

Financial Engineering



Indian Institute of Technology Kharagpur

Dual Degree Program in Financial Engineering

[B.Tech.(Hons) in Core Engineering

&

M.Tech. in Financial Engineering]

Introduction:

Financial markets are becoming more complex in terms of instruments and processes while diversifying across the globe. The players in the markets, particularly the banking and securities industries have got challenging tasks in securities valuation, risk management, portfolio structuring, market practices and regulatory compliances. The industry needs individuals equipped with advanced mathematical and computational skills dovetailed with knowledge in different facets of financial products and markets.



The Financial Engineering Programme: Strengths and Relevance:

The unique inter-disciplinary Dual-Degree programme in Financial Engineering was introduced by IIT Kharagpur in the year 2010. The programme leads to *B.Tech (Hons) in any Core Engineering* and *M.Tech in Financial Engineering*. A student pursuing this programme takes a



total of 5 years to earn the B.Tech (Hons.) in core engineering and M.Tech in Financial Engineering.

The main objective of this program is to train students to develop strong fundamentals knowledge and expertise in the field of quantitative finance. Accordingly, the course equips the students with required skill set for careers that involve the quantitative analysis of financial instruments and financial risks. The financial engineering program is based on four key areas: *(a) mathematics and statistics, (b) economics and econometrics models, c) computer and information systems(d) finance concepts, risk management tools & techniques applicable to financial institutions and financial products.*

Detailed course structure is available in the weblink titled “[Detailed Curriculum](#)”.

Admission Process:



IIT Kharagpur admits students through joint entrance examination (JEE) which is conducted throughout India for admissions to top ranked engineering institutions of the country. Unlike traditional dual degree courses, the students in financial engineering programme are enrolled after completion of one year of common academic curriculum at IIT Kharagpur. Applications are invited from the first year students belonging to various engineering disciplines for switch over inter-disciplinary financial engineering programme at the end of their first year. The selection of twenty (20) candidates is done on the basis of the *cumulative grade point average (CGPA) secured by them at the end of the first year.*

Facilities at Campus:

Students and faculty of Financial Engineering have access to cutting edge infrastructure provided by IIT Kharagpur needed for this programme.

They have access to the Central Library which is one of the largest libraries in Asia having diverse collection of online and offline resources. Computer laboratories used for this course have up to date hardware and software with many financial databases such as *CMIE-PROWESS, ACE-EQUITY and CAPITALINE*. IIT Kharagpur also has acquired *BLOOMBERG terminals* that have made the learning experience of financial



engineering students more practical oriented and has facilitated access to worldwide financial data. The campus guest houses and Kolkata guest houses, which are well-equipped with all modern facilities, serves as a pleasant haven for the institutes' guests from various fraternities. Students and faculty reside in the campus which is equipped with high-speed wireless connectivity

For more details contact:



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Financial Engineering, IIT, Khargapur

Financial Engineering

Dual Degree Curriculum

for

B.Tech. (Hons) in Core Engineering

&

M.Tech. in Financial Engineering



Indian Institute of Technology Kharagpur
West Bengal, 721 302
India

**Dual Degree Curriculum for B.Tech.(Hons.) in Core Engineering
& M.Tech. in Financial Engineering**

<i>Semester No.</i>	<i>Subject Name</i>	<i>Subject No.</i>	<i>L-T-P(*)</i>	<i>Credits</i>	<i>Dept. to offer</i>
3	Economics (Mandatory Breadth)	HS20001	3-1-0	4	HSS
4	Corporate Finance and Financial Accounting	BM61002	3-0-0	3	VGSOM
5	Regression and Time Series Model	MA31020	3-1-0	4	MA
	Total Credit upto 5th Semester			11	
7	Financial Institutions and Market	BM60023	3-0-0	3	VGSOM
7	Stochastic Process in Finance	MA41031	3-1-0	4	MA
	Total Credit upto 7th Semester			18	
8	Derivatives and Risk Management	BM40012	3-0-0	3	VGSOM
8	Financial Risk Modeling	BM40006	3-0-0	3	VGSOM
8	Lab - I: Financial Analytics	BM49002	0-0-3	2	VGSOM
	Total Credit upto 8th Semester			26	
9	Investment Management	BM51001	3-0-0	3	VGSOM
9	Financial Econometrics	HS51002	3-0-0	3	HSS
9	Elective-I		3-0-0	3	
9	Lab – II: Modeling and Simulation of Financial Systems	BM59001	0-0-3	2	VGSOM
9	Comprehensive Viva Voce	FP58001	0-0-0	2	
9	Thesis Project –I	FP67001	0-0-0	12	
	Total Credit in 9th Semester			25	
10	Fixed Income Securities and Interest Rate Derivatives	HS51001	3-0-0	3	HSS
10	Market Microstructure	BM51002	3-0-0	3	VGSOM
10	Elective-II		3-0-0	3	
10	Thesis Project - II	FP67002	0-0-0	13	
	Total Credit in 10th Semester			22	
	Total Credit Loading Excluding Breadth subjects			62	
	Total Credit Loading Including Breadth Subjects			73	

(*): LTP: Lecture-Tutorial- Practical

MA: Dept of Mathematics, **HSS:** Dept of Humanities & Social Science

VGSOM: Vinod Gupta School of Management **ME:** Dept. of Mechanical Engineering

CSE: Dept. of Computer Science

Elective-I List (One subject to be opted)	Department	Subject No.
• Soft Computing	ME	MF41601
• Intelligent Control for Finance	EE	EE50001
• Optimization Methods in Finance	MA	MA61061
• Data Analytics	CSE	CS40003
Elective-II List (One subject to be opted)		
• Behavioural Finance	HSS	HS50026
• Dynamic Models for Financial Systems	IEM	IM50002
• Artificial Intelligence	MA	MA61008
• Commodity Derivatives & Price Risk Management	VGSOM	BM50010.

Brief Subject Outline

ECONOMICS (3-0-0)

Monetary Policy Strategy: The International Experience; Monetary Theory; The Demand for Money; Aggregate Demand and Supply Analysis; Money and Inflation; Rational Expectations: Implications for Policy; Financial Market Regulations, Demand and Supply Analysis, Production and Cost, Price Output Determination, Capital Market and Investment Decisions, Outline of Welfare Economics, Resource Accounting and Sustainability, Income Determination and Fluctuations, Trade, Aid and Development. Economic Systems & Indian Economic Policies, Interest Rate and Money Supply.

CORPORATE FINANCE AND ACCOUNTING (3-0-0)

Finance Function and Role of Finance Manager, Agency Problem; Present Value Concepts; Valuation of Bonds and Shares; Risk Return; Capital Budgeting; Cost of Capital; CAPM and AJ Models, Corporate Financing; Capital Structure Policy; Dividend Policy and Bonus Issues; Share buyback; Working Capital Management; Introduction to Mergers, Acquisitions and Business Restructuring; Introduction to Real Options. Basics of Financial Accounting and Reporting; Financial Reporting Standards; Financial Statement Preparation and Interpretation; Accounting Standards and Taxation Issues for Derivatives.

REGRESSION AND TIME SERIES MODELS (3-0-0)

Concept of regression, Simple linear regression, multiple linear regression, model adequacy checking, transformations and weighting to correct model inadequacies, diagnostics for leverage and influence. Polynomial regression models, orthogonal polynomials. Classical techniques of Time Series Analysis, Different Smoothing Techniques, General linear process, Autoregressive Processes AR(P), Moving average Process Ma(q): Autocorrelation, Partial autocorrelation & Spectrum, Identification in time domain, Forecasting, Estimation of Parameters, Model diagnostic checks, Elements of ARCH and GARCH models, Use of time series techniques in Finance.

FINANCIAL INSTITUTIONS AND MARKETs (3-0-0)

Introduction to Financial Institutions and Markets , Stock Market (Types of Securities, Primary & Secondary Market, Bookbuilding process, role of investment bankers), shares with DVR, Bonus issue, stock split, rights, buy back, delisting, Stock Market Operators, Stock Exchanges, Market Efficiency, International Aspect of Stock Market Regulations, Stock Trading, ADRs, GDRs, Money Market Instruments, players, T-Bills, LIBOR, MIBOR, MIBID, Commercial Papers International Aspects of Money Market, Bond Market, Bond Price, Maturity, Duration & Convexity, Bond Rating, Inflation Bonds, Corporate Bonds, Convertible Bonds Euro Bond, Foreign Bond, Sovereign Bonds, Bond Market Participants, Mutual Fund, Size, Structure, Types, Ratings, ETFs, Hedge Funds, Pension Funds, Financial Derivatives Market, Futures, Options, Swaps, FRAs, Hedging of various price risk using derivatives instruments, Foreign Exchange Market, Market participants, Instruments, Commodity Derivative Market, Market Participants, Commodity Index, Products, Insurance Companies, structure, products, Venture Financing, Securitization Market

STOCHASTIC PROCESSES IN FINANCE(3-0-0)

Definition and classification of stochastic processes, Poisson process, Birth and death process, Markov process in discrete time, random walks, gambler's 'ruin', first return probabilities. Diffusion Processes - Brownian motion (introduction), Weiner process,

Simulation of Brownian motion, Brownian Bridge, scaling symmetry, Brownian motion with drift, waiting times, geometric Brownian motion, applications in financial modelling. Introduction to Martingales. Stochastic Calculus - stochastic differential equations, stochastic integral (Ito's formula), applications in financial modelling. The Risk Process: definition and the intuitive description of risk, stochastic process with independent increments, Markov process. The Risk in the Collective: Risk-theoretical definition, risk and collective, the structure function, the weighted risk process as description of the risk in the collective, weighted laws of probability, the risk pattern in the collective

Risk measurement and management including market risk, credit risk, liquidity risk, settlement risk, volatility risk, kurtosis risk and other types of financial risks.

Introduction to credit risk modeling and conceptual overview of current techniques. Covers default probabilities, loss given default, correlation, credit portfolio analytics, bond valuation, loan valuation, and credit derivative valuation; Market Risk Modeling Using VaR Etc.

DERIVATIVES AND RISK MANAGEMENT (3-0-0)

Define and measure risk, pricing forwards and futures using cost of carry, calculation of repo and implied repo rates, risk management using futures, stock index futures, hedge ratio, FRAs, interest rate futures (T-bill futures), duration & convexity management Pricing & Valuation of Swaps (interest rate, currency, commodity, equity index), Use of Swaps to Manage Risk, Options valuations using Binomial and Black-Scholes Model, use of options for Risk Management, intro to exotic options, VaR, Credit Derivatives.

FINANCIAL RISK MODELING (3-0-0)

Introduction, Sources of risk, Statistical Tools for measuring Risk, Time Varying Models of Risk and Correlations, Computation of VaR, Backtesting VaR (Conditional and Unconditional Models), Portfolio Risk, VaR Mapping, Stress Testing, Liquidity Risk, Credit Risk, Operational Risk, Using VaR for Active Risk Management, BASEL III norms.

FINANCIAL ANALYTICS (*Laboratory*) (0-0-3)

Using spreadsheet package, SAS, SPSS concepts like Time Value of Money, Bond and Equity valuation, Portfolio Risk-Return and Efficient Frontier, Minimum Variance Portfolio and Optimal Portfolio Selection, Fixed Income Modelling (Valuation, Duration, Convexity, Portfolio) Term Structure Modelling, Options Pricing using Binomial Method, Monte Carlo Simulation, Logistic Regression, Kalman Filter, Time Series Modelling – AR and MA models, and GARCH models.

INVESTMENT MANAGEMENT (3-0-0)

Introduction to Investment Management; Risk and Return of Individual Assets and Portfolio; Efficiency of Capital Market; Stock Valuations, Fundamental and Technical Analysis of Stock, Optimal Portfolio Selection Models (Markowitz Theory, Sharpe's Single Index Model, Lagrange Multiplier Theory, Utility Theory); Passive Equity Portfolio Strategy; Active Equity Portfolio Strategy; Bond Fundamentals and Valuation of Bond; Bond Price Volatility; Passive Bond Portfolio Strategy; Active Bond Portfolio Strategy; Portfolio Strategy using Futures and Options; Portfolio management and Portfolio Revisions; Portfolio Performance Evaluation; Overview of Investment Banking; Investment Banking Strategies; Private Equity, Debt and Equity Underwriting, Securitization and Financial Restructuring.

FINANCIAL ECONOMETRICS (3-0-0)

Introduction to Financial Econometrics; Financial Model Specifications and Diagnostic Testing; Linear Econometric Models in Finance (Predictability of Asset Return, Event Study, Financing Decisions); Qualitative Response Models in Finance (Pecking Order Hypothesis); Testing the Capital Asset Pricing and Conditional Asset pricing Models; Econometrics of Panel Data (Testing Capital Structure Theories, Corporate Investment, Market Timing); Unit Root Tests (Testing the Efficient Market Hypothesis); Causality Analysis (FDI vs. Growth rate, Money Supply Vs. Interest Rate); Persistence and Co-integration (Interest Rate Determination, Financial Market Integration); Conditional Heteroscedasticity Models (Tests for Financial Market Volatility); Generalized Methods

of Moments Analysis and its Use in the Financial Market; Econometrics of Derivatives (Measurement of Implied Volatility, Testing Black-Schole Model); Dynamic Financial Models for High Frequency Data.

MODELNG & SIMULATION OF FINANCIAL SYSTEMS (*Laboratory*) (0-0-3)

Model building (decision analysis and modeling), Monte Carlo simulation (risk quantification and prediction), Real options analysis (strategic options and management flexibility), Forecasting (simulation and prediction with and without data), Optimization (combinations of deterministic, dynamic, stochastic, continuous, discrete, and nonlinear problems), application of risk analysis in real life situations like, pharmaceutical, biotech deal structuring, oil and gas exploration and production, military strategy, financial planning, employee stock options, healthcare administration etc. The course also covers topics like data generating process and sampling distribution in Monte Carlo simulations.

FIXED INCOME SECURITIES AND INTERST RATE DERIVATIVES (3-0-0)

Modeling and Valuation of Fixed Income Securities, ZCYC, Ho-Hee, Hull-White, Balck-Derman-Toy, Black Karanshki, Bond Duration, Immunization, and Convexity, Yield Curve and Term Structure of Interest rates, Bond Portfolio Hedging Technique, Monte Carlo Methods and Multi Factor Models.

MARKET MICROSTRUCTURE (3-0-0)

Market microstructure is the study of the process and outcomes of exchanging assets under explicit trading rules. This course deals with high frequency secondary trading data, market microstructure of electronic financial markets and the development of automated trading algorithms, auction and matching protocols, inventory-based models and information based models of the bid-ask spread, price discovery and gradual information revelation in securities markets, methods for measuring the bid-ask spread, the principles of price and winner determination and the market micro-structures in available electronic trading networks, modeling of trading, order information arrival and their implications of price dynamics, design of optimal transactions scheduling in order to minimize liquidity or execution risk

Elective – I List:

SOFT - COMPUTING (3-0-0)

Introduction of Soft-computing tools: Fuzzy Logic, Genetic Algorithm, Neural Networks and Probabilistic Reasoning; Applications of Fuzzy Logic concepts in Engineering Problems; Engineering optimization problem solving using genetic algorithm; Neural network approaches in engineering analysis, design and diagnostics problems; applications of probabilistic reasoning approaches.

OPTIMIZATION METHODS IN FINANCE (3-0-0)

Linear Programming, Simplex Algorithm and Duality Theorems, Integer Programming, Basics of Nonlinear Programming, Dynamic Programming, and Discrete-Event Simulation. Two-Person Zero-Sum and Non-Zero-Sum Games. Co-operative & Non-Cooperative Games. Soft Computing Methods such as Genetic Algorithm and Simulated Annealing. Applications in Capital Budgeting, Capital Structures, Working Capital Management, and Hedging Decisions.

INTELLIGENT CONTROL FOR FINANCE (3-0-0)

Control theory: Mathematical modeling of dynamic system in (i) transfer function domain (ii) state space domain; System response due to standard test signals; Different performance indices; Concept of stability analysis in (i) s-domain (ii) time domain; Concept of eigen value and eigen vector, controllability and observability; and Dynamic Programming: Receding horizon control; Model predictive control. Concept of Artificial Neural Networks and its basic mathematical model; McCulloch-Pitts neuron model; Simple perceptron, Adaline, Madaline and Feedforward multilayer perceptron; Learning and training mechanism. Introduction to crisp sets and fuzzy sets; Fuzzy set operation and approximate reasoning; Fuzzification, inferencing and defuzzification; Fuzzy knowledge and rule base; Fuzzy modeling and control. Application of control approaches in Finance.

DATA ANALYTICS (3-0-0)

The course will cover fundamental algorithms and techniques used in data analytics. The statistical foundations will be first covered, followed by various machine learning and data mining algorithms used in data analytics. Technological aspects like data management, scalable computation, and visualization will also be covered. The course will provide exposure to theory as well as practical systems and software used in data analytics. As a part of the course students will take up analytics project from various domains. Topics include: Data management and indexing , Data representation and characterization, Basic statistical analysis tools and models , Data analytics programming languages – R, SPSS, Matlab, Python, Association and correlation analysis- regression models, Predictive analytics, Exploratory analysis, Feature engineering, Visualization , Scalable and parallel computing, Text analytics, Case study and project

Elective – II List:

BEHAVIOURAL FINANCE (3-0-0)

Overview of Behavioral Finance; Limits to Arbitrage: Theory; Short-Sale Constraints; Agency Problems in Investment Management. Hedge Fund Performance.; IPOs (Khaneman and Tversky); Investor Psychology; Overreaction and Momentum (Shleifer vs. Fama); Investor Behavior; Behavioral Corporate Finance; Value vs. Growth; common biases and heuristics identified by psychologists; over-confidence, the attribution theory, the representative heuristic, the availability heuristic, anchoring and adjustment, fairness, and prospect theory

DYNAMIC MODELS FOR FINANCIAL SYSTEMS (3-0-0)

Casual relationships between financial variables, Stock-flow mapping, Developing system dynamics models, Analysis of the financial systems through continuous simulation. Diffusion models for large-scale, integrated, coupled financial systems, Policy coordination Issues. Equivalent dynamic models, stability and controllability analysis, Optimal control theory and application, Chaotic dynamics in financial systems, Differential Games. Modelling of large-scale integrated/coupled systems, Diffusion models for contagion effect – Propagation of chaos and filtering tools.

ARTIFICIAL INTELLIGENCE (3-0-0)

Basic concepts of AI, Production systems and AI, Search strategies for AI, Search strategies for decomposable production systems, Predicate calculus, knowledge representation, Semantic nets, Frames, conceptual dependency, planning, planning as search, plan generation, Game theory.

COMMODITY DERIVATIVES & RISK MANAGEMENT (3-0-0)

Commodity Derivatives Trading & Commodity Exchanges, Commodity Contracts, Trading platform for Major Commodity Exchanges: Open Outcry vs. Electronics. Kerb Trading Commodity Indices creation, Collateralized vs. uncollateralized index, commodity index based on contract side. Brief introduction to Futures, Options, Swaps, Exchange of Futures for Physicals, Futures Pricing & Valuation, Futures Pricing Valuation for Storable/non Storable Commodity, Contango/Backwardation, Hedge Ratio, Pricing & Valuation of Commodity Options, Commodity Price risk in Agricultural, Dairy, Forest & Livestock, Commodity Price risk in Crude Oil & Natural Gas, Gold & Silver Commodity Derivatives, Electricity Derivatives Pricing and Trading, Weather Derivatives Carbon Derivatives, Miscellaneous Derivatives: Freight, Water, Property and Non-Farm Payroll Index. Commodity price modeling involving various time series techniques such as ARIMA, Granger Causality, ARCH-GARCH family of models, Vector Autoregressive Models (VECM) and Error Correction Mechanism(ECM).



PAST RECRUITERS



PARTHENON



Cognizant

