edition, O'Reilly Media.

Electives/ Optional Courses

FM-711 Financial Risk Management and Measurement (3 + 0)

Assess Risk Maturity of the organization, Risk Management framework, Market risk, Interest rate risk, Credit risk, Value at Risk (VaR), Conditional VaR measures for market risk in trading operations, Calculating and aggregating VaR, Testing VaR, VaR-driven capital for market risk, and limitations of the VaR-based approach, Asset Liability Management (ALM), Models for interest rate, spread, and volatility risks,Credit analysis models, Sources of credit risk, Credit derivatives, Calculating default probabilities with actuarial and market prices based methods, Portfolio risk aggregation approaches, The foreign exchange market and currency risk.

Recommended books:

1. Christopher Marrison. (2002). The Fundamentals of Risk Measurement, 1st edition, McGraw Hill.
2. Francisco .J.P. (2017). Financial Risk Management: Identification, Measurement and Management, 1st edition, Palgrave Macmillan.
3. Hull, John C. (2007). Risk Management and Financial Institutions, Prentice-Hall.
4. Hull, John C. (2006). Options, Futures, and Other Derivatives, 6th edition, Prentice-Hall.
5. Ross, Stephen A., Wester field, & Randolph W. (1999). Corporate Finance, 3rd edition, McGraw Hill.

FM-712 Fixed Income Markets (3+0)

Review of Market Analytics, Term Structure of Rates, Libor and Swaps, Trading, Linear Optimization and Portfolio Replication, Yield Volatility, Convexity, and Long Rates, Real Rates and Inflation Expectations, Deliverable Bond Futures and Options, Bond Options, Currencies, Prepayment Model,Mortgage Bonds, Product Design and Portfolio Construction, Calculating Parameters of the TSIR, Implementation, Time Value of Money, Yield Curve Analysis: Spot Rates and Forward Rates, Day Count Conventions and Accrued Interests, Valuation of Option-Free Bonds, Analysis of Floating Rate Securities, Valuation of Bonds with Embedded Options, Total Return, Measuring Interest Rate Risk, Value-at-Risk Measure and Extensions, Analysis of Inflation-Protected Bonds, The Tools of Relative Value Analysis, Analysis of Interest Rate Swaps, Estimating Yield Volatility.

Recommended Textbooks

1. Frank J. Fabozzi & Choudhry. M. (2022). Fixed Income Mathematics, 5th edition, McGraw Hill.
2. Saied Simozar. (2015).The Advanced Fixed Income and Derivatives Management Guide,1st edition, Wiley.
3. Suresh Sundaresan . (2009). Fixed Income Markets and Their Derivatives, 3rd edition, Academic Pres.
4. Tuckman. B,.& Serrat. A. (2011). Fixed Income Securities: Tools for Today's Markets, 3rd edition, Wiley.
5. Wolfgang Marty. (2017), Fixed Income Analytics: Bonds in High and Low Interest Rate Environments, 1st edition, Springer.

FM-713 Asset Pricing (3+0)

Consumption-Based Model and Overview, Applying the Basic Model, Contingent Claims Markets, The Discount Factor, Relation between Discount Factors, Mean-Variance Frontiers, Implications of Existence and Equivalence Theorems, Conditioning Information, Factor Pricing Model, Estimating and Evaluating Asset Pricing Models, GMM in Explicit Discount Factor Models, Regression-Based Tests of Linear Factor Models, GMM for Linear Factor Models in Discount Factor Form, Maximum Likelihood, Time Series, Cross-Section, and GMM/DF Tests of Linear, Factor Models, Bonds and Options, Option Pricing, Option Pricing without Perfect Replication, Term Structure of Interest Rate, Expected Returns in the Time Series and Cross Section, Equity Premium Puzzle and Consumption-Based Models.

Recommended books

1. Clauss Munk. (2015). Financial Asset Pricing Theory, Oxford University Press.
2. John H. Cochrane. (2005). Asset Pricing, Princeton University Press.
3. Kerry E. Back. (2017). Asset Pricing and Portfolio Choice Theory, 2nd edition, Oxford University Press.
4. Turan G. Bali, Robert F. Engle, &Murray.S,.(2016). Empirical Asset Pricing, 1st edition, Wiley.
5. Wayne Ferson . (2019). Empirical Asset Pricing: Models and Methods, 1st edition, MIT Press.

FM-714 Nonlife Actuarial Model (3+0)

Introduction to life and long-term health insurance, Survival models, Life tables and selection, Insurance benefits, Annuities, Premium calculation, Policy values, Multiple state models, Multiple decrement models, Joint life and last survivor benefits, Pension mathematics, Yield curves, Non-diversifiable risk, Emerging costs for traditional life insurance, Universal life insurance, Emerging costs for equity-linked insurance, Option pricing, Embedded options, Estimating survival models, Utility theory and insurance, Individual risk model, Collective risk models, Ruin theory, Premium principles and Risk measures, Bonus-Malus systems, Ordering of risk, Credibility theory, Generalized linear models.

Recommended books

1. Angus S.M, Richards. S.J, & Iain D.C. (2018). Modelling Mortality with Actuarial Applications, 1stedition, Cambridge University Press.
2. Daykin. C.D., Pentikainen. A, & Pesonen. M. (1993). Practical Risk Theory for Actuaries, 1stedition, Chapman and Hall/CRC.
3. Denuit. M, Dhaene. J, Goovaerts. M, & Rob Kaas. (2005).Actuarial Theory for Dependent Risks: Measures, Orders and Models, 1st edition, Wiley.
4. Dickson. D.V, Mary R. H, & Howard R. W,. (2020). Actuarial Mathematics for Life Contingent Risks, 3rd edition, Cambridge University Press.
5. Yiu-Kuen Tse. (2009).Nonlife Actuarial Models: Theory, Methods and Evaluation, 1st edition, Cambridge University Press.

FM-715 Mathematics to Bond Markets (3+0)

Overview of bond markets, Types of bonds (e.g., government bonds, corporate bonds etc.), Importance of mathematics in bond pricing and analysis, Time value of money, Application of time value of money in bond valuation, Understanding the concept of present value and future value, Discounting and compounding techniques, Bond Pricing Fundamentals, Basic bond terminology, Bond pricing formulas, Yield to maturity (YTM) calculations, Relationship between bond prices, coupon rates, Concept of duration and its importance in bond portfolio management, Macaulay duration, Modified duration, Understanding convexity and its impact on bond price changes, Application of duration and convexity in risk management, Yield Curve Analysis, Overview of yield curves and their shapes, Construction and interpretation of yield curves, Yield curve dynamics and forecasting, Yield curve strategies for bond investors, Hedging interest rate risk with bond futures, options, and swaps, Credit Risk Analysis, Understanding credit risk in bond investments.

Recommended books

1. Donald J. Smith. (2014).Bond Math: The Theory behind the Formulas, 2nd edition, Bloomberg Press.
2. Fabozzi. F& Edward T. Z. (2021). Bond Markets, Analysis, and Strategies, 10th edition, The MIT Press.
3. Michal. B, & Jerzy Z. (2020).Mathematics of the Bond Market: A Levy Processes Approach, 1st edition, Cambridge University Press.
4. Moorad Choudhry. (2003).Bond and Money Markets: Strategy, Trading, Analysis, 1st edition, Butterworth-Heinemann.
5. Steven Dym. (2010). The Complete Practitioner's Guide to the Bond Market, 1st edition, McGraw Hill.

FM-716 Stochastic Volatility (3+0)

Local volatility, Forward-start options, Variance swaps, One-factor dynamics, The heston model, Static and dynamic properties of stochastic volatility models, Multi-asset stochastic volatility, Local-stochastic volatility models, Binomial no-arbitrage pricing model, Probability theory on coin toss space, American derivative securities, Random walk, Interest-rate-dependent assets, Levy processes, stochastic integration and partial differential equations, Modelling the forward price dynamics and derivatives pricing.

Recommended books

1. Antonio. M, & Fabio. F. (2000). Stochastic Volatility in Financial Markets, Springer.
2. Lorenzo Bergomi. (2016). Stochastic Volatility Modeling, 1st edition, Routledge.
3. Luc. B, Christian M.H, & Sebastien. L. (2012). Handbook of Volatility Models and Their Applications, 1st edition, Wiley.
4. Pascal Debus. (2013). Application of Stochastic Volatility Models in Option Pricing, Grin Verlag.
5. Steele. J.M. (2010). Stochastic Calculus and Financial Applications, 1st edition, Springer.

FM-717Monte Carlo Methods (3+0)

Monte Carlo inference, Pseudo randomness, Simple exact sampling, Simple approximate sampling via importance sampling, Basic asymptotic theory, Correctness, Debugging and performance evaluation of randomized algorithms, Control variants, Limitations and failure cases of simple methods, Scalable inference methods for sequences and their generalizations, Hidden and state space models, Bayesian inference of multilevel models, Monte Carlo principles, Rejection, Weighting, Metropolis algorithm, The Gibbs sampler, Random numbers, Random variables, Generating sample paths, Variance reduction techniques,Simulation of Brownian motion, Stochastic calculus, Quasi-Monte Carlo, Markov chain Monte Carlo, Simulation-based estimation for dynamical (state-space) models,Time permitting, Sensitivity analysis, Simulation-based optimization, Discretization methods, Estimating sensitivities, Applications of Monte Carloin Finance.

Recommended books

1. George S. FishmanA. (2005). First Course in Monte Carlo, 1st edition, Duxbury Press.
2. Kroese.D.P, Taimre.T, &Botev.I. (2011). Hand Textbooks of Monte Carlo Methods, 1st edition, Wiley.
3. Liu.J.S, &Owen.A.B.(2008). Monte Carlo Strategies in Scientific Computing, Springer.
4. Paul Glasserman. (2003). Monte Carlo Methods in Financial Engineering, 3rd edition, Springer.
5. Thomas C. M. Lee. (2013). Monte Carlo Simulation and Resampling Methods for Social Science, 1st edition, SAGE Publications.

FM-718 Time Series Modeling (3+0)

Introduction to time series, Time series analysis, Components of time series model, Time series plots, Special features of time series data, means, variance, auto covariance, auto-correlation and partial auto-correlation for sample time series data, Simple descriptive techniques, Stationary time series, Transformations, Analyzing the secular trend, Filtering, Differencing, Analyzing seasonal variations, Analyzing cyclical variations, Analyzing irregular variations, Autocorrelation (correlograms) and other tests of randomness, General linear processes and continuous processes, Stochastic processes, Purely random process, Random walk, Univariate Time Series Models for Stationary Data, Moving average process, Invertibility of Moving Average (MA) models, Auto-Regressive (AR) process, Duality between MA and AR models, Principle of parsimony, Yule-Walker equations for AR process, Mixed ARMA models, ARIMA model, SARIMA model, Trends and Non-stationarity, Models for non-stationary time series, Parameter estimation and model identification, Decomposition of time series.

Recommended books

1. Box, G.E.P., Jenkins, G.M. &Reinsel, G.C. (2004). Time series analysis: Forecasting and control, 3rd edition, Holden-dayk: San Francisco.
2. Brockwell, P.J., & Davis, R.A. (2002). Introduction to time series and forecasting, 2nd edition, Springer.
3. Chatfield, C. (2003). The analysis of time series: An introduction, 6th edition, Chapman & Hall.
4. Montgomery, D.C. (1990). Forecasting and time series analysis, 2nd edition, McGraw Hill.
5. Wei, W. (1990). Time series analysis: Univariate and multivariate methods. Addison-Wesley publishing company, Inc.

FM-719 Decision Sciences (3+0)

Overview of decision-making processes, Decision Analysis, Decision theory and decision-making under uncertainty, Decision trees and influence diagrams, Utility theory and risk preferences, Sensitivity analysis and scenario planning, Probability and Statistics for Decision Making, Basic probability concepts, Probability distributions and their applications, Statistical inference and hypothesis testing, Regression analysis and correlation, Optimization Techniques, Linear programming and integer programming, Network optimization (e.g., shortest path, maximum flow), Nonlinear optimization methods, Applications of optimization in resource allocation and production planning, Simulation Modeling, Monte Carlo simulation method, Discrete-event simulation techniques, Simulation modeling for decision support, Analytic Hierarchy Process (AHP), TOPSIS (Technique for Order of Preference by Similarity to Ideal Solution), Decision-making methods for complex and conflicting objectives.

Recommended books

1. Kleindorfer. P.R, Kunreuther. H.G, & Schoemaker. PJ. (1993).Decision Sciences: An Integrative Perspective, Cambridge University Press.
2. Martin Peterson. (2017). An Introduction to Decision Theory, 2nd edition, Cambridge University Press.
3. Nandan .R, Sengupta, & Chakravarty. S,. (2016). Decision Sciences: Theory and Practice, 1st edition, CRC Press.
4. Nutt. P.C, & Wilson. D.C. (2010).Handbook of Decision Making, 1st edition, Wiley-Blackwell.
5. Sinha. B.K, & Bagchi. S.B. (2021). Strategic Management, Decision Theory, and Decision Science: Contributions to Policy Issues, Springer.

FM-720 Machine Learning for Finance (3+0)

Data collection and cleaning techniques, Feature selection strategies, feature extraction methods, Handling missing data and outliers, Machine Learning (ML)fundamentals, Supervised, unsupervised, and reinforcement learning, Regression, classification, clustering algorithms, Model evaluation and validation techniques, Simulation for risk assessment, portfolio management, Predictive modeling for stock price movements, Credit risk assessment, Algorithmic trading strategies, Introduction to neural networks, Deep learning (DL) architectures (e.g., convolutional neural networks, recurrent neural networksetc.), Applications of ML and DL Deep learning inpre-processing the financial data, financial forecasting and trading.

Recommended books

1. Abedin. M.Z, Hassan. M.K , Hajek. P, & Mohiuddin. M. (2021). The Essentials of Machine Learning in Finance and Accounting, 1st edition, Routledge.
2. Dixon. M.F, Halperini, & Bilokon. P. (2020). Machine Learning in Finance: From Theory to Practice, 1st edition, Springer.
3. Hao Ni ,Dong. X, & Zheng. J. (2021). Introduction To Machine Learning In Quantitative Finance, 1st edition, WSPC .
4. Jannes Klaas. (2019). Machine Learning for Finance, Packt Publishing.
5. Marcos Lopez de Prado. (2018). Advances in Financial Machine Learning, 1st edition, Wiley.
