Unit II: Portfolio Theory and Risk Management (12 Hours)

Introduction to Portfolio Theory: Diversification, risk, return. Mean-Variance Analysis: Efficient frontier, capital market line, security market line. Capital Asset Pricing Model (CAPM): Assumptions, derivation, applications. Risk Measures: Value at risk (VaR), conditional VaR, applications. Portfolio Optimization: Techniques, constraints, applications. Introduction to Derivatives: Forwards, futures, options, and swaps, basic pricing and applications.

Unit III: Financial Markets and Instruments (12 Hours)

Overview of Financial Markets: Types, functions, role in the economy. Equity Markets: Stock exchanges, trading mechanisms, stock indices. Fixed Income Markets: Treasury, corporate, and municipal bonds. Derivatives Markets: Structure, participants, trading strategies. Market Efficiency and Behavioral Finance: Efficient market hypothesis, behavioral finance anomalies. Financial Instruments and Innovations: Securitization, structured products, financial engineering.

References:

[1] Steven Roman, *Introduction to the Mathematics of Finance*, Springer; 2004th edition.

[2] David G. Luenberger, *Investment Science*, Oxford University Press, 2nd edition 2014.

[3] Samuel A. Broverman, *Mathematics of Investment and Credit*, 4th ed., ACTEX Publications, 2008.

[4] Stephen G. Kellison, *The Theory of Interest*, 3rd ed., McGraw-Hill, 2009.

[5] John McCutcheon and William F. Scott, *An Introduction to the Mathematics of Finance*, Elsevier Butterworth-Heinemann, 1986.

[6] Petr Zima and Robert L. Brown, *Mathematics of Finance,* 2nd ed., Schaum's Outline Series, McGraw-Hill, 1996.

MTH 502	Complex Analysis - I	4 Credits (48 hours)

Course Objectives

1. **Understand Complex Numbers**: Develop a solid foundation in complex numbers, including geometric interpretation, square roots, and rational powers.
2. **Explore Complex Functions**: Learn the topology of the complex plane, one-to-one and onto functions, limits, and continuity.
3. **Analyze Differentiability**: Study differentiability, Cauchy-Riemann equations, harmonic functions, and power series.
4. **Investigate Complex Integrals**: Examine complex line integrals, the Cauchy-Goursat theorem, and the winding number.
5. **Apply Integral Theorems**: Apply Cauchy's integral formula, Morera's theorem, and compute line integrals.

Course Outcomes

1. Demonstrate proficiency in complex number operations, geometric interpretations, rational powers and stereographic projection.

2. Apply topological concepts of the complex plane to understand the continuity and differentiability of complex functions.
3. Solve problems involving differentiability, Cauchy-Riemann equations, and harmonic functions.
4. Evaluate complex line integrals using the Cauchy-Goursat theorem and understand the concept of winding number.
5. Compute integrals using Cauchy's integral formula, understand Morera's theorem, and develop Taylor and Laurent series.

Contents

Unit I

Recapitulation of Complex numbers, Geometric interpretation, Square roots.
Rational powers of a complex number, Topology of the complex plane, One-to-one and onto functions, Concepts of limit and continuity, Stereographic projection, Sequences and series of functions.

(12 Hours)

Unit II

Differentiability and Cauchy-Riemann equations, Harmonic functions, Power series as an analytic function, Exponential and trigonometric functions, Logarithmic function, Inverse functions.

(12 Hours)

Unit III

Curves in the complex plane, Properties of complex line integrals, Cauchy-Goursat theorem, Consequence of simply connectivity, Winding number or index of a curve, Homotopy version of Cauchy's theorem. (12 Hours)

Unit IV

Cauchy integral formula and computation of line integrals, Morera's theorem, Existence of harmonic conjugate, Taylor's theorem, Zeros of analytic functions, Laurent series.

(12 Hours)

References:

1. S. Ponnusamy - Foundations of Complex Analysis, Narosa, New Delhi, 2nd edition, 2005.
2. S. Ponnuswamy and H. Silverman – Complex Variables with Applications, Birkhäuser, 2006.
3. J. B. Conway – Functions of one Variable, Narosa, New Delhi, 1996.
4. Lars V. Ahlfors – Complex Analysis, McGraw Hill, 3rd Edition, 1979.
5. 2. B. R. Ash – Complex Variables, Dover Publications, 2nd Edition, 2007.
6. R. V. Churchill, J. W. Brown and R. F. Verlag – Complex Variables and Applications, Mc Graw Hill, 8th Edition, 2009.

MTH 503	Measure and Integration	4 Credits (48 hours)

Course Objectives

1. **Understand Fundamental Concepts**: Gain a comprehensive understanding of the fundamental concepts in Lebesgue measure theory, including outer measures, σ-algebras, and measurable sets.