Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

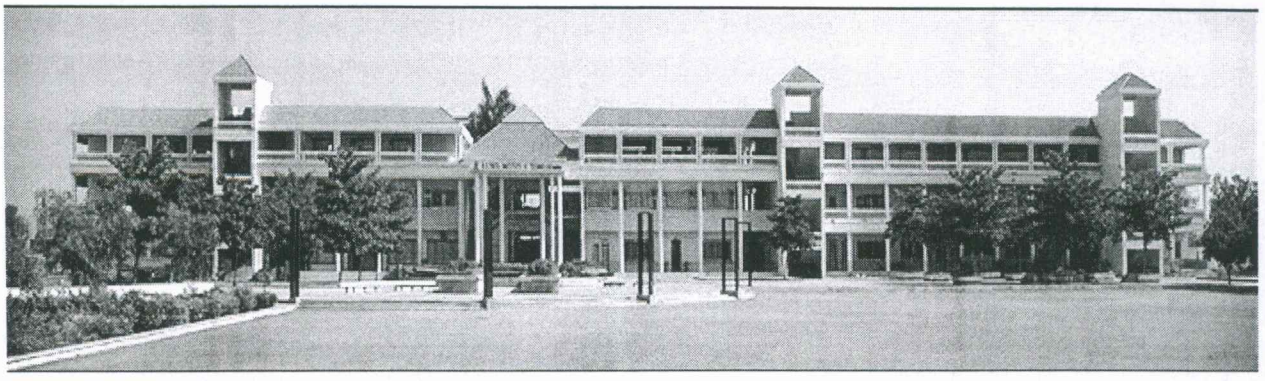
(An Autonomous Institute)

Course Structure and Syllabus

Honors Degree Program in Computational Finance

Computer Science and Engineering (Data Science)

With effect from Year 2024-25



Shahada Road, Near Nimzari Naka, Shirpur, Maharashtra 425405
Ph: 02563 259 802, Web: www.rcpit.ac.in

Honors Degree Program in Computational Finance(w.e.f. 2024-25)

Sr	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credit	
							Continuous Assessment (CA)							
							TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Average of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
Sem-III														
1	H1	RCP23DCH1301	Financial Market and Risk Analysis	3			25	15	15	15	60	100	3	3
Sem-IV														
2	H1	RCP23DCH1401	Computational Methods and Pricing Models	3			25	15	15	15	60	100	3	4
	H1	RCP23DLH1401	Computational Methods and Pricing Models Laboratory			2	25					25	1	
Sem-V														
3	H1	RCP23DCH1501	Econometric Modelling	3			25	15	15	15	60	100	3	3
Sem-VI														
4	H1	RCP23DCH1601	Quantitative Portfolio Management	3			25	15	15	15	60	100	3	4
	H1	RCP23DLH1601	Quantitative Portfolio Management Laboratory			2	25					25	1	
Sem-VII														
5	H1	RCP23DCH1701	Stochastic Calculus for Financial Modelling	3			25	15	15	15	60	100	3	3
6	H1	RCP23DLH1701	Mini Project			2	50					50	1	1
			Total	15		6	225			75	300	600	18	

Prepared by:
Dr. P. S. Sanjekar

Prof. Dr. U. M. Patil
BOS Chairman

Prof. Dr. P. J. Deore
Dean Academics/Dy. Director

Checked by:
Ms. S. P. Salunkhe

Prof. S. P. Shukla
C.O.E.

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Prof. Dr. J. B. Patil
Director

Honors Degree Program in Computational Finance(w.e.f. 2024-25)														
Sr	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credit	
							Continuous Assessment (CA)							
							TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Average of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
Sem-III														
1	H1	RCP23DCH1301	Financial Market and Risk Analysis	3			25	15	15	15	60	100	3	3

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Honors Degree Program in Computational Finance Sem-IV (w.e.f. 2024-25)														
Sr	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credit	
							Continuous Assessment (CA)							
							TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Average of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
Sem-IV														
1	H1	RCP23DCH1401	Computational Methods and Pricing Models	3			25	15	15	15	60	100	3	4
	H1	RCP23DLH1401	Computational Methods and Pricing Models Laboratory			2	25					25	1	

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Financial Market and Risk Analysis (RCP23DCH1301)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 15 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 60 Marks
Total Marks : 100 Marks

Prerequisite: Basic Mathematics

Course Objectives:

1. To provide an understanding of various financial institutions, their functions, as well as to introduce various financial instruments and their associated risks.
2. Measurement, analysis and managing the risk using advanced techniques.
3. To introduce risk exposure in money markets, capital markets, and forex markets

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the structures, functions, and operations of financial institutions and markets.	L2	Understand
CO2	Identify and evaluate various financial instruments and assess the risks associated with them.	L3	Apply
CO3	Assess the risk in money markets, capital markets and forex markets.	L2	Understand

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Course Contents

Unit-I — 06 Hrs.

Introduction to Financial Instruments:

Money, Equity, Debt instruments, Foreign Exchange and their risk structure. Introduction to crypto currency (or contemporary currency).

Unit-II — 09 Hrs.

Money Market Instruments and Structure of Risk:

Interest rate and valuation: present value and future value computation, annuity valuation, loan amortization, capital recovery and sinking fund factory, money market instruments and structure of their risk and returns.

Equity Market and Risk Matrix:

Stocks, Ordinary and Preferential Stocks, primary and secondary stock market, Initial Public Offering (IPO), public equity and private equity, stock market index, market participants, trading risk in equity market.

Unit-III — 08 Hrs.

Financial Markets and Products:

Structures and functions of financial institutions, structure and mechanics of Over – the – Counter (OTC) and exchange markets, Spot market, Commodity market, Foreign exchange market, Corporate bonds and mortgage-based-securities.

Unit-IV — 07 Hrs.

Debt Market, Structure of Risk and Return: Risk and Return of Debt instruments, types of bonds, term structure for interest rates, yield curve, spot rate and forward rate, duration and convexity of yield curve.

Unit-V — 09 Hrs.

International Finance:

Foreign exchange market, determination of foreign exchange rate, purchasing power parity theory, interest rate parity, Fisher effects, international Fisher effect.

Foreign Exchange Risk:

Currency derivatives, currency quotes, triangular currency arbitrage, exchange rate exposure.

Text Books:

1. Jimmy Skoglund, Wei Chen, "Financial Risk Management", Wiley Publication, 2015.

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2. Bharti. V. Pathak, "The Indian Financial System", Pearson Publication, 2018.

Reference Books:

1. Saunders. A. and Cornett M, "Financial Markets and Institutions", McGraw Hill Education, 2014.

2. Hull. J. C, "Options, Future and other Derivatives", PHL publication 2013.

3. Brealey, Myers, Allen, "Principals of Corporate Finance", McGraw Hill, 2020.

Online Resources:

1. Financial Instruments:
   https://corporatefinanceinstitute.com/resources/wealth-management/financial-instrument/

2. NPTEL course in Financial Institution and Markets:
   https://nptel.ac.in/courses/110105121

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.

2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 60 marks.

2. Total duration allotted for writing the paper is 2 hrs.

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Computational Method and Pricing Models (RCP23DCH1401)

Teaching Scheme
Lectures : 03 Hrs./week
Credits : 03

Examination Scheme
Term Test : 15 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 60 Marks
Total Marks : 100 Marks

Prerequisite: Basic Mathematics, Financial Markets and Risk Analysis

Course Objectives:

1. Various numerical methods used in option pricing and financial models.
2. Calibrate pricing models and apply optimization techniques to market data.
3. Foundational knowledge of actuarial science, interest rate models, and bond pricing techniques.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Analyze numerical approaches in option pricing.	L4	Analyze
CO2	Describe Model Calibration to Market Data.	L2	Understand
CO3	Understand Actuarial Science, Interest Rate Basics and bond prices.	L2	Understand

Course Contents

Unit-I — 08 Hrs.

Numerical Methods for Option Pricing:

Introduction to Options and the Option Market, Types of Options: Vanilla Options (Call and Put), Exotic Options (Barrier, Asian, Lookback, etc.); Participants in the Option Market: Hedgers, Speculators, Arbitrageurs; Introduction to Option Pricing: The need for numerical methods in option pricing, Overview of different stock price evolution models.

Analytical vs. Numerical Approaches in Option Pricing: Black-Scholes Model: Assumptions and derivation of the Black-Scholes formula, Limitations of the Black-Scholes model; Introduction to Numerical Integration: Trapezoidal and Simpson's Rule, Applications to option pricing.

Unit-II — 08 Hrs.

Fourier Transform in Option Pricing:

Fourier Transform in Option Pricing: Overview of Fourier transform in financial engineering, Key advantages in dealing with characteristic functions, Fourier Transform, Numerical Evaluation of the Integral, Pricing Several Options Using FFT.

Fast Fourier Transform (FFT) in Option Pricing:

Inverse Fourier Transform, and Characteristic Function, Call Price via the Inverse Fourier Transform, The algorithm and its computational efficiency.

Case studies: Selection of parameters for the Black-Scholes-Merton (BMS), Heston, and Variance Gamma (VG) models.

Unit-III — 07 Hrs.

Model Calibration:

Calibration of Models to Market Data: Fitting Market Option Prices, Calibrating models to fit observed option prices, Pictorial demonstration of the implied volatility surface; Calibration as an Optimization Problem: Formulating the calibration problem as an optimization, Introduction to objective functions and initial parameter set selection.

Optimization Routines for Model Calibration:

Brute-Force Search Method: Overview of brute-force search for calibration, Nelder-Mead Algorithm: Theoretical background of the Nelder-Mead optimization algorithm, BFGS Algorithm: Introduction to BFGS (Broyden-Fletcher-Goldfarb-Shanno) optimization.

Unit-IV — 06 Hrs.

Interest Rate Analytics:

Introduction to Interest Rates, Data-Driven Analysis of Interest Rates, LIBOR and Swap Curves.

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Introduction to LIBOR and swap rates, Building and interpreting the LIBOR curve; Calibration Techniques: Calibrating LIBOR and Swap Curves using market data, Analyzing cross- correlations between different interest rate instruments.

Pricing Interest Rate Products:

Pricing Bonds using Interest Rate Curves: Discounting techniques based on spot rates, Pricing Swaps: Valuation of interest rate swaps based on forward rates.

Unit-V 04 Hrs.

The Vasicek and Cox-Ingersoll-Ross (CIR) Models:

The Vasicek Model: Key characteristics: mean reversion and Gaussian processes, Pricing bonds with the Vasicek model, The Cox-Ingersoll-Ross (CIR) Model: Key characteristics: mean reversion and non-negative rates, Bond pricing using the CIR model.

Unit-VI 06 Hrs.

Actuarial Science Fundamentals:

Overview of Actuarial Science: Introduction to the role of actuaries in the finance industry. Basics of insurance, pensions, and actuarial risk assessment. Life Tables and Mortality Rates: Basic concepts of life expectancy, mortality rates, and life table construction. Application in simple actuarial models like life insurance. Actuarial calculations: Calculations using life tables and risk assessment exercises. Actuarial Models in Python: Simple.

Text Books:

1. Tuckman, Bruce, and Angel Serrat, "Fixed income securities: tools for today's markets", 2nd Edition, John Wiley & Sons, 2022.
2. Joshi, Mark S.,"The concepts and practice of mathematical finance", Vol. 1. Cambridge University Press, 2003.
3. Don M. Chance and Robert Brooks, "An Introduction to Derivatives and Risk Management", Joe Sabatino, 8th Edition, 2010
4. S. David Promislow, "Fundamentals of Actuarial Mathematics", 3rd Edition, John Wiley & Sons, 2015.

Reference Books:

1. Achdou, Yves, and Olivier Pironneau, "Computational methods for option pricing", Society for Industrial and Applied Mathematics, 2005.
2. Wu, Lixin, "Interest rate modeling: Theory and practice", CRC Press, 2019.

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3. Tavella, Domingo, "Quantitative methods in derivatives pricing: an introduction to computational finance", John Wiley & Sons, 2003.

4. Jiang, Lishang, "Mathematical modeling and methods of option pricing", World Scientific Publishing Company, 2005.

Weblinks:

1. Coursera Course in Computational Methods in Pricing and Model Calibration:
   https://www.coursera.org/learn/financial-engineering-computationalmethods

2. Computational Methods in Pricing and Model Calibration, Columbia University via Coursera
   Free Course: Computational Methods in Pricing and Model Calibration from Columbia University — Class Central

3. Computational Methods for Quantitative Finance:
   Finite Element Methods for Derivative Pricing — Springer Journal Link
   https://link.springer.com/book/10.1007/978-3-642-35401-4

4. Course on Computational Methods in Pricing and Model Calibration by Coursya Link:
   Computational Methods in Pricing and Model Calibration - Coursya

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.

2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 60 marks.

2. Total duration allotted for writing the paper is 2 hrs.

Computational Method and Pricing Models Laboratory (RCP23DLH1401)

Practical Scheme
Practical : 02 Hrs./week
Credit : 01

Examination Scheme
Teacher Assessment : 25 Marks
Total : 25 Marks

Course Objectives:

To provide students with a comprehensive understanding of financial data analysis, mathematical modeling, and algorithmic implementation for solving complex financial problems.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Demonstrate the ability to analyze, preprocess, and visualize financial datasets from various sources.	L3	Apply
CO2	Apply advanced mathematical and statistical models, such as linear regression, FFT-based pricing, and interest rate models (Vasicek, CIR), to solve real-world financial problems.	L3	Apply
CO3	Implement and calibrate computational algorithms for financial modeling.	L3	Apply

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List of Laboratory Experiments

1. Analysis of Volume Data and Historical Price for one Stock on Yahoo Finance Dataset.
2. Implementation of time period specific setting on web data source Alpha Vantage.
3. An Exploratory Data Analysis of Indian Start-up Funding.
4. Predicting Stock Prices with Linear Regression.
5. Implement FFT-Based Option Pricing.
6. Perform Model Calibration using Brute-Force Search.
7. Python implementation of bond pricing using LIBOR curves fitting.
8. Implement swap curve fitting techniques and analyse the pricing of interest rate swaps based on the fitted curve.
9. Implement the Vasicek model to price zero-coupon bonds. Perform basic calibration using historical interest rate data.
10. Implement the Cox-Ingersoll-Ross (CIR) model for bond pricing and fit it to interest rate data.
11. Python implementations of life table calculations and insurance premium calculations.

Minimum eight experiments from the above-suggested list or any other experiment or mini project based on syllabus will be included, which would help the learner to apply the concept learnt.

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on RCP23DCH1401 with minimum 08 experiments to be incorporated. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

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