# Four year degree

# Program of Financial Mathematics

BS (Financial Mathematics)

**DEPARTMENT OF MATHEMATICS**
**UNIVERSITY OF KARACHI**

# Program overview

As a highly regarded discipline, mathematics both underpins contemporary life and is a fascinating subject in its own right. The skills learnt by studying and applying mathematics prove invaluable in solving the complex problems faced in business.

BS four year degree program aims to develop students' understanding of the foundations of financial mathematics, and to equip them with the knowledge of a range of mathematical and computational techniques that are required for a variety of quantitative positions in the financial sector.

The program starts with a compulsory pre-calculus course (FM301), which introduces some key concepts and techniques.

Depth of understanding prepares students to respond to today's rapidly evolving, world-wide economic and financial landscape. During four year program, students will be encouraged to focus in areas such as Business Management, Statistics, Mathematics and Risk Management.

This program will produce graduates, highly numerate and computer literate, and who have also developed well-honed analytical and other transferable skills, equipping them for a variety of interesting and rewarding careers.

Providing the ideal preparation for a career in finance, our BS Financial Mathematics consists on core courses of mathematics, statistics, economics and finance. This program also includes financial topics such as analysis of shares, equities, cash flows and interest rates, portfolio management along with an introduction to the principles of microeconomics and macroeconomics.

This degree provides high-level instruction in the mathematical theory underlying finance, and training in appropriate computational methods. It offers the following benefits:

- A focus on the development of student understanding of quantitative methodologies and techniques that are important for a range of jobs in investment banks and other financial institutions
- Research-led teaching that aims at enhancing students' critical appreciation of major issues and emerging theory in the area of financial mathematics
- Preparation for a range of careers in the financial sector, industry, and research
- The opportunity to improve personal skills, including logical reasoning, quantitative analysis, and the presentation of technical result

Many prestigious universities all over the world offer this degree program such as

*Brunel University London* *Lancaster University*

*University of Nottingham* *The University of Kent*

*Cardiff University* *University of Heriot-Watt*

*The University of Chicago* *Stanford University etc.*

**Learning Outcomes**

After getting this degree, students will be able to:

- Apply deep understanding of a range of mathematical and statistical theories and algorithms of use in finance both in theory and practice
- Formulate, soundly and rigorously, solutions to applied mathematical and statistical problems by identifying and implementing relevant mathematical, statistical and computational tools and techniques
- Communicate their ability and knowledge, verbally and through written documentation, and have experienced team work
- Progress in employment or postgraduate study in areas of business finance or risk modeling
- Demonstrate and apply advanced modeling skills relevant to the intersection of business finance and applied mathematics
- Interpret, construct and apply tools from modern Financial Computer Simulation, select financial instruments appropriate to risk mitigation and employ mathematical tools germane to risk modelling

**Eligibility: Intermediate/ A-Levels**

**Total Credit Hours: 126**

**Minimum CGPR Qualification: 2.20**

## DEPARTMENT OF MATHEMATICS
## UNIVERSITY OF KARACHI
## Module of BS in Financial Mathematics

| SEMESTER I | | | SEMESTER II | | |
|---|---|---|---|---|---|
| 300.1 | Pakistan Studies | 3+0 | 300.2 | English | 3+0 |
| FM-301 | Pre-calculus | 3+0 | FM-302 | Calculus with Applications | 3+0 |
| FM-303 | Introductory Statistics for Business | 2+1 | FM-304 | Multivariate Statistical Analysis | 2+1 |
| FM-305 | Microeconomics | 3+0 | FM-306 | Macroeconomics | 3+0 |
| FM-307 | Business Mathematics | 3+0 | FM-308 | Introduction to Business Finance | 3+0 |

| SEMESTER III | | | SEMESTER IV | | |
|---|---|---|---|---|---|
| 400.1 | Islamic Learning | 3+0 | 400.2 | Urdu | 3+0 |
| FM-401 | Mathematical Methods | 3+0 | FM-402 | Multivariate Calculus and Geometry | 3+0 |
| FM-403 | Inferential Statistics for Business | 2+1 | FM-404 | Quantitative Methods in Business | 2+1 |
| FM-405 | Money, Banking and Trade | 3+0 | FM-406 | Pakistan Economics | 3+0 |
| FM-407 | Financial Accounting-I | 3+0 | FM-408 | Financial Accounting-II | 3+0 |
| FM-409 | Programming Language-I | 2+1 | FM-410 | Programming Language-II | 2+1 |

| SEMESTER V | | | SEMESTER VI | | |
|---|---|---|---|---|---|
| FM-501 | Real and Complex Analysis | 3+0 | FM-502 | Discrete Mathematics | 3+0 |
| FM-503 | Numerical Analysis-I | 3+0 | FM-504 | Numerical Analysis-II | 3+0 |
| FM-505 | Differential Equations-I | 3+0 | FM-506 | Differential Equations-II | 3+0 |
| FM-507 | Linear Algebra with Applications | 3+0 | FM-508 | Actuarial Mathematics | 3+0 |
| FM-509 | Cost and Management Accounting-I | 3+0 | FM-510 | Cost and Management Accounting-II | 3+0 |

| SEMESTER VII | | | SEMESTER VIII | | |
|---|---|---|---|---|---|
| FM-601 | Operations Research | 2+1 | FM-602 | Analysis of Financial Report Writing | 3+0 |
| FM-603 | Financial Derivatives | 3+0 | FM-604 | Portfolio theory and Management | 3+0 |
| FM-605 | Stochastic Processes | 3+0 | FM-606 | Stochastic Calculus | 3+0 |
| | Optional-I | | | Optional-I | |
| | Optional-II | | | Optional-II | |

# Optional Courses

| | Course No. | Optional Course Title | Credit Hours |
|---|---|---|---|
| 1 | FM-607 | Corporate Finance | 3+0 |
| 2 | FM-608 | Games, Markets and Information | 3+0 |
| 3 | FM-609 | Management Information System | 3+0 |
| 4 | FM-610 | Financial Modelling and Simulation | 3+0 |
| 5 | FM-611 | Discrete time Modelling and Derivative Security | 3+0 |
| 6 | FM-612 | Life Insurance and Institutional Investment | 3+0 |
| 7 | FM-613 | Principles of Risk | 3+0 |
| 8 | FM-614 | Global Financial Market | 3+0 |
| 9 | FM-615 | Equities Foreign Exchange and Commodities Modelling | 3+0 |
| 10 | FM-616 | Interest rate and Credit Modelling | 3+0 |
| 11 | FM-617 | Financial Computer Simulation- I | 2+1 |
| 12 | FM-618 | Financial Computer Simulation- II | 2+1 |
| 13 | FM-619 | Analysis of Financial Time Series | 3+0 |

***Optional Courses will be offered on the availability of course in charge or permission of Chairperson. There is no restriction of even/odd course numbers in any semester except 617 and 618.**

# BS- I Financial Mathematics

| SEMESTER I | | | SEMESTER II | | |
|---|---|---|---|---|---|
| **300.1** | **Pakistan Studies** | **3+0** | **300.2** | **English** | **3+0** |
| **FM-301** | **Pre-calculus** | **3+0** | **FM-302** | **Calculus with Applications** | **3+0** |
| **FM-303** | **Introductory Statistics for Business** | **2+1** | **FM-304** | **Multivariate Statistical Analysis** | **2+1** |
| **FM-305** | **Microeconomics** | **3+0** | **FM-306** | **Macroeconomics** | **3+0** |
| **FM-307** | **Business Mathematics** | **3+0** | **FM-308** | **Introduction to Business Finance** | **3+0** |

## *First Semester*

**FM-301 Pre-Calculus ( 3 + 0 )**

**Function and Graphs:** Increasing, Decreasing, and Piecewise Functions, The Composition of Functions, Symmetry and Transformations, Quadratic Equations, Functions, Polynomial Functions and Modeling, Graphing Polynomial Functions, Polynomial Division

**Theorems:** The Remainder and Factor Theorems, Theorems about Zeros of Polynomial Functions

**Some important functions:** Rational Functions, Polynomial and Rational Inequalities, Inverse Functions, Exponential Functions, Logarithmic Functions

**Matrices and Determinants:** Matrix Operations, Determinants and Cramer's Rule, Nonlinear Systems of Equations and Inequalities

**Sequence and Series:** Arithmetic Sequences and Series, Geometric Sequences and Series, Mathematical Induction, The Binomial Theorem,

**Trigonometry:** Trigonometric Functions of All Angles, Graphs of Sine and Cosine Functions, Double-Angle, and Half Angle, Inverse of the Trigonometric Functions, The Law of Sines, The Law of Cosines, Complex Numbers: Trigonometric Form, Polar Coordinates and Graphs, De-Moivers Theorem and its applications, Hyperbolic and inverse functions, complex number representation in polar coordinates, Derivative, Integration

**Books Recommended:**

01. R. Larson, Precalculus, Cengage Learning ($9^{th}$ edition), 2013

02. J. Stewart, L. Redlin, S. Watson, Precalculus: Mathematics for Calculus, Brooks/Cole, 2013
03. C.Y. Young, Precalculus: with Limits, Wiley (2nd edition), 2013
04. D.G. Zill, J.M. Dewar, Precalculus with Calculus Previews, Jones & Bartlett Learning, 2011
05. P.A. Foerster, Precalculus with Trigonometry: Concepts and Applications, Key Curriculum Press, 2002
06. D. Cohen, T.B. Lee, D. Sklar, Precalculus, Brooks/Cole, 2011
07. E. Swokowski, J. Cole, Precalculus: Functions and Graphs, Enhanced Edition, Cengage Learning, 2016

## FM-303 Introductory Statistics for Business (2+1)

**Statistical Methods**: Concepts of statistical population and sample from a population, quantitative and qualitative data, Nominal, ordinal and time series data, discrete and continuous data. Presentation of data by table and by diagrams, frequency distributions by histogram and frequency polygon, cumulative frequency distributions (inclusive and exclusive methods) and ogive. Bivariate data-scatter diagram, principle of least squares and fitting of polynomials and exponential curves. Measures of location (or central tendency) and dispersion. moments, measures of skewness and kurtosis, absolute moments and factorial moments, Inequalities concerning moments, Sheppard's corrections. Theory of attributes: Consistency of data, conditions for consistency, independence and association of attributes, measures of association and contingency.
**Probability Theory:** Permutation, Combination, Random experiments, sample point and sample space, event, algebra of events. Definition of Probability – classical and relative frequency approach to probability; Richard Von-Mises, and Kolmogorov's approach to probability, merits and demerits of these approaches (only general ideas to be given), theorems on probability, conditional probability, independent events, Bayes theorem and its applications.
**Random Variables**: Discrete and continuous random variables, p.m.f., p.d.f., c.d.f. illustrations of random variables and its properties. Univariate transformations. Expectation of random variable and its properties. Moments and cumulants, moment generating function. Cumulant generation function and characteristic function.

### Books Recommended:

01. Thomas H. Wonnacott, Ronald J. Wonnacott, Introductory Statistics for Business and Economics, Textbook and Workbook, (4th edition)
02. Thomas H. Wonnacott, Ronald J. Wonnacott, Introductory Statistics, 5th Edition, ISBN: 978-0-471-61518-7
03. Richard N. Landers, A Step-by-Step Introduction to Statistics for Business, SAGE Publishing

04. Michael Barrow, Statistics for Economics, Accounting and Business Studies, Pearson Education (6th edition), 2013
05. Goon A.M., Gupta M.K. and Dasgupta B., Fundamentals of Statistics, Vol. I, World Press (8th edition), Kolkata, 2005
06. Goon, A.M., Gupta, M.K. and Dasgupta, B., An Outline of Statistical Theory, Vol. I, World Press (4th edition), Kolkata, 2003

## FM-305 Microeconomics ( 3 + 0 )

**Introduction:** An overview of the social system, Economy as integral part of the social system, Economic agents and economic problem, Economics as a science of choices between competing wants and limited resources, Classification of economics, Importance and scope of micro-economics, Basic concepts: Commodities, Income and Resources, Production and Consumption, Exchange and Distribution.
**The Price Mechanism:** The concept of a market economy, Laws of demand and supply, schedules & graphs of demand and supply, Market equilibrium and determination of price, Movement along and shifting of demand and supply curves, Concept of elasticity of demand and supply, Importance of elasticity.
**Consumer's Behavior:** Consumers/ households as economic agents, Problem of the consumers, The utility theory, Laws of diminishing marginal utility and equi-marginal utilities, Budget constraint and consumer's equilibrium, Individual demand and market demand, Introduction to demand elasticity.
**Firms and Industries:** Business enterprises, Forms of business organization: Proprietorship, Partnership, Joint stock companies, Multinational corporations, Classification of the firms, Production and supply of commodities (goods and services), Objectives of the firm: The profit motive, Output maximization and cost minimization, Industrial structure & market supply.
**Production and Cost Functions:** Production function, Primary inputs: factors of production, Secondary/intermediate inputs: Raw material and energy, The laws of returns, Revenues of the firm: total, average and marginal revenues, Cost function: Total, average and marginal costs, Short-run and Long-run costs, Equilibrium of the firm.
**Market Structure:** Classification of markets according to nature of commodity, extent, time and degree of competition, Perfect competition among buyers and sellers, Imperfect competition: Monopoly and Monopsony, Monopolistic competition, Price determination, The need for market regulation and role of the government, Public goods and their provision beyond the market.

## Books Recommended:

01. N. Gregory Mankiw, Principles of Microeconomics, Cengage Learning, 7th edition, 2014

02. David Besanko and Ronald Braeutigam, Microeconomics, Wiley, 4th edition, 2014
03. Michael Parkin, Microeconomics, Prentice Hall, 11th edition, 2013.
04. Robert Frank and Ben Bernanke, Principles of Microeconomics, McGraw-Hill/Irwin, 5th edition, 2012.
05. Robert Pindyck and Daniel Rubinfeld, Microeconomics, Prentice Hall, 8th edition, 2012.

**FM-307 Business Mathematics ( 3 + 0 )**

**Accounts and Banking:** Business Formulas, Ratio and Proportion, Electronic Banking, Checking Accounts, and Check Registers, Checking Services and Credit-Card Transactions, Bank Statement Reconciliation, Simple interest, Compound Interest, Interest rate, annuities.
**Earning and Taxes:** Gross Earnings: Wages and Salaries, Gross Earnings: Piecework and Commissions, Social Security, Medicare, and Other Taxes, Income Tax Withholding
**Markup and Discounts:** Series Discounts and Single Discount Equivalents, Cash Discounts: Ordinary Dating Methods, Cash Discounts: Other Dating Methods, Markup on Cost, Markup on Selling Price, Markdown, Turnover and Valuation of Inventory
**Analysis on Tax:** Property Tax, Personal Income Tax, Straight-Line Method, Declining-Balance Method, Sum-of-the-Year's-Digits Method, Units-of-Production Method, Modified Accelerated Cost Recovery System, The Income Statement, Analyzing the Income Statement, The Balance Sheet, Analyzing the Balance Sheet

**Books Recommended:**

06. K. Trivedi, C. Trivedi, Business Mathematics, Pearson, 2011.
07. P.K. Giri, J. Banerjee, Introduction to Business Mathematics, Academic Publishers, 2009.
08. M. Hansen, Business Math, South-Western, 2010.
09. J.E. Deitz, J.L. Southam, Contemporary Business Mathematics, South-Western, 2012.
10. G. Clendenen, S.A. Salzman, Business Mathematics, Pearson, 2015

## *Second Semester*

**FM-302 Calculus with Applications ( 3 + 0 )**

**Introduction:** Real Numbers & its properties, Introduction to functions, domain, range, symmetry tests, Graph of functions

**Limits & Continuity:** Limits, Continuity, Tangent lines & Rate of Change,

**Some especial types of Functions:** Logarithmic & exponential functions, Inverse functions, hyperbolic functions, inverse trigonometric & hyperbolic functions

**Introduction to derivatives:** Techniques of differentiation, Chain rule and implicit differentiation, derivatives of Inverse functions, hyperbolic functions, inverse trigonometric & hyperbolic functions, Applications of differentiation, Maxima and Minima of a function of single variable, Marginal analysis and approximations using increments, Indeterminate forms and L' Hospital Rule

**The Integral:** Riemann integral, Integration techniques, Integration by substitution, differentiation & integration of logarithmic & exponential function, Integrals of inverse trigonometric & hyperbolic function, Integration of Power of sine, cosine, secant and tangent, by parts, trigonometric substitution, Improper integrals, additional applications to business and economics, Beta and gamma integrals

**Differential Equations I:** Differential equations, formation and solution, equations of first order, initial and boundary value problems, various methods of solving first order differential equations: Separable, Exact & Homogeneous equation, integration factor and orthogonal trajectories. Non-Linear First Order Equations, Envelopes and Singular solutions.

**Differential Equations II:** Higher order Homogeneous Differential equations with constant coefficients, superposition of solutions, Cauchy-Euler's equations, systems of two first order linear homogenous equations, nonlinear equations.

Applications of all above topics from business and finance

**Books Recommended:**


01. Hoffmann, Calculus for Business, Economics and the social and the life sciences, McGraw Hill (10th edition), 2007
02. Kreyszig, E., Advanced Engineering Mathematics, John Wiley (9th edition), 2005
03. Thomas and Finney, Calculus and Analytic Geometry, Addision Wesley, 2005
04. Howard Anton, Calculus, Wiley (7th edition), 2001
05. Yousuf, S. M., Mathematical Methods, Fourth Edition, Ilmi Kitab Khana, Lahore, 2003
06. Morris Tenenbaum, Harry Pollard, Ordinary Differential Equations, Dover Publications, Incorporated, 2012

## FM-304 Multivariate Statistical Analysis ( 2 + 1 )

**Standard probability distributions**: Degenerate, Binomial, Poisson, Geometric, Negative Binomial, Hypergeometric. Normal, uniform, exponential, beta, gamma, Cauchy, Laplace.

**Bivariate and Multivariate Distributions**: Discrete and continuous type, c.d.f., p.d.f., marginal and conditional distributions, independence, expectation and conditional expectation, characteristic function and its properties, Inversion Theorem (without proof). Multinomial Distribution. Bivariate Transformations-concept and examples in uniform, normal, exponential, beta, gamma and Cauchy distributions. Variance stabilizing transformations-sin-1, square root, log and Fisher's z. Bivariate normal distribution and its properties. Multivariate normal distribution, its marginal and conditional distributions.

**Correlation and regression**: Karl Pearson's Coefficient of Correlation, lines of regression, Spearman's Rank Correlation Coefficient. Correlation Ratio. Multiple and partial correlation coefficients (for three variates only). Limit Laws: Convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution. Chebyshev's inequality, De-Moivre-Laplace theorem, central limit theorem (C.L.T.) for i.i.d. variates, Liapunov theorem (without proof) and applications of C.L.T.

**Sampling Distribution**: Definitions of random sample, parameter and statistic, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean and sample proportion. Sampling distributions of chi-square, t and F statistic. Distribution of sample correlation coefficient r when $\rho = o$.

**Tests of significance:** Null and alternative hypotheses, level of significance and probabilities of Type I and Type II errors, critical region and p-value. Large sample tests, use of CLT for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations. Tests of significance based on t, F and Chi-square distributions.

### Books Recommended:


01. Izenman, J. Modern Multivariate Statistical Techniques: Regression, Classification, and Manifold Learning, Springer
02. Tinsley, H. and Brown, S., Handbook of Applied Multivariate Statistics and Mathematical Modeling. Academic Press, 2000
03. Alvin C. Rencher, William F. Christensen, Methods of Multivariate Analysis, (3rd edition)
04. Timm, Neil H., Applied Multivariate Analysis, 2002
05. Hogg, R.V. and Tanis, E.A., A Brief Course in Mathematical Statistics. Pearson Education, 2009

**FM-306 Macroeconomics ( 3 + 0 )**

**Introduction to Macro Economics:** What macroeconomics is about? Issues addressed by macroeconomists, Positive versus Normative analysis, Classical versus Keynesians.

**Measurement and Structure of the National Economy:** National Income Accounting: the measurement of Production, Income and Expenditure, Gross Domestic Product and Gross National Product, Saving and Wealth, Real GDP, Price Indices and Inflation, Interest rates.

**Productivity, Output and Employment:** The Production Function, The Demand for Labor, The Supply of Labor, Labor Market Equilibrium, Unemployment, Relating Output and Unemployment: Okun's Law.

**Consumption, Saving and Investment in Closed and Open Economy:** Consumption and Saving, Investment, Goods Market Equilibrium, Balance of Payment Accounting, Goods Market Equilibrium in an Open Economy, Saving and Investment in a Small Open Economy, Saving and Investment in Large Open Economies, Fiscal Policy and the Current Account.

**The Assets Market, Money and Prices:** Introduction to Money, Portfolio allocation and the Demand for Assets, The Demand for Money, Assets Market Equilibrium, Money Growth and Inflation.

**The IS-LM and the AD-AS Model:** The FE Line: Equilibrium in the Labor Market Equilibrium, The IS Curve: Equilibrium in the Goods Market Equilibrium, The LM Curve: Equilibrium in the Assets Market Equilibrium, General Equilibrium in the complete IS-LM Model, Price adjustment and the Attainment of General Equilibrium, Aggregate Demand and the Aggregate Supply.

**Money and Inflation:** Inflation and its causes, Demand–pull Inflation, Cost–push Inflation, Stagflation and Hyperinflation, Inflation as a Monetary Phenomenon, The Philips Curve and Accelerating Inflation, Inflation in Pakistan: Sources and Managing Policies, Sources of Inflation in Pakistan, Policies to Combat Inflation in Pakistan.

**Books Recommended:**


01. Andrew B. Abel, Ben Bernanke and Dean Croushore, Macroeconomics, Prentice Hall, 8th edition, 2013.
02. Paul Krugman and Robin Wells, Macroeconomics, Worth Publishers, 3rd edition, 2012.
03. N. Gregory Mankiw, Principles of Macroeconomics, South-Western Cengage Learning, 6th edition, 2011.
04. Campbell McConnell, Stanley Brue and Sean Flynn, Macroeconomics, McGraw-Hill/Irwin, 19th edition, 2011.
05. William J. Baumol and Alan S. Blinder, Macroeconomics: Principles and Policy, Cengage Learning, 12th edition, 2011.

**FM-308 Introduction to Business Finance ( 3 + 0 )**

**An Overview of Finance:** Scope of Finance and its Career Opportunities, Alternative Form of Business Organization, Finance in the Organizational Structure of the Firm, Managerial Actions to Maximize Shareholders Wealth, Functions of a Finance Manager

**The Financial Environment: Markets, Institutions, and Interest Rates:** The Financial Market**,** Financial Institutions**,**The Stock Market**,** The Cost of Money, Interest Rate Level, The Determinants of Market Interest Rates

**Time Value of Money:** Future Value Concept, Present Value Concept, Future Value of an Annuity, Present Value of an Annuity

**Risk and Return,** Investment Return, The Trade–Off between Risk and Return, Risk in Portfolio Context

**Analysis of Financial Statements,** Ratio Analysis, Liquidity Ratio, Assets Management Ratios, Debt Management Ratios, Profitability Ratios, Market Value Ratio, Trend Analysis, Uses and Limitations of Ratio Analysis

**The Impact of Operating and Financial Decisions on the Firm:** Operating Leverage, Financial Leverage, Combined or Total Leverage

**The Framework of Financial Planning:** Short–Term Financial Planning, Long–Term Financial Planning

**The Cost of Capital:** Basic Definition**,** Cost of Debt**,** Cost of Preferred Stock**,** Cost of Retained Earning

**The Basic Concept of Capital Budgeting,** Importance of Capital Budgeting**,** Generating Ideas for Capital Budgeting, Project Classification, Capital Budgeting Decision Rules, Comparison of NPV and IRR Methods

**Working Capital Management:** The Importance of Working Capital, Short–Term Financial Decisions and Value Maximization, Why Current Assets and Current Liabilities are Required, Deciding on an Appropriate Working Capital Policy

**Cash and Near–Cash Item Management:** The Efficient Collection and Disbursement of Operating Cash, The Optimal Level of Operating Cash Balance, Investment Excess Cash in Marketable Securities, Evaluating Cash Management Strategies

**Recommended Books**


1. Houston and Brigham, Financial Management, Theory and Practice, 10th International Edition, Harcourt Brace College Publishers. 2004.
2. Rao Ramesh K. S., Fundamentals of Financial Management, Latest International Edition Maxwell Macmillan. 1989.
3. E. McLaney, Business Finance: Theory and Practice, Pearson Education 2009.

4. Madura, J. (2006). *International Financial Management*, 8th edition (West Publishing Company).
5. P. P. Drake, F. J. Fabozzi, The Basics of Finance: *An Introduction to Financial Markets, Business Finance, and Portfolio Management, John Wiley 2010*

# BS- II Financial Mathematics

| SEMESTER III | | | SEMESTER IV | | |
|---|---|---|---|---|---|
| **400.1** | **Islamic Learning** | **3+0** | **400.2** | **Urdu** | **3+0** |
| **FM-401** | **Mathematical Methods** | **3+0** | **FM-402** | **Multivariate Calculus & Geometry** | **3+0** |
| **FM-403** | **Inferential Statistics for Business** | **2+1** | **FM-404** | **Quantitative Methods in Business** | **2+1** |
| **FM-405** | **Money, Banking and Trade** | **3+0** | **FM-406** | **Pakistan Economics** | **3+0** |
| **FM-407** | **Financial Accounting-I** | **3+0** | **FM-408** | **Financial Accounting-II** | **3+0** |
| **FM-409** | **Programming Language-I** | **2+1** | **FM-410** | **Programming Language-II** | **2+1** |

## ***Third Semester***

**FM-401 Mathematical Methods ( 3 + 0 )**

**Sequence and Series:** Sequence and Their Divergence and Convergence Test, Introduction to Infinite Series, Taylor and Maclaurin Series
**Convergence and Divergence Test for Series:** Limit comparison test, Ratio test, Root test
**Fourier Series:** Periodic function, periodic extensions, even and odd functions, Fourier coefficients, expansion of functions in Fourier series, functions with arbitrary periods, Fourier sine and cosine series
**Group Theory:** Groups and their properties, subgroups, order of a group, cyclic groups, cosets, Lagrange's theorem, permutation groups, rings, fields
**Matrices and Determinants:** Elementary row operations, echelon and reduced echelon forms, inverse, rank and normal form of a matrix, matrix of linear transformation, partitioning of a matrix, system of linear equations, Gaussian methods, Axiomatic definition of a determinant, determinant as sum of product of elements, Adjoint and inverse of a matrix.
**Linear Programming:** LP definition, Linear Programming (LP), LP and allocation of resources, Graphical Linear Programming – Minimization solution, Linear Programming – Simplex Method for Maximizing
**Equations:** Solutions of cubic and biquadratic equations, numerical solution of equations, Newton-Raphson, Regula falsi and bisection methods.

**Books Recommended:**

01. Dennis G. Zill, A First Course In Differential Equations With Modelling Applications, Brooks/Cole Publishing Company (10th edition), 2013
02. Hoffmann, Calculus for Business, Economics and the social and the life sciences, McGraw Hill (10th edition), 2007
03. William E. Boyce, Differential Equations: An Introduction to Modern Methods and Applications, John Wiley & Sons Inc (2nd edition), 2007
04. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley (8th Edition), 2005
05. Morris Tenenbaum, Harry Pollard, Ordinary Differential Equations, Dover Publications, Incorporated, 2012

## FM-403 Inferential Statistics for Business ( 2 + 1 )

**Estimation:** Parametric space, sample space, point estimation. Requirements of good estimator: Consistency, unbiasedness, efficiency, sufficiency and completeness. Minimum variance unbiased (MVU) estimators. Cramer-Rao inequality. Minimum Variance Bound (MVB) estimators, Rao-Blackwell theorem, Lehmann-Scheffe theorem. **Methods of estimation:** Maximum likelihood, moments, minimum chi-square, least squares and minimum variance. Properties of maximum likelihood estimators (without proof).

**Interval estimation**: Confidence intervals for the parameters of various distributions. Confidence intervals for difference of means and for ratio of variances. Confidence interval for binomial proportion and population correlation coefficient when population is normal. Pivotal quantity method of constructing confidence interval. Large sample confidence intervals.

**Empirical distribution function**: one sample and two-sample sign test. Wald-Wolfowitz run test. Run test for randomness, Median test, Wilcoxon-Mann-Whitney U-test. Kolmogorov-Smirnov one-sample test, Kruskal-Wallis test.

**Books Recommended:**

01. Mercedes Orús Lacort, Descriptive and Inferential Statistics - Summaries of theory and Exercises solved
02. Sahu, Pradip Kumar, Pal, Santi Ranjan, Das, Ajit Kumar, Estimation and Inferential Statistics
03. Howard M. Reid, Introduction to Statistics: Fundamental Concepts and Procedures of Data Analysis, 1st edition
04. Casella, G. and Berger, R.L., Statistical Inference, Thomson Duxbury (2nd edition), 2002

05. Goon, A.M., Gupta, M.K. and Dasgupta, B., An Outline of Statistical Theory,Vol. II, World Press (3rd edition), Kolkata, 2005

**FM-405 Money, Banking and Trade ( 3 + 0 )**

**Introduction:** Why study Money, Banking and Financial markets, The Bond Market and Interest Rates, The Stock Market, The Foreign Exchange Market, Structure of the Financial System, Money and Monetary Policy, Money and Business Cycles, Money and Inflation, Money and Interest Rates, Conduct of Monetary Policy, Aggregate Output, Income, the Price Level and the Inflation Rate. Real Versus Nominal Magnitudes.
**Money:** Evolution of Money and Payment System, Definition of Money, Functions of Money & Measurement of Money, Demand for Money & Supply of Money, Definitions of Money, M1, M2, M3 etc., Role of Money in the Economy, Debate on neutrality and non-neutrality of money, Money in Aggregate Demand & Aggregate Supply Analysis. Keynesian versus Monetarist views of Equilibrium Output, Employment and Prices.
**Money Demand and Money Supply:** Quantity Theory of Money, Transaction Theories of Demand for Money, Portfolio Theories of Demand for Money, Monetary Base, Keynesian Liquidity Preference Framework, Friedman's Modern Quantity Theory of Money, Multiple Deposit Creation, Determinants of the Money Supply: Exogenous and Endogenous, Understanding Movements in the Monetary Base, Money Multiplier, Velocity of Money and its variability, Explaining Depositor and Bank Behavior.
**Banking:** Banking structure in the economy, different types of banks, Structure and Functions of a Central Bank, Independence of Central Bank and its role in economic growth, Tools of Central Bank for Money Control, Monetary Base, The Conduct of Monetary Policy: Goals and Targets, Tools of Monetary Policy, Central Bank as a lender of last resort, Financial Intermediaries, Monetization of Public Debt, Infectiveness of Stabilization Policies, Targeting interest rate and inflation.
**Trade:** The gains from trade, The pattern of trade, Protectionism, The balance of payments, Exchange rate determination, International policy coordination, The international capital market.
**Models of International Trade:** The Ricardian Model: The concept of comparative advantage, Trade in one factor world, Misconception about comparative advantage, Comparative advantage with many goods, The Specific Factors Model: Assumptions of the model, International trade in the specific factors model, Income distribution and the gains from trade, The Heckscher Ohlin Model: A model of a two factor economy, Effects of international trade, Empirical evidence, The Standard Trade Model: A standard model of a trading economy, Economic growth, International transfers of income, Tariff and export subsidies.
**International Finance:** Introductory Finance Issues: National Income and the Balance of Payments Accounts, The Trade Imbalances, Foreign Exchange Markets and Rates of Return, Interest Rate Parity, Purchasing Power Parity, Interest Rate Determination, National Output Determination, Exchange Rates and its management, Policy Effects with floating exchange rates, Policy effects with fixed exchange rates, Short and long term financing.

**Books Recommended:**


01. R. Glenn Hubbard and Anthony Patrick O'Brien. Money, Banking, and the Financial System, Prentice Hall, 2nd edition, 2013.
02. Frederic S. Mishkin, Economics of Money, Banking, and Financial Markets, Prentice Hall, 10th edition, 2012.
03. Laurence Ball. Money, Banking and Financial Markets, Worth Publishers, 2nd edition, 2011.
04. Stephen Cecchetti and Kermit Schoenholtz. Money, Banking and Financial Markets, McGraw-Hill/Irwin, 3rd edition, 2010.
05. James Gerber. International Economics, Prentice Hall, 6th edition, 2013.
06. Paul R. Krugman, Maurice Obstfeld and Marc Melitz. International Economics: Theory and Policy, Prentice Hall, 10th edition, 2014.
07. Dominick Salvatore, International Economics, Wiley, 11th edition, 2013.


## FM-407 Financial Accounting-I ( 3 + 0 )

**Introduction of Financial Accounting and Principles** The Impact of International Accounting Standards as Applicable in Pakistan for the Preparation of Financial Statements and their Disclosure Requirement, Forms of Business Enterprises such as Non–profit Organization, Sole Proprietorship, Partnerships and Corporation

**Financial Statements–The Outputs of the System** Objectives of Financial Reporting**,** Qualitative Characteristics of Financial Information**,** The Uses and Limitations of Classified Balance Sheets, The Uses and Limitations of Classified Income Statements, The Retained Earnings Statement or Statements of Changes in Stockholders Equity

**Inventory Accounting** Nature and Classes of Inventories, Periodic and Perpetual Inventory Valuation as per International Accounting Standard (IAS–2), LIFO, FIFO Methods, Weighted Average Method, Moving Average, Inventory Valuation at Cost or NRV Whichever is Lower

**Cash Flow Statement** Preparation of Cash Flow Statements According to the Requirement of IAS 7,Classification of Cash Flow Statements as Operating Activities, Investing Activities and Financial Activities by Using Direct and Indirect Methods

**Interpreting Financial Statement Data,** Users of Financial Statements and The Purposes of Financial Statement Analysis**,** The Techniques and Tools of Financial Analysis**,** Common Financial Ratios, Common Size Balance Sheet and Income Statement, Limitations of Financial Statement Analysis

**Recommended Books**


1. Horngren, Harrison, Robinson, Financial Accounting, Prentice Hall, 3rd Edition, 1995.
2. Weygandt, Kieso, Kimmel, Financial Accounting, John Wiley and Sons, Inc., 2nd Edition, 1998.

3. Meigs Robert F., Williams Jan R., Haka Susan F., Bettner Mark S., Accounting, McGraw–Hill, 10th Edition, 1999.

**FM-409 Programming Language-I ( 2 + 1 )**

**Introduction:** Introduction to Computer Programming, Principles of Structured and Modular Programming, Overview of Structured Programming Languages

**Algorithms and Problem Solving:** Program Development: Analyzing Problem, Designing Algorithm/Solution, Testing Designed Solution, Translating Algorithms into Programs, Fundamental Programming Constructs

**Data Types:** Basics of Input and Output

**Selection and Decision structures:** Operators (If, If-Else, Nested If-Else, Switch Statement and Condition Operator), Repetition (While and For Loop, Do-While Loops), Break Statement, Continue Statement, Control Structures, Functions, Arrays, Pointers Records, Files (Input-Output), Testing & Debugging.

**Books Recommended:**


01. C How to Program, Paul Deitel and Harvey Deitel, Prentice Hall (7th edition), 2012
02. Programming in C, Stephen G. Kochan, Addison-Wesley Professional (4thedition), 2013
03. Greg Perry, The Absolute Beginner's Guide to C", Pearson Education Inc (3rd edition), 2013
04. Brian W. Kernighan, Dennis M. Ritchie, The C Programming Language, Prentice Hall (2nd edition), 2005
05. Brian W. Kernighan, The C programming language, Prentice Hall (2nd Ed), 2005
06. Reema Threja, Introduction to C Programming, Oxford University Press (2nd Ed), 2015
07. By Harry H. Chaudhary, C Programming:: Step By Step Beginner's To Experts Edition, First MIT-Creatspace Inc. o-D-Publishing, 2014


# ***Fourth Semester***

**FM-402 Multivariate Calculus and Geometry ( 3 + 0 )**

**Polar Coordinates:** Polar Coordinate & Sketching the graph of polar coordinates, Slope of tangent line and arc length for parametric and polar curve, Area in polar Coordinates

**Introduction to Vectors, Line and Plane:** Product of vectors, Projection of vectors, Parametric equation of line, Plane in three spaces, Quadratic surfaces, Cylindrical & Spherical coordinate

**Derivatives of function of two variables:** Partial derivative, Tangent plane, Total differential for function of two variables, Directional derivatives and gradient for function of two variables, Maxima and minima for the function of two variables and Jacobians

**The Integral:** Introduction of double and triple integrals and their application

**Books Recommended:**


01. Hoffmann, Calculus for Business, Economics and the social and the life sciences, McGraw Hill ($10^{th}$ edition), 2007
02. Kreyszig, E., Advanced Engineering Mathematics, John Wiley (9th edition), 2005
03. Thomas and Finney, Calculus and Analytic Geometry, Addision Wesley, 2005
04. Howard Anton, Calculus, Wiley (7th edition), 2001
05. Yousuf, S. M., Mathematical Methods, Fourth Edition, IlmiKitabKhana, Lahore, 2003


**FM-404 Quantitative Methods in Business ( 2 + 1 )**

**Index Numbers**: Definition, construction of index numbers by different methods, Problems faced in their construction, criterion of a good index number-Test Theory-unit, time reversal, factor reversal and circular tests. Errors in the construction of index numbers. Chain and Fixed base index numbers. Base Shifting, Splicing and Deflating of index numbers. Cost of Living Index numbers- construction and uses. Wholesale Price Index and Index of Industrial Production.

**Demand Analysis**: Demand function, price and income elasticity of demand, nature of commodities, laws of supply and demand, Income distributions, Pareto – curves of concentration. Utility and Production Functions: utility function, constrained utility maximization, indifference curves, derivation of demand curve, production function, homogeneous production functions, Isoquant and Isocost curves, Elasticity of substitution, C.E.S. functions, Multiple production by monopolist, discriminating monopolistic form, multiplant form.

**Application of integration in Economics**: Given Elasticity of any function then how to find function, consumer surplus, producer surplus, learning curves, finding consumption function from M.P.C, finding profit function from M.R and M.C.

**Time Series**: Introduction, decomposition of a time series, different components with illustrations. Measurement of trend-Graphical Method, Method of Semi-averages,

Method of fitting curves (straight line, polynomials, growth curves-modified exponential curve, Gompertz curve and logistic curve). Method of Moving Averages. Measurement of seasonal variation- Method of Simple Averages, Ratio to Trend Method, Ratio to Moving Average Method and Link Relative Method. Measurement of cyclical variation residual method. Random component-estimation of its variance by Variate Difference Method.

**Pool/Panel Data Analysis:** introduction of longitudinal data, estimation of panel data regression models: the fixed effects approach, The Fixed Effects or Least-Squares Dummy Variable (LSDV) Regression Model, estimation of panel data regression models: the random effects approach, fixed effects (LSDV) versus random effects model

**Books Recommended:**


01. Gupta, S.C. and Kapoor, V.K., Fundamentals of Applied Statistics, Sultan Chand and Sons ($4^{th}$ edition).2008
02. Montgomery, D.C., Introduction to Statistical Quality Control, Wiley,2007
03. Jürgen Franke, Wolfgang Karl Härdle, Christian Matthias Hafner, Statistics of Financial Markets: An Introduction, Springer (4th edition), 2015
04. James H. Stock , Mark W. Watson, Introduction to Econometrics, Pearson Series in Economics, 3rd edition
05. Jeffrey M. Wooldridge, Introductory Econometrics: A Modern Approach, 5th edition


## FM-406 Pakistan Economics ( 3 + 0 )

**Overview of the Economy of Pakistan:** Development experience, Approaches, Policies and outcomes, Identification of issues in the history of Pakistan, Structural change and sources of growth, Emergence of economic issues, Human Resource Development, Unemployment, Poverty, Income distribution, Debt, Deficit etc., Growth with limited development in Pakistan.

**Development Planning and Resource Mobilization:** Agricultural development policies and priorities, Major targets of development plan and emerging issues, Neglects and successes: Mobilization of domestic resources: Shortages, Deficits and Role of foreign aid, Agricultural versus industrial development debate, Agricultural adequacy.

**Agricultural and Industrial Development:** Pattern of Agricultural and industrial development, Lan reforms and its impacts, the role of Green Revolution and its impacts: Present status, Agricultural price policy and Income tax, Sectoral terms of trade, industrial development policies and strategies, Development of Large and Small industries, Value added: Manufacturing versus Primary goods production, Agriculture versus industry: Development debate.

**Sectoral Development, Employment Pattern and Unemployment:** Sectoral priorities and development issues, Human resource Development and emerging Issues: Population growth, Labor force participation rate and employment pattern, Unemployment and underemployment, Forecasting manpower needs and employment, Strategies to combat unemployment, Criteria to measure unemployment / underemployment: Time criterion, productivity criterion and new index of unemployment: Application to Pakistan and empirical evidences, Good governance, Social Action Plan and its impact, Role of institutions in development, Social sectors development versus High Return Sectors, Growth trade off.

**International Debt and Dependency:** Concepts of foreign aid and debt, Borrowing versus Domestic Reserve Mobilization (failure), Size of foreign debt, Debt saving and its impacts, Strategies to combat with high debt: Saving policy, Foreign trade promotion, Cutting non-development expenditures, Rescheduling and its impacts, Debt management in Pakistan and its impacts, Debt modeling and future implications.

**Poverty and Income Distribution:** Pattern of income distribution: Rural and Urban, Definitions and Approaches to measure poverty: Income approach, Expenditure approach, Basic Needs Approach, Poverty of Participatory Index (POPI), How to combat poverty, Growth strategy, Basic needs, Labor intensive investment: Education / Training etc. and Social Action Plan (SAP): Role and critical review, Evasion of policies / Strategies to combat poverty and improving income distribution: Critical evaluation, Neglect of Human Resource Development, Child labor, Factors productivity issues.

**Inflation, Foreign Trade Deficit and Emerging Issues:** Sources of inflation in Pakistan, Policies to combat inflation and their impacts, Trade performance, Instability and its impacts, Policies to combat deficit and trade instability, WTO and its impacts, Reforms and further needs, Expected impacts of WTO and challenges, Terms of trade issues, Market Access and health related issues.

**Books Recommended:**


01. S. Akbar Zaidi. Issues in Pakistan Economy, Second Edition Revised and Expanded, Oxford University Press, Karachi, 2017.
02. Chaudhary M. Aslam and Ahmad Eatzaz. Globalization, WTO and Trade Liberalization in Pakistan, Feroz Sons, Lahore, 2004.
03. Shahrukh R. Khan. 50 Years of Pakistan's Economy – Traditional Topics and Contemporary Concerns, Oxford University Press, Karachi, 2000.
04. Pakistan Economic Surveys, Ministry of Finance, Government of Pakistan, Islamabad.
05. Annual Reports, State Bank of Pakistan, Karachi
06. World Development Report, World Bank.

## FM-408 Financial Accounting-II ( 3 + 0 )

**Accounting For Receivables** Accounting for Receivables Under Income Statement and Balance Sheet Approach, Notes Receivable and their Matters
**Current Liabilities and Accounting for Long Term Liabilities** Definition and Recognition of Liabilities**,** Types of Current Liabilities, Types of Long Term Liabilities, Bonds, Accounting for Bonds by Borrowers, Accounting for Bonds by the Investor, Other Forms of Long Term Debt, Time Value of Money Concept

**Corporate Organization and Capital Stock Transactions** Characteristics of A Corporation**,** The Formation and Organization of a Corporation**,** Types of Capital Stock, The Components of Stockholders' Equity, Accounting for the Issuance of Stock, Use of Stock Information

**Stockholders Equity Retained Earnings and Dividends:** Corporate Income Statements, Earnings Per Share, Dividends, Stock Splits Prior Period Adjustments, Appropriations, and Treasury Stock, Retirement of Capital Stock, Statement of Stockholder's Equity

### Recommended Books


4. Horngren, Harrison, Robinson, Financial Accounting, Prentice Hall, 3rd Edition, 1995.
5. Weygandt, Kieso, Kimmel, Financial Accounting, John Wiley and Sons, Inc., 2nd Edition, 1998.
6. Meigs Robert F., Williams Jan R., Haka Susan F., Bettner Mark S., Accounting, McGraw–Hill, 10th Edition, 1999.


## FM-410 Programming Language-II ( 2 + 1 )

**Introduction:** Evolution of Object Oriented Programming (OOP), Object Oriented concepts and principles, problem solving in Object Oriented paradigm
**Operators and Process:** OOP design process, classes, functions/methods, objects and encapsulation; constructors and destructors, operator and function/method overloading, association, aggregation, composition, generalization, inheritance and its types, derived classes, abstract and concrete classes, virtual functions, polymorphism, exception handling.

### Books Recommended:


01. C++: How to Programme, Deitel and Deitel, Pearson (5th edition)
02. Object Oriented Programming in C++, (3rd edition), Robert Lafore
03. C How to Program, Paul Deitel and Harvey Deitel, Prentice Hall (7th edition), 2012

04. Programming in C, Stephen G. Kochan, Addison-Wesley Professional (4th edition), 2013
05. Greg Perry, The Absolute Beginner's Guide to C", Pearson Education Inc (3rd edition), 2013
06. Brian W. Kernighan, Dennis M. Ritchie, The C Programming Language, Prentice Hall (2nd edition), 2005
07. Brian W. Kernighan, The C programming language, Prentice Hall (2nd Ed), 2005
08. ReemaThreja, Introduction to C Programming, Oxford University Press (2nd Ed), 2015
09. By Harry H. Chaudhary,C Programming :: Step By Step Beginner's To Experts Edition, First MIT-Creatspace Inc. o-D-Publishing 2014

# BS- III Financial Mathematics

| SEMESTER V | | | SEMESTER VI | | |
|---|---|---|---|---|---|
| **FM-501** | **Real and Complex Analysis** | **3+0** | **FM-502** | **Actuarial Mathematics** | **3+0** |
| **FM-503** | **Numerical Analysis-I** | **3+0** | **FM-504** | **Numerical Analysis-II** | **3+0** |
| **FM-505** | **Differential Equations-I** | **3+0** | **FM-506** | **Differential Equations-II** | **3+0** |
| **FM-507** | **Linear Algebra with Applications** | **3+0** | **FM-508** | **Discrete Mathematics** | **3+0** |
| **FM-509** | **Cost and Management Accounting-I** | **3+0** | **FM-510** | **Cost and Management Accounting-II** | **3+0** |

## *Fifth Semester*

**FM-501 Real and Complex Analysis ( 3 + 0 )**

**The Spaces R, $R^k$, and C:** The Real Numbers R, The Real Spaces $R^k$, The Complex Numbers C

**Point-Set Topology:** Bounded Sets, Classification of Points, Open and Closed Sets, Nested Intervals and the Bolzano–Weierstrass Theorem, Compactness and Connectedness

**Limits and Convergence:** Definitions and First Properties, Convergence Results for Sequences, Topological Results for Sequences, Properties of Infinite Series, Manipulations of Series in R

**Functions; Definitions and Limits:** Definitions, Functions as Mappings, Some Elementary, Complex Functions, Limits of Functions

**Functions; Continuity and Convergence:** Continuity, Uniform Continuity, Sequences and Series of Functions

**The Derivative:** The Derivative for $f: D^1 \rightarrow R$, The Derivative for $f: D^k \rightarrow R$, The Derivative for $f: D^k \rightarrow R^p$, The Derivative for $f: D \rightarrow C$, The Inverse and Implicit Function Theorems

**Real Integration:** The Integral of $f[a, b] \rightarrow R$, Properties of the Riemann Integral

Further Development of Integration Theory, Vector-Valued and Line Integrals

**Complex Integration:** Introduction to Complex Integrals, Further Development of Complex Line Integrals, Cauchy's Integral Theorem and Its Consequences, Cauchy's Integral Formula, Further Properties of Complex Differentiable Functions

**Taylor Series, Laurent Series, and the Residue Calculus:** Power Series, Taylor Series, Analytic Functions, Laurent's Theorem for Complex Functions, Singularities, The Residue Calculus

**Complex Functions as Mappings:** The Extended Complex Plane, Lineal Fractional Transformations, Conformal Mappings

## Books Recommended:


01. DiBenedetto, E., Real Analysis, Springer, 2016
02. Pugh, C. C., Real Mathematical Analysis, Springer, 2015
03. M.A. Al-Gwaiz, S.A. Elsanousi, Elements of Real Analysis, CRC Press, 2006
04. Steven G. Krantz, Real Analysis and Foundations, Third Edition, CRC Press, 2013
05. Hugo D. Junghenn, A Course in Real Analysis, CRC Press, 2015
06. Knapp, A. W., Advanced Real Analysis, Springer, 2005
07. Richard L. Wheeden, Measure and Integral: An Introduction to Real Analysis, Second Edition, CRC Press, 2015


## FM-503 Numerical Analysis-I ( 3 + 0 )

**Fundamentals:** Floating Point Arithmetic, Overflow and Underflow Absolute, Relative Error, Machine Epsilon, Forward and Backward Error Analysis, Loss of Significance, Robustness, Error Testing and Order of Convergence, Computational Complexity Condition

**Linear Systems:** Simultaneous Linear Equations, Gaussian Elimination and Pivoting LU Factorization, Cholesky Factorization, QR Factorization , The Gram–Schmidt Algorithm Givens Rotations, Householder Reflections, Linear Least Squares, Singular Value Decomposition, Iterative Schemes and Splitting, Jacobi and Gauss–Seidel Iterations Relaxation, Steepest Descent Method, Conjugate Gradients, Krylov

Subspaces and Pre-Conditioning, Eigenvalues and Eigenvectors, The Power Method, Inverse Iteration, Deflation

**Interpolation and Approximation Theory:** Lagrange Form of Polynomial Interpolation, Newton Form of Polynomial Interpolation, Polynomial Best Approximations, Orthogonal polynomials, Least-Squares Polynomial Fitting, The Peano Kernel Theorem, Splines, B-Spline

**Non-Linear Systems:** Bisection, Regula Falsi, and Secant Method, Newton's Method, Broyden's Method, Householder Methods, Müller's Method, Inverse Quadratic Interpolation, Fixed Point Iteration Theory, Mixed Methods

**Numerical Integration:** Mid-Point and Trapezium Rule, The Peano Kernel Theorem, Simpson's Rule, Newton–Cotes Rules, Gaussian Quadrature, Composite Rules, Multi-Dimensional, Integration, Monte Carlo Methods,

**Ordinary Differential Equations:** One-Step Methods, Multistep Methods, Order, and Consistency, Order Conditions, Stiffness and A-Stability, Adams Methods, Backward Differentiation Formulae, The Milne and Zadunaisky Device, Rational Methods, Runge–Kutta Methods

**Numerical Differentiation**: Finite Differences, Differentiation of Incomplete or Inexact Data

## Books Recommended:


01. J. C. Butcher, Numerical Methods for Ordinary Differential Equations, Wiley (3rd edition), 2016
02. Gautschi, W., Numerical Analysis, Springer, 2012
03. Al-Baali, M. (Ed), Grandinetti, L. (Ed), Purnama, A., Numerical Analysis and Optimization, Springer, 2015
04. Azmy S. Ackleh, Edward James Allen, R. Baker Kearfott, PadmanabhanSeshaiyer, Classical and Modern Numerical Analysis: Theory, Methods and Practice, CRC Press, 2009
05. A.C. Faul, A Concise Introduction to Numerical Analysis, CRC Press, 2016
06. Nabil Nassif, Dolly Khuwayri Fayyad, Introduction to Numerical Analysis and Scientific Computing, CRC Press, 2013
07. Phillips, G. M., Interpolation and Approximation by Polynomials, Springer, 2003


## FM-505 Differential Equation-I ( 3 + 0 )

**Introduction:** Definitions and Terminology, A Taste of Ordinary Differential Equations**,** The Nature of Solutions

**The Initial Value Problem:** Direction Fields, Fundamental Theorems, Solution of Simple First-Order Differential Equations, Numerical Solution

**Applications of the Initial Value Problem:** Learning Theory Models, Population Models, Simple Epidemic Models, Falling Bodies, Mixture Problems, Curves of Pursuit, Chemical Reactions

**N-th Order Linear Differential Equations:** Basic Theory, Roots of Polynomials, Homogeneous Linear Equations with Constant Coefficients, Nonhomogeneous Linear Equations with Constant Coefficients, Initial Value Problems

**The Laplace Transform Method:** The Laplace Transform and Its Properties, Using the Laplace Transform and Its Inverse to Solve Initial Value Problems, Convolution and the Laplace Transform, The Unit Function and Time-Delay Functions, Impulse Functions

**Applications of Linear Differential Equations with Constant Coefficients**: Second-Order Differential Equations, Higher Order Differential Equations

**Linear Systems of First-Order Differential Equations**: Matrices and Vectors, Eigenvalues and Eigenvectors, Linear Systems with Constant Coefficients

**Applications of Linear Systems with Constant Coefficients**: Coupled Spring-Mass Systems, Pendulum Systems, The Path of an Electron

**Applications of Systems of Equations:** Richardson's Arms Race Model, Phase-Plane Portraits Modified Richardson's Arms Race Models, Lanchester's Combat Models, Models for Interacting Species, Epidemics, Pendulums, Duffing's Equation, Van der Pol's Equation, Mixture Problems, The Restricted Three-Body Problem

## Books Recommended:


01. William E. Boyce, Richard C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiley ($10^{th}$ edition International Student Version), 2013
02. Jane Cronin, Ordinary Differential Equations: Introduction and Qualitative Theory, Third Edition, CRC Press, 2007
03. Charles Roberts, Ordinary Differential Equations: Applications, Models, and Computing, Chapman and Hall/CRC, 2010
04. Stephen A. Wirkus, Randall J. Swift, A Course in Ordinary Differential Equations, Second Edition, Chapman and Hall/CRC, 2014
05. Ulrich, H., Weber, H., Laplace-, Fourier- und z-Transformation, Springer, 2017
06. Steven G. Krantz, Differential Equations: Theory, Technique and Practice, Second Edition, Chapman and Hall/CRC, 2014

07. Dyke, P., An Introduction to Laplace Transforms and Fourier Series, Springer, 2014

## FM-507 Linear Algebra with Applications ( 3 + 0 )

**Vector spaces and subspaces:** Vector Spaces, Subspaces, Null spaces, column spaces, Linear combination, Spanning, Linearly independent sets
**Basis and Dimensions:** basis, The dimension of a vector space, Rank and Nullity Change of basis
**Inner Product Spaces:** General inner products, weighted Euclidean inner product, Norm and Distance, angle between vectors
**Orthogonality:** orthogonal vectors, Orthonormal basis, Orthogonal projections, orthogonal matrices
**Eigenvectors and eigenvalues:** The characteristic equation, Eigenvectors and linear transformations
**Diagonalization:** Diagonalization of symmetric matrices, orthogonal diagonalization
**Linear transformations:** Matrix of a linear transformation, composition of two transformations, Linear models in business, science, and engineering, Kernel and Range, Rank and Nullity of Transformation, Inverse linear transformation
**Applications:** Differential equations, Cubic Spline Interpolation, Markove Chains, Games of Stratagy, Leontief Economic Model, Age-Specific population growth

**Books Recommended:**

01. David C. Lay, Steven R. Lay, and Judi J. McDonald, Linear Algebra and Its Applications, Pearson Education (5th Edition), 2014
02. Howard Anton and Chris Rorres, Elementary Linear Algebra: Applications Version, Wiley (11th edition), 2013
03. Lee W. Johnson, Riess, Ronald Dean Riess, Jimmy Thomas Arnold, Introduction to Linear Algebra, Pearson Education (6th Edition), 2015
04. Vectors, Pure and Applied: A General Introduction to Linear Algebra By T. W. Körner, Cambridge University Press, 2013
05. Elliott Ward Cheney, David Ronald Kincaid, Linear Algebra: Theory and Applications, Jones & Bartlett Publishers, 2009
06. Ward Cheney, David R. Kincaid, Linear Algebra: Theory and Applications, Jones & Bartlett Learning (2nd Edition), 2012

## FM-509 Cost and Management Accounting-I ( 3 + 0 )

**Basic Concept of Target Costing:** Characteristics of Strong Enterprises, Roots of Target Costing, Comprehensive Target Costing, Profit vs. Profit Margin, Cost

Management, Cost Visibility, Engineering Change Requests, Survival Triplet, Cultural Differences

**Getting Started on the Target Costing Journey:** Project initiation; the cost plan; cost control; cost reporting; productivity; problem solving for management.

**The Cost Planning/Cost Management Group:** The Cost Planning Group, Mission of Cost Planning Group

**The Development of Cost Tables:** Shift in Financial Thinking, Three Major Requirements for Cost Tables, Cost Table Sophistication, Material Cost Table Development, Direct Conversion Cost Tables, Product Development Cost Tables, Cost Tables by Process

**How to Set the Target Cost:** Subtraction Method, Addition Method, Setting Target Costs by Function, Contingency Cost Allocation, Special Situations, Exceeding the Target Cost, Allocation of the Target Cost, Advanced Applications of Target Costing Concepts

## Books Recommended:


01. Stefan Seuring, Maria Goldbach, Cost Management in Supply Chains, Physica-Verlag Heidelberg, 2002
02. Don R. Hansen, Maryanne M. Mowen, Liming Guan,Cost Management: Accounting and Control, South-Western, Cengage Learning ($6^{th}$ edition), 2006
03. ChihiroSuematsu, Transaction Cost Management, Springer International Publishing, 2014
04. Jim Rains, Target Cost Management: The Ladder to Global Survival and Success, CRC Press, 2010
05. Leslie G. Eldenburg, Susan Wolcott, Liang-Hsuan Chen, Gail Cook, Cost Management: Measuring, Monitoring, and Motivating Performance, Second Canadian Edition, Wiley, 2005,
06. Sara Trucco, Financial Accounting, Springer International Publishing, 2015,
07. Fredrik Nilsson, Anna-Karin Stockenstrand, Financial Accounting and Management Control, Springer International Publishing, 2015


# *Sixth Semester*

## FM-502 Actuarial Mathematics ( 3 + 0 )

**Introduction:** The economics of insurance, the future lifetime random variables (discrete and continuous), force of mortality, Life Tables: Select, Ultimate and Select

and Ultimate, Annuities and Assurance in both discrete and continuous case, Commutation Functions

**Function:** Straightforward functions, Estimation in straightforward function, Main variables, benefit, disability, long term care contract, Calculation of net premiums and reserves. Future expenses, Bonus influence of inflation. Equation of value for fixed benefits and variable benefits. Techniques of discounted emerging costs, pricing, reserving and assessing of profitability.

**Decision theory:** Fundamental concepts of Bayesian statistics and its use. Probabilities and moments of loss distributions, Construction of risk models. Concepts of credibility theory, rating systems, techniques for analyzing delay (or run off) triangle and projecting the ultimate position

**Survival distributions:** age at death, life tables, fractional ages, mortality laws, select and ultimate life tables. Life insurance: actuarial present value function (apv), moments of apv, basic life insurance contracts, portfolio. Life annuities: actuarial accumulation function, moments of apv, basic life annuities. Net annual premiums: actuarial equivalence principle, loss function, accumulation type benefits.

**Actuarial reserves:** Prospective loss function, basic contracts, recursive equations, fractional durations.

## Books Recommended:


01. Vladimir I. Rotar, Actuarial Models: The Mathematics of Insurance, Second Edition, Chapman and Hall/CRC,2014
02. Philip J. Boland, Statistical and Probabilistic Methods in Actuarial Science, Chapman and Hall/CRC, 2007
03. Arjun K. Gupta, Tamas Varga, An Introduction to Actuarial Mathematics, Springer Netherlands, 2002
04. Marco Micocci, Greg N. Gregoriou, Giovanni Batista Masala, Pension Fund Risk Management: Financial and Actuarial Modeling, Chapman and Hall/CRC, 2010
05. Mario V. Wüthrich, Michael Merz, Financial Modeling, Actuarial Valuation and Solvency in Insurance, Springer-Verlag Berlin Heidelberg, 2013
06. S. David Promislow, Fundamentals of Actuarial Mathematics, Wiley (3rd edition), 2014
07. Yiu-KuenTse, Nonlife Actuarial Models: Theory, Methods and Evaluation (International Series on Actuarial Science), Cambridge, 2009


## FM-504 Numerical Analysis-II ( 3 + 0 )

**Approximations:** Pade, Chebysheve and Legender approximations and properties.

**Partial Differential Equations:** Classification of PDEs, Parabolic PDEs, Elliptic PDEs, Parabolic PDEs in Two Dimensions, Hyperbolic PDEs, Spectral Methods, Finite Element Method

**Two-Point Boundary Value Problem:** The Maximum Principle, Green's Function, Variational Formulation,

**Elliptic Equations:** A Maximum Principle, Dirichlet's Problem for a Disc. Poisson's Integral, Fundamental Solutions. Green's Function, Variational Formulation of the Dirichlet Problem, A Neumann Problem, Regularity

**Finite Difference Methods for Elliptic Equations:** A Two-Point Boundary Value Problem, Poisson's Equation

**Finite Element Methods for Elliptic Equations:** A Two-Point Boundary Value Problem, Some Facts from Approximation Theory, Error Estimates, An A Posteriori Error Estimate, Numerical Integration, A Mixed Finite Element Method

**The Elliptic Eigenvalue Problem:** Eigenfunction Expansions, Numerical Solution of the Eigenvalue Problem

**Parabolic Equations:** The Pure Initial Value Problem, Solution by Eigenfunction Expansion, Variational Formulation. Energy Estimates, A Maximum Principle

**Finite Difference Methods for Parabolic Problems:** The Pure Initial Value Problem, The Mixed Initial-Boundary Value Problem

**The Finite Element Method for a Parabolic Problem:** The Semi discrete Galerkin Finite Element Method, Some Completely Discrete Schemes

**Hyperbolic Equations:** Characteristic Directions and Surfaces, The Wave Equation, First Order Scalar Equations, Symmetric Hyperbolic Systems

**Finite Difference Methods for Hyperbolic Equations:** First Order Scalar Equations, Symmetric Hyperbolic Systems, The Wendroff Box Scheme

**The Finite Element Method for Hyperbolic Equations:** The Wave Equation, First Order Hyperbolic Equations

## Books Recommended:


01. J. Douglas Faires, Richard L. Burden, Numerical Methods, Cengage Learning ($4^{th}$ edition), 2013
02. Santanu Saha Ray, Numerical Analysis with Algorithms and Programming, CRC Press, 2016
03. Nabil Nassif, Dolly Khuwayri Fayyad, Introduction to Numerical Analysis and Scientific Computing, CRC Press, 2013
04. Vitoriano Ruas, Numerical Methods for Partial Differential Equations: An Introduction, Wiley, 2016

05. Li, Z. (Ed), Vulkov, L. (Ed), Wásniewski, J. (Ed), Numerical Analysis and Its Applications, Springer, 2005
06. Ronghua Li, Zhongying Chen, Wei Wu, Generalized Difference Methods for Differential Equations: Numerical Analysis of Finite Volume Methods, CRC Press, 2000
07. S. Rout-Hoolash, Choi-Hong Lai, Computing Financial Derivatives: A Finite-Difference Approach, CRC Press, 2017
08. Dimov, I. (Ed), Faragó, I. (Ed), Vulkov, L. (Ed), Finite Difference Methods, Theory and Applications, Springer, 2015

## FM-506 Differential Equations-II ( 3 + 0 )

**Sturm-Liouville Theory:** The Sturm-Liouville Problem, Mixed Boundary Conditions, Examples of Sturm-Liouville Problems

**One-Dimensional Hyperbolic Equations:** Derivation of the Basic Equations, Boundary and Initial Conditions, Other Boundary Value Problems: Longitudinal Vibrations of a Thin Rod, Torsional Oscillations of an Elastic Cylinder, Acoustic Waves, Waves in a Shallow Channel, Electrical Oscillations in a Circuit, Traveling Waves: D'Alembert Method, Semi-infinite String Oscillations and the Use of Symmetry Properties, Finite Intervals: The Fourier Method for One-Dimensional Wave Equations, Generalized Fourier Solutions, Energy of the String

**Two-Dimensional Hyperbolic Equations:** Derivation of the Equations of Motion, Oscillations of a Rectangular Membrane, The Fourier Method Applied to Small Transverse Oscillations of a Circular Membrane

**One-Dimensional Parabolic Equations:** Physical Problems Described by Parabolic Equations, Boundary Value Problems, The Principle of the Maximum, Correctness, and the Generalized Solution, The Fourier Method of Separation of Variables for the Heat, Conduction Equation, Heat Conduction in an Infinite Bar, Heat Equation for a Semi-infinite Bar

**Parabolic Equations for Higher-Dimensional Problems:** Heat Conduction in More than One Dimension, Heat Conduction within a Finite Rectangular Domain, Heat Conduction within a Circular Domain

**Elliptic Equations:** Elliptic Partial Differential Equations, The Dirichlet Boundary Value Problem for Laplace's Equation in a Rectangular Domain, Laplace's and Poisson's Equations for Two-Dimensional Domains with Circular Symmetry, Laplace's Equation in Cylindrical Coordinates

**Bessel Functions:** Boundary Value Problems Leading to Bessel Functions, Bessel Functions of the First Kind, Properties of Bessel Functions of the First Kind, Bessel Functions of the Second Kind, Bessel Functions of the Third Kind, Modified Bessel

Functions, The Effect of Boundaries on Bessel Functions, Orthogonality and Normalization of Bessel Functions, The Fourier-Bessel Series, Spherical Bessel Functions, The Gamma Function

**Legendre Functions:** Boundary Value Problems Leading to Legendre Polynomials, Generating Function for Legendre Polynomials, Recurrence Relations, Orthogonality of Legendre Polynomials, The Multipole Expansion in Electrostatics, Associated Legendre Functions, Orthogonality and the Norm of Associated Legendre Functions, Fourier-Legendre Series in Legendre Polynomials, Fourier-Legendre Series in Associated Legendre Functions, Laplace's Equation in Spherical Coordinates and Spherical Functions

## Books Recommended:


01. Vladimir A. Dobrushkin, Applied Differential Equations: The Primary Course, Chapman and Hall/CRC, 2014
02. Jüngel, A. (Ed), Manasevich, R. (Ed), Markowich, P. A. (Ed), Shahgholian, H. (Ed), Nonlinear Differential Equation Models, Springer-Verlag Wien, 2004
03. John Srdjan Petrovic, Advanced Calculus: Theory and Practice, Chapman and Hall/CRC, 2013
04. Dyke, P., *An Introduction to Laplace Transforms and Fourier Series*, Springer, 2014
05. M.W. Wong, *Partial Differential Equations: Topics in Fourier Analysis*, CRC Press, 2013
06. Abdelmoujib Benkirane, A. Touzani, *Partial Differential Equations*, CRC Press, 2002


## FM-508 Discrete Mathematics ( 3 + 0 )

**Logic:** Propositions and Truth Values, Logical Connectives and Truth Tables, Tautologies and Contradictions, Logical Equivalence and Logical Implication, The Algebra of Propositions, Arguments, Formal Proof of the Validity of Arguments, Predicate Logic, Arguments in Predicate Logic

**Mathematical Proof:** The Nature of Proof, Axioms and Axiom Systems, Methods of Proof, Mathematical Induction

**Sets:** Sets and Membership, Subsets, Operations on Sets, Counting Techniques, The Algebra of Sets, Families of Sets, The Cartesian Product, Types and Typed Set Theory

**Relations:** Relations and Their Representations, Properties of Relations, Intersections and Unions of Relations, Equivalence Relations and Partitions, Order Relations, Hasse Diagrams, Relational Databases

**Functions**: Functions, Composite Functions, Injections and Surjections, Bijections and Inverse Functions, More on Cardinality, Functional Dependence and Normal Forms

**Algebraic Structures:** Binary Operations and Their Properties, Algebraic Structures, Groups, Some Families of Groups, Substructures, Morphisms, Group Codes

**Introduction to Number Theory**: Divisibility, Prime Numbers, Linear Congruences, Groups in Modular Arithmetic, Public Key Cryptography

**Boolean Algebra:** Introduction, Properties of Boolean Algebras, Boolean Functions, Switching Circuits, Logic Networks, Minimization of Boolean Expressions

**Graph Theory**: Definitions and Examples, Paths and Cycles, Isomorphism of Graphs, Trees, Planar Graphs, Directed Graphs

**Applications of Graph Theory:** Introduction, Rooted Trees, Sorting, Searching Strategies, Weighted Graphs, The Shortest Path and Traveling Salesman Problems, Networks and Flows

**Fuzzy Relations:** Introduction, operation on fuzzy relations, α-cuts of a fuzzy relation, composition of fuzzy relations, projections of fuzzy relations, cylindrical extensions, fuzzy relation on a domain

**Books Recommended:**


01. Discrete Mathematics: Proofs, Structures and Applications, Rowan Garnier, John Taylor, CRC Press (3rd edition), 2009
02. Handbook of Discrete and Combinatorial MathematicsKenneth H. Rosen, September 28, 1999 by Chapman and Hall/CRC
03. Willem Conradie, Valentin Goranko, Logic and Discrete Mathematics: A Concise Introduction, Wiley, 2015
04. Gallier, J., Discrete Mathematics, Springer, 2011
05. Govindarajan, S. (Ed), Maheshwari, A., Algorithms and Discrete Applied Mathematics, Springer, 2016
06. Rowan Garnier, John Taylor, Discrete Mathematics: Proofs, Structures and Applications, Third Edition, CRC Press, 2009
07. Darel W. Hardy, Fred Richman, Carol L. Walker, Applied Algebra: Codes, Ciphers and Discrete Algorithms, Second Edition, CRC Press, 2009
08. Marty Lewinter, Jeanine Meyer, Elementary Number Theory with Programming, Wiley, 2015
09. Rahman, M. S., Basic Graph Theory, Springer, 2016


## FM-510 Cost and Management Accounting-II ( 3 + 0 )

**Concept and Scope of Cost Accounting**: Definition and concept of cost. Cost object, Cost elements. Definition, concept and scope of cost accounting. Objectives of cost

accounting, Cost Accounting Vs Financial Accounting, Use of cost data, Chart of accounts and coding for costing

**Cost Classification and Flow**: Product and period cost, direct and indirect cost, Differential cost and revenue, Opportunity and Sunk cost, fixed and variable cost, mixed cost, statement of cost of goods manufactured and sold statement

**Material Costing, Planning and Control:** Procedure for material procurement and use, Material costing methods, Costing Procedure for spoiled, scrap and defective work, Planning materials requirement (EOQ, Inventory levels and reserve stocks), Materials control (Principles and Methods)

**Labor Costing, Control and Accounting:** Productivity and efficiency of labor, Remuneration Methods (Straight piece rate, differential piece rate, Incentive wage plans), Learning curve theory, Organization for labor cost accounting and control, Accounting for labor related costs (Overtime, Bonus payments, vacation pay, guaranteed annual wage plans, apprenticeship and training programs, pension, Labor related deductions

**Factory Overhead Costing and Control:** Nature of factory overhead, Procedure of factory overheads including allocation, apportionment, reapportionment and absorption, Repeated distribution and algebraic method for reciprocal, service department costs, Calculation and use of Predetermined factory overhead rate, Applied and actual FOH, under /overapplied FOH

**Types of Costing Systems:** Establishment of Cost Accounting system, Principles of double entry system of costing, integrated and interlocking cost accounts, Job costing and batch costing, Process Costing – Cost of Production Report, Process Costing – Average and FIFO method, Joint product and by-product, Service Costing

**Books Recommended:**


01. Stefan Seuring, Maria Goldbach, Cost Management in Supply Chains, Physica-Verlag Heidelberg, 2002
02. Don R. Hansen, Maryanne M. Mowen, Liming Guan, Cost Management: Accounting and Control, 6th Edition, South-Western, Cengage Learning, 2006
03. Chihiro Suematsu, Transaction Cost Management, Springer International Publishing, 2014
04. Jim Rains, Target Cost Management: The Ladder to Global Survival and Success, CRC Press, 2010
05. Leslie G. Eldenburg, Susan Wolcott, Liang-Hsuan Chen, Gail Cook, Cost Management: Measuring, Monitoring, and Motivating Performance, Second Canadian Edition, Wiley, 2005,

06. Sara Trucco, Financial Accounting, Springer International Publishing, 2015,
07. Fredrik Nilsson, Anna-Karin Stockenstrand, Financial Accounting and Management Control, Springer International Publishing, 2015

# B.S-IV Financial Mathematics

| SEMESTER VII | | | SEMESTER VIII | | |
|---|---|---|---|---|---|
| **FM-601** | **Operation Research** | **2+1** | **FM-602** | **Analysis of Financial Report Writing** | **2+1** |
| **FM-603** | **Financial Derivatives** | **3+0** | **FM-604** | **Portfolio theory and Management** | **3+0** |
| **FM-605** | **Stochastic Processes** | **3+0** | **FM-606** | **Stochastic Calculus** | **3+0** |
| | **Optional-I** | | | **Optional-I** | |
| | **Optional-II** | | | **Optional-II** | |

## Optional Courses for 7th & 8th Semesters

| | Course No. | Optional Course Title | Credit Hours |
|---|---|---|---|
| **1** | **FM-607** | **Corporate Finance** | **3+0** |
| **2** | **FM-608** | **Games, Markets and Information** | **3+0** |
| **3** | **FM-609** | **Management Information System** | **3+0** |
| **4** | **FM-610** | **Modelling and Simulation** | **3+0** |
| **5** | **FM-611** | **Discrete time Modelling and Derivative Security** | **3+0** |
| **6** | **FM-612** | **Life Insurance and Institutional Investment** | **3+0** |
| **7** | **FM-613** | **Principles of Risk** | **3+0** |
| **8** | **FM-614** | **Global Financial Market** | **3+0** |
| **9** | **FM-615** | **Equities Foreign Exchange and Commodities Modelling** | **3+0** |
| **10** | **FM-616** | **Interest rate and Credit Modelling** | **3+0** |
| **11** | **FM-617** | **Financial Computer Simulation- I** | **2+1** |
| **12** | **FM-618** | **Financial Computer Simulation- II** | **2+1** |
| **13** | **FM-619** | **Analysis of Financial Time Series** | **3+0** |

***Optional Courses will be offered on the availability of course in charge or permission of Chairperson. There is no restriction of even/odd course numbers in any semester except 617 and 618.**

# *Seventh Semester*

## FM-601 Operations Research ( 3 + 0 )

**Introduction:** Characteristic of Operations Research(OR), Scope of OR, Objective of OR, Models in OR, Two-phase simplex method

**Transportation Problems:** Definition of transportation model, North-west corner method, Least cost or matrix minima method, Vogel's approximation method, Degenerancy in transportations problem, test for optimality

**Assignment Problem:** Introduction, Theorem 1, Theorem 2, Hungarian method, Non-square matrix, Restriction on assignments

**Goal Programming:** Goal Programming (Pre-emptive, Non pre-emptive), Integer Programming, Binary Integer Programming (BIP) Applications

**Sequencing Models:** Introduction, Basic assumptions, Travelling salesman problem

**Decision Analysis:** Decision making environments, Decision making under conditions of uncertainty, Maximin criterion, Minimax criterion, Maximax criterion, Minimin criterion

**Game Theory:** Definition and explanation of some important terms, Two person zero-sum game, Games without saddle points

**Inventory Management:** Definition, Inventory classification, Objective of inventory control, Deterministic inventory models, Probabilistic models

**Pert and CPM:** Introduction, Definition, Rules for network construction, Fulkerson's rule for numbering the events, Float or slack values, PERT computations, Probability of meeting the scheduled dates, Time-cost relationships and project crashing, Updating (PERT and CPM)

## Books Recommended:


01. A. Emrouznejad, W. Ho, Applied Operational Research with SAS, Chapman & Hall/CRC, 2011
02. A.R. Ravindran, Operations Research Applications, CRC Press, 2008
03. J.H. Greenberg, Tutorials on Emerging Methodologies and Applications in Operations Research, Springer, 2005
04. E. Grigoroudis, M. Doumpos, Operational Research in Business and Economics, Springer, 2017
05. G.S.R. Murthy, Applications of Operations Research and Management Science, Springer, 2015
06. S. Nickel, O. Stein, K. Waldmann, Operations Research, Springer, 2014

## FM-603 Financial Derivatives ( 3 + 0 )

Fundamental derivatives concept, Analysis of derivative securities, Pricing of options and futures contracts, Arbitrage, Hedging, Spreads, Portfolio insurance, Derivatives for financial risk management, Applications of futures and forwards, Volatility, Volatility products, Interest rate derivatives, Mortgages, Credit risk, Blockchain and Bitcoins, Principles of Swaps, Structural models of Credit Risk, Market operations on stock index, Foreign Currencies

### Books Recommended:

01. Don M. Chance, R. Brooks, An Introduction to Derivatives and Risk Management, Southwestern Cengage Learning (10th edition), 2014
02. J.C. Hull, Options, Futures, and Derivative Securities, Prentice Hall (9th edition), 2014
03. Sundaram & Das, Derivatives Principles and Practice, McGraw-Hill Irwin (2nd edition), 2015
04. R. McDonald, Derivative Markets, Addison Wesley (2nd edition), 2006
05. R. Whaley, Derivatives: Markets, Valuation, and Risk Management, John Wiley(1stedition), 2006
06. C. Ekstrand, Financial Derivatives Modeling, Springer, 2011
07. B. Schmid, Credit Risk Pricing Models, Springer, 2004
08. D. Sornette, S. Ivliev, H. Woodard, Market Risk and Financial Markets Modeling, Springer, 2012

## FM-605 Stochastic Calculus ( 3 + 0 )

**Introduction:** Brownian motion, Stochastic Integration, ltô's formulas, Recurrence and transience, Lévy's Theorem, Burkholder Davis Gundy Inequalities, Martingales Adapted to Brownian Filtrations

**Applications:** Stochastic differential equations, Applications to Brownian Motion, Feller's Test, Greens function, Harris Chains, Girsanov's Theorem, Radon-Nikodym derivative, Prokhorov's Theorem, Skorohod's Existence theorem for Stochastic differential equation, Donsker's Theorem, Feynman-Kac formula, Diffusion equations, Black-Scholes models, Option pricing, Interest rate models

### Books Recommended:

01. J.M. Steele, Stochastic Calculus and Financial Applications, Springer, 2003
02. D. Lamberton, B. Lapeyre, Introduction to Stochastic Calculus Applied to Finance, Chapman and Hall/CRC Financial Mathematics Series, 2007
03. R. Durret, Stochastic Calculus: A Practical Introduction
04. B. Oksendal, Stochastic Differential Equations, 6th Ed. Universitext, Springer-Verlag, Berlin, 2003
05. J. Le Gall, Brownian Motion, Martingales, and Stochastic Calculus, Springer, 2016
06. S. Cohen, R.J. Elliott, Stochastic Calculus and Applications, Springer, 2015
07. M. Grigoriu, Stochastic Calculus, Springer, 2002

# ***Eighth Semester***

## FM-602 Analysis of Financial Report Writing (3+0)

**Introduction:** Introduction to financial reporting, Development of generally accepted accounting principles (GAAP) in the United States, Harmonization of international accounting standards, Financial reporting standards for small and medium-sized Entities

**Introduction to Financial Statements and other Financial Reporting Topics:** Forms of business entities, The financial statements, The accounting cycle, Auditor's opinion, Management responsibility for financial statements, Summary annual report, The efficient market hypothesis, Ethics, Consolidated statements, Accounting for Business combinations, Role of financial statement analysis in an effective capital market,

**Income Statement:** Basic elements of the income statement, special income statement items, income taxes related to operations, International consolidated income statement, Preparing the statement of cash flow

**Basic of Analysis:** Ratio analysis, Common-size analysis (vertical and Horizontal), Year-to-year change analysis, Financial statement variation by type of industry

**Risk Analysis:** Disclosures regarding risk and risk management, Analysing financial flexibility by Disaggregating ROCE, Analysing short-term liquidity risk, Analysing long-term solvency risk, Analysing credit risk, Analysing bankruptcy risk, Measuring systematic risk

**Expended Analysis:** Financial Ratios as perceived by commercial loan departments, Financial Ratios as perceived by corporate controls, Financial Ratios as perceived by certified public accountants, Financial Ratios as perceived by chartered financial analyst, Financial ratios used in annual reports, Forecasting financial failure, Analytical review procedures, Graphing financial information

## Books Recommended:


01. Charles Gibson, Financial Reporting and Analysis: Using Financial Accounting Information, Cengage Learning (13th edition), 2013
02. John Wild, K. R. Subramanyam, Financial Statement Analysis, McGraw-Hill Education (11th edition), 2013
03. Michael J. Sandretto, Cases in Financial Reporting, Cengage Learning, 2012
04. Fred Mittelstaedt, Lawrence Revsine, Bruce Johnson, Leonard Soffer, Daniel Collins, Financial Reporting and Analysis, McGraw-Hill Education (7th edition), 2017
05. David Young, Jacob Cohen, Corporate Financial Reporting and Analysis, John Wiley & Sons (3rd edition), 2013


## FM-604 Portfolio theory and Management ( 3 + 0 )

Portfolio mathematics, Risk and Return, Utility theory, Optimal portfolio selection and allocation, Markowitz mean-variance portfolio analysis, Models of risk and Expected returns, Capital asset pricing model, Arbitrage pricing theory, Market efficiency, Global portfolio diversification, Applied portfolio strategies and performance evaluation, The Black-Litterman model, Portfolio decision quality, Multicriteria methods in Portfolio decision analysis

## Books Recommended:


01. P. Xidonas, G. Mavrotas, T. Krintas, J. Psarras, C. Zopounidis, Multicriteria Portfolio Management, 2012
02. W. Marty, Portfolio Analytics, Springer, 2015
03. H. Hult, F. Lindskog, O. Hammarlid, C.J. Rehn, Risk and Portfolio Analysis, Springer, 2012
04. A. Salo, J. Keisler, A. Morton, Portfolio Decision Analysis, Springer, 2011
05. O. Yu, Technology Portfolio Planning and Management, Springer Us, 2006

06. N. Amenc, V. Le Sourd, Portfolio Theory and Performance Analysis, Wiley Finance, 2003
07. G. West, An Introduction to Modern Portfolio Theory, Financial Modelling Agency, 2004

## FM-604 Stochastic Processes ( 3 + 0 )

Fundamentals of probability, Laplace transform, Stochastic process, Poisson process with different types of events, Compound and nonhomogeneous Poisson process, Renewal reward process, Renewal equation, Regenerative process, Queuing systems and PASTA, Discrete and continuous time Markov chains, Multi-step transition and reaching probabilities, Stationary distribution, Exponential Queuing systems, Standard Brownian motion, Single stock market model

## Books Recommended:

01. M. Liao, Applied Stochastic Processes, Chapman and Hall/CRC Press, 2013
02. G.F. Lawler, Introduction to Stochastic Processes, Chapman and Hall/CRC Probability Series(2nd edition), 2006
03. S.M. Ross, Introduction to Probability Models, Academic Press(11th edition), 2014
04. A. Papoulis & S.U. Pillai, Probability, Random Variables and Stochastic Processes, McGraw-Hill (4thedition), 2002
05. U. Hassler, Stochastic Process and Calculus, Springer, 2016
06. I.I. Gikhman, A.V. Skorokhod, The Theory of Stochastic Process III, 2007

# *Optional Courses*

## FM-607 Corporate Finance ( 3 + 0 )

Goals of Financial Management, Conflicts between Company Stakeholders, Financial Markets, FV/PV of Cash Flows and Cash Flow Streams, Compounding/Discounting, Multiple Compounding and Discounting, Different compounding periods, Amortized Loans, Terminology and characteristics of bonds, Bond valuation, Bond yields, Terminology and characteristics of stocks, Stock valuation models, Growth opportunities & PVGO model, Expected Rate of Return, Standard Deviation of Returns, Relationship between Risk and Return, Measuring Portfolio Risk, Diversification, The Capital Asset Pricing Model (CAPM), Cost of Debt, Cost of Equity, Weighted Average Cost of Capital, Capital budgeting decision rules, NPV versus IRR, Independent and Mutually exclusive

Projects, Cash Flow Estimation, Identifying Relevant Cash Flows, Evaluating Capital Budgeting Projects, Sensitivity Analysis, Scenario Analysis, Real Options, Decision Trees, Financial Leverage and Firm Value, Financial Distress Costs, Estimating the Optimal Capital Structure, Capital Structure Theory

## Books Recommended:


01. J. Berk, P. DeMarzo, *Corporate Finance*, 2nd Edition, Pearson, Boston, 2010
02. Ross, Westfield, Jordon, *Fundamentals of Corporate Finance*, 9th Edition, The McGraw-Hill Companies, 2009
03. Brealey, Myers, Allen, *Principles of Corporate Finance*, 9th Edition, The McGraw-Hill Companies, 2007
04. Brigham, Ehrhardt, *Financial Management: Theory and Practice*,10th Edition, Cengage Learning, 2002
05. Horne, Wachowicz, *Fundamentals of Financial Management*, 12th Edition, Pearson Education, 2005


## FM-608 Games, Markets and Information ( 3 + 0 )

Combinatorial Optimisation: The Shortest Path Problem, The Minimal Spanning Tree Problem, Flows in Networks, Scheduling Theory, Computational Complexity, Theory of Games: Matrix Games – Pure Strategies, Matrix Games – Mixed Strategies, Bimatrix Games, N-person Games, Multi-criteria Decision Theory

## Books Recommended:


01. M. Gairing, R. Savani, *Algorithm Game Theory*, Springer, 2016
02. F.M. Garcia, D.T. Gonzalez, *Strategy and Game Theory*, Springer, 2016
03. T. Ichiishi, T. Marschak, *Markets, Games, and Organization*, Springer, 2003
04. A. El Rhalibi, F. Tian, Z. Pan, B. Liu, *E-Learnings and Games*, Springer, 2016
05. H. Peters, *Game Theory*, Springer, 2015


## FM-609 Management Information System ( 3 + 0 )

Foundations of Information Systems in Business, Competing with Information Technology, The Internetworked E-Business Enterprise, Electronic Business Systems, Electronic Commerce Systems, E-Business Decision Support, Developing E-Business Strategies, Developing E-Business Solutions, Security and Ethical Challenges of E-

Business, Enterprise and Global Management of E-Business Technology, Computer Hardware, Computer Software, Data Resources Management, Telecommunications and Networks

## Books Recommended:


01. J.A. O'Brien, *Management Information Systems: Managing Information Technology in the E-Business Enterprise*, 5th Edition, McGraw-Hill/Irwin, 2002
02. J. N. Morgan, *Application Cases in MIS: Using the Internet and Spreadsheet and Database Software*, 4th Edition, McGraw-Hill/Irwin, 2002
03. K.C. Laudon, J.P. Laudon, *Management Information Systems: Managing the Digital Firm*, 10th Edition, Pearson/Prentice-Hall, New Jersey, 2007
04. C.K. Laudon, J.P. Laudon, *Essentials of Management Information Systems*, 10th Edition, Pearson Prentice-Hall, 2012
05. T. Lucey, *Management Information Systems*, 9th Edition, Thompson, 2005
06. S. McNurlin, Bui, *Information Systems Management in Practice*, 8th Edition, Prentice Hall, 2013
07. O.Z. Effy, *Management Information Systems*, 6th Edition, Thomson, 2008


## FM-610 Financial Modelling and Simulation ( 3 + 0 )

Difference equations, Stationary Time Series: Autoregressive moving average (ARMA) process, Nonstationary Processes: ARIMA Model Building and Testing: Estimation, Box Jenkins, Criteria for choosing between models, Diagnostic tests. Forecasting: Box-Jenkins, Prediction bounds. Testing for Trends and Unit Roots: Dickey-Fuller, ADF, Structural change, Trend-stationarity vs difference stationarity, Seasonality and Volatility: ARCH, GARCH, ML estimation, Multiequation Time Series Models: Spectral Analysis, Generation of pseudo – random numbers, simulation methods: Generation of Uniform Random Numbers, Generation of Gaussian White Noise, Simulation Using a State-Space Model, inverse transform and acceptance-rejection, design issues and sensitivity analysis

## Books Recommended:


01. G. Kitagawa, *Introduction to Time Series Modelling*, Chapman & Hall/CRC, 2010
02. R. Prado, M. West, *Time Series: Modelling, Computation and Inference*, Chapman & Hall/CRC, 2010
03. G.B. Louis, A. Gilbert, *Modelling and Simulation*, Springer-Verlag London, 2013

04. K. Koyamada, S. Tamura, O. Ono, *Systems Modelling and Simulation*, Springer Japan, 2007
05. W. Andrzej, L. Henrik, *Modelling Foundations and Applications*, Springer International Publishing, 2016
06. I.C. Dima, M. Man, *Modelling and Simulation in Management*, Springer, 2015
07. L. Bernard, U. Nyambuu, *Dynamic Modeling, Empirical Macroeconomics, and Finance*, Springer, 2016

## FM-611 Discrete time Modelling and Derivative Security ( 3 + 0 )

Building Blocks, Ito's Lemma, Stochastic Differential Equations, The Factor Model Approach to Arbitrage Pricing, Constructing A Factor Pricing Framework, Equity Derivatives, Derivatives securities, Interest and Credit Derivatives, Hedging, Fair Pricing, The Road to Risk Neutrality, Stock price Evolution, European Puts and Calls, Cox-Ross-Rubinstein model, American call and Put options, Stochastic interest rates, Transaction Costs

### Books Recommended:

01. D. Furihata, T. Matsuo, *Discrete Variational Derivative Method: A Structure-Preserving Numerical Method for Partial Differential Equations*, Chapman and Hall/CRC, 2010
02. K. Back, *A Course in Derivative Securities*, Springer US, 2005
03. C. Chiarella, X.Z. He, C.S. Nikitopoulos, *Derivative Security Pricing*, Springer US, 2015
04. J.A. Primbs, *A factor Model Approach to Derivative Pricing*, Chapman & Hall/CRC, 2016
05. S.R. Pliska, *Introduction to Mathematical Finance*, Blackwell, 2001
06. R. Stewart, R. Brooks, K. Kotiaids, D.J. Van Der Zee, *Conceptual Modelling for Discrete-Event Simulation*, CRC Press, 2010

## FM-612 Life Insurance and Institutional Investment ( 3 + 0 )

Introduction to Insurance, Introduction to pension savings, Calculation of pensions, Life Insurance, Legal Principles of Life Insurance, Life Insurance Products, Types of Insurance, Applications of Life Insurance, Pricing and Valuation in Life Insurance, Provident Funds and education Funds, Pension-new funds, older funds, LTC, Distribution Channels ( the Bachelor reform-insurance agents and pension advisers, Property and Liability Loss Exposures, Introduction to Capital market, Capital Market

and financial institution-investment principles, The stock market crisis, Market reforms Bachar Reform, Hodak Committee

## Books Recommended:


01. F.J. Fabozzi, *Institutional Investment Management: Equity and Bond Portfolio strategies and Applications*, Wiley, 2009
02. J. Laurent, R. Norberg, F. Planchet, *Modelling in Life Insurance- A Management Perspective*, Springer, 2016
03. M. Koller, *Life Insurance Risk Management Essentials*, Springer, 2011
04. P. Parodi, *Pricing in General Insurance*, Chapman & Hall/CRC, 2014
05. I. Basile, P. Ferrari, *Asset Management and Institutional Investors*, Springer, 2016
06. C. d'Aspremont, V.A. Ginsburgh, H.R. Sneessens, F. Spinnewyn, *Institutional and Financial Incentives for Social Insurance*, Springer, 2002


## FM-613 Principles of Risk ( 3 + 0 )

Concepts of Risk: Subjective and objective risks, Static and dynamic risks, Pure and speculative risks, Fundamental and particular risk, Operational and strategic risk, Economic and social cost of risk, Economic Theory of Risk: Expected Utility Hypothesis, Risk preferences, Risk premium, Measurement of risk attitudes, Risk aversion coefficient, Risk Measurement: Loss frequency and severity, Expected value and variance, Degree of risk, Loss distributions, Stochastic dominance, Value at risk, Corporate Risks & Rationale of Corporate Risk Management: Overview of key pure risks, Overview of key financial risks, Rationales of corporate risk management, Holistic/integrated risk management, Risk Management Organization and Process: Objectives of risk management and risk management policy statement, Risk manager and responsibility, Risk management decisions, Ethical aspects of risk management decisions, Identification and evaluation of risks, Risk Mapping, Choosing risk management methods, Implementation, monitoring & review of the chosen methods, Major Tools of Risk Management: Risk avoidance, Risk reduction & loss control, Risk retention & self-insurance, Risk transfer via insurance, Concept of financial risks hedging, Alternative risk transfer.

## Books Recommended:


01. E.R. George, *Principles of Risk Management and Insurance*, latest edition, Person Education.

02. S.E. Harrington, G.R. Niehaus, *Risk Management and Insurance*, 2nd Edition, McGraw-Hill, 2003
03. E. Baranoff, *Risk Management and Insurance*, John Wiley, 2004
04. J.S. Trieschmann, R.E. Hoyt, D. Sommer, *Risk Management and Insurance*, 12th Edition, South-Western College Publishing, 2005
05. A. Gupta, *Risk Management and Simulation*, CRC Press, 2013
06. S. Roeser, R. Hillerbrand, P. Sandin, M. Peterson, *Essentials of Risk Theory*, Springer, 2013
07. V. Huynh, V. Kreinovich, S. Sriboonchitta, K. Suriya, *Econometrics of Risk*, Springer, 2015

## FM-614 Global Financial Market ( 3 + 0 )

Introduction Financial Market, Asset pricing, Security, Investment companies and investment process, Performance of securities, Asset Backed securities, Risk and return, Diversification, Index models and the capital Asset pricing model (CAPM), Market Indexes, Fama-French Factors, Arbitrage pricing theory, Portfolio Evaluation, Alpha, Market efficiency, Behavioural Finance, Bubbles and Market crashes, Equity valuation, Dividend discount models, Price earnings ratios, Equity trading, margins, Short Sales, Bond prices and Yields, Bond Portfolios, Default risk, Credit default swaps, The credit crisis, Dimensional Fund Advisors, Money Management Industry, Derivatives markets, Option pricing, Bonds with embedded options, Black-Scholes formula, Future basics, Future pricing and commodities, Hegde Funds and crashes, Macroeconomics analysis

## Books Recommended:

01. Bodie, Zvi, A. Kane, A. Marcus, *Investments*, McGraw-Hill, 7th Edition
02. Malkiel, Burton, *A Random Walk Down Wall Street*, Norton, 8th Edition, 2004
03. Siegel, Jeremy, *Stocks for the Long Run*, McGraw-Hill, 3rd Edition, 2002
04. G. Bekaert, R.J. Hodrick, *International Financial Management*, Prentice Hall, 2008
05. S. Nayak, *The Global Financial Crisis*, Springer, 2013
06. G. Chakrabarti, C. Sen, *Anatomy of Global Stock Market Crashes*, Springer, 2012
07. T.A. Cook, *Managing Growth and Expansion into Global Markets: Logistics, Transportation, and Distribution*, CRC Press, 2015

## FM-615 Equities Foreign Exchange and Commodities Modelling ( 3 + 0 )

Arbitrage-free pricing theory and equity markets: Replication strategies, risk-neutral Pricing, Brownian motion, Ito calculus, First and Second Fundamental Theorems of Asset Pricing, examples from equity markets, Foreign Exchange Markets: Modelling of FX markets, foreign and domestic risk-neutral measures, forward measures, triangular arbitrage and the carry trade, Commodity Markets: Modelling of electricity, gas and metal prices, jump diffusion processes, pricing of energy derivatives

### Books Recommended:


01. S. Shreve, *Stochastic Calculus for Finance II: Continuous Time Models*, Springer Finance, 2004.
02. A. Eydeland, K. Wolyniec, *Energy and Power Risk Management: New Development in Modelling, Pricing and Hedging*, Wiley, 2000.
03. F.J. Fabozzi, *Institutional Investment Management: Equity and Bond Portfolio strategies and Applications*, Wiley, 2009
04. C. Ullrich, *Forecasting and Hedging in the Foreign Exchange Markets*, Springer, 2009
05. Z. Vukanovic, *Foreign Direct Investment Inflows into the South East European Media Market*, Springer, 2016
06. R. Francionic, R.A. Schwartz, *Equity Markets in Transition,* Springer, 2017
07. U. Lossen, *Portfolio Strategies of Private Equity Firms*, Springer, 2007


## FM-616 Interest rate and Credit Modelling ( 3 + 0 )

Basics of interest rates and bond markets, Vasicek and Cox-Ingersoll-Ross bond price models, Black-Derman-Toy binomial model, Short-rate models, Heath-Jarrow-Morton models, Rational valuation of derivative securities, Structural models of default: Black-Scholes-Merton model, First-passage models of default, Hazard function approach: hazard function and hazard rate, bond pricing with recovery at maturity or at the default-time, Pricing of simple default able claims

### Books Recommended:


01. D. Filipovic, *Term-Structure Models: A graduate Course*, Springer, 2009
02. L. Wu, *Interest Rate Modelling: Theory and Practice*, Chapman & Hall/CRC, 2009
03. I. Beyna, *Interest Rate Derivatives*, Springer, 2013
04. D. Brigo, F. Mercurio, *Interest Rate Models-Theory and Practice*, Springer, 2006

05. Z. Grbac, W.J. Runggaldier, *Interest Rate Modeling: Post-Crisis Challenges and Approaches*, Springer, 2015
06. C. Bluhm, L. Overbeck, C. Wagner, *Introduction to Credit Risk Modeling*, 2nd Edition, Chapman & Hall/CRC, 2010
07. N. Wagner, *Credit Risk: Models, Derivatives, and Management*, Chapman & Hall/CRC, 2008

## FM-617 Financial Computer Simulation- I ( 2 + 1 )

**Analytical Thinking** What Is Financial Analytics? Laboratory for Data Science, Professional Analytics World, Language Features: Functions, Assignment, Arguments, and Types, Language Features: Binding and Arrays, Error Handling, Numeric, statistical, and Character Functions, Data Frames and Input–Output,

**Financial Statistics** Probability, Combinatorics, Mathematical Expectation, Sample Mean, Standard Deviation, and Variance, Sample Skewness and Kurtosis, Financial Returns, Capital Asset Pricing Model

**Financial Securities,** Bond Investments, The Housing Crisis, The Euro Crisis, Securities Datasets and Visualization, Adjusting for Stock Splits, Adjusting for Mergers, Plotting Multiple Series, Securities Data Importing, Securities Data Cleansing, Securities Quoting

**Dataset Analytics and Risk Measurement** Generating Prices from Log Returns, Normal Mixture Models of Price Movements, Sudden Currency Price Movement

**The Sharpe Ratio** Sharpe Ratio Formula, Time Periods and Annualizing, Ranking Investment Candidates, The Quantmod Package, Measuring Income Statement Growth Sharpe Ratios for Income Statement Growth

All the contents may be cover with software (e.g **R, PYTHON** etc.)

## Books Recommended:

01. M. J. Bennett, D. L. Hugen, Financial Analytics with R: Building a Laptop Laboratory for Data Science, Cambridge University Press, 2016
02. D.Eddelbuettel, Seamless R and C++ Integration with Rcpp. New York: Springer, 2013, ISBN 978-1461468677
03. J.Ledolter, Data Mining and Business Analytics with R. John Wiley, May. ISBN: 978-1-118-44714-7, 2013
04. J.Ledolter, Data Mining and Business Analytics with R. John Wiley, May. ISBN: 978-1-118-44714-7, 2013
05. D.Ruppert, Statistics and Data Analysis for Financial Engineering, Springer Texts in Statistics. New York: Springer, ISBN 9781441977861, 2011

## FM-618 Financial Computer Simulation- II ( 2 + 1 )

**Time Series Analysis** Examining Time Series, Stationary Time Series, Auto-Regressive Moving Average Processes, Power Transformations, The TSA Package, Auto-Regressive Integrated Moving Average Processes, Case Study: Earnings of Johnson & Johnson, Case Study: Monthly Airline Passengers, Case Study: Electricity Production, Generalized Auto-Regressive Conditional Heteroskedasticity, Case Study: Volatility of Google Stock Returns

**Markowitz Mean-Variance Optimization** Optimal Portfolio of Two Risky Assets, Quadratic Programming, Data Mining with Portfolio Optimization, Constraints, Penalization, and the Lasso Extending to High Dimensions, Case Study: Surviving Stocks of the S&P 500 Index

**Cluster Analysis** K-Means Clustering, Dissecting the K-Means Algorithm, Sparsity and Connectedness of Undirected Graphs, Covariance and Precision Matrices, Visualizing Covariance, The Wishart Distribution, Glasso: Penalization for Undirected Graphs, Running the Glasso Algorithm, Tracking a Value Stock through the Years

**Simulating Trading Strategies** Foreign Exchange Markets, Chart Analytics, Initialization and Finalization, Momentum Indicators, Bayesian Reasoning within Positions, Entries, Exits, Profitability, Short-Term Volatility, The State Machine

**Data Exploration Using Fundamentals** The RSQLite Package, Finding Market-to-Book Ratios, The Reshape2 Package, Value Investing

All the contents may be cover with any software (e.g **R, PYTHON** etc.)

## Books Recommended:


01. M. J. Bennett, D. L. Hugen, Financial Analytics with R: Building a Laptop Laboratory for Data Science, Cambridge University Press, 2016
02. D. Eddelbuettel, Seamless R and C++ Integration with Rcpp. New York: Springer, 2013, ISBN 978-1461468677
03. J. Ledolter, Data Mining and Business Analytics with R. John Wiley, May. ISBN: 978-1-118-44714-7, 2013
04. J. Ledolter, Data Mining and Business Analytics with R. John Wiley, May. ISBN: 978-1-118-44714-7, 2013
05. D. Ruppert, Statistics and Data Analysis for Financial Engineering, Springer Texts in Statistics. New York: Springer, ISBN 9781441977861, 2011

## FM-619 Analysis of Financial Time series (3+0)

Stochastic process and its main characteristics Stochastic process, Time series as a discrete stochastic process, Stationarity, Main Characteristics of stochastic processes (means, auto-covariation and autocorrelation functions), Stationary stochastic processes, Stationarity as the main characteristic of stochastic component of time series, World decomposition, Lag operator, Autoregressive-moving average models ARMA (p,q) Moving average models MA(q), Condition of invertability, Autoregressive models AR(p), Yull-Worker equations, Stationarity conditions, Autoregressive-moving average models ARMA(p,q), Coefficient estimation in ARMA (p,q) processes, Box-Jenkins' approach, Coefficients estimation in autoregressive models, Coefficient estimation in ARMA (p) processes, Quality of adjustment of time series models, AIC information criterion, BIC information criterion, "Portmonto"-statistics, Box-Jenkins methodology to identification of stationary time series models, Forecasting in the framework of Box-Jenkins model Forecasting, trend and seasonality in Box-Jenkins mode, Non-stationary time series Non-stationary time series, Time series with non-stationary variance, Non-stationary mean, ARIMA (p,d,q) models, The use of Box-Jenkins methodology to determination of order of integration, The unit root problem The unit root problem, Spurious trends and regressions, Unit root tests (Dickey-Fuller). ADF test and the choice of the number of lags, Other unit root tests. Unit root and structure changes Non-stationary time series, TSP or DSP: methodology of research. Segmented trends and structure changes, Regressive dynamic models Regressive dynamic models, Autoregressive models with distributed lags (ADL), Vector auto regression model and co-integration Time series co-integration, Co-integration regression, Testing of co-integration, Vector auto regression and co-integration, Co-integration and error correction model, Causality in time series Granger causality, Hypothesis testing on rational expectations, Hypothesis testing on market efficiency

**Books Recommended:**


01. Ruey S. Tsay, Analysis of Financial Time Series. Wiley, 2014
02. Banerjee, A., J.J. Dolado, and D.V. Hendry. Co-Integration, Error Correction, and Econometric Analysis of Non-Stationary Data. Oxford University Press, 1993