16. Evaluate $\int_{C_1^+(0)} \exp\left(\frac{2}{z}\right) dz$, where $C_1^+(0)$ denotes the circle $\{z: |z| = 1\}$ with positive orientation. Similarly evaluate $\int_{C_1^+(0)} \frac{1}{z^4+z^3-2z^2} dz$.

B.Sc. (Hons) Mathematics, Semester-VI, DSE-Courses

DISCIPLINE SPECIFIC ELECTIVE COURSE – 4(i): MATHEMATICAL FINANCE

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Mathematical Finance	4	3	0	1	Class XII pass with Mathematics	DSC-3, 11, & 15: Probability and Statistics, Multivariate Calculus, & PDE's

Learning Objectives: The main objective of this course is to:
- Introduce the application of mathematics in the financial world.
- Understand some computational and quantitative techniques required for working in the financial markets and actuarial sciences.

Learning Outcomes: The course will enable the students to:
- Know the basics of financial markets and derivatives including options and futures.
- Learn about pricing and hedging of options.
- Learn the Itô's formula and the Black–Scholes model.
- Understand the concepts of trading strategies.

SYLLABUS OF DSE-4(i)

Unit - I: Interest Rates, Bonds and Derivatives (15 hours)
Interest rates, Types of rates, Measuring interest rates, Zero rates, Bond pricing, Forward rates, Duration, Convexity, Exchange-traded markets and Over-the-counter markets, Derivatives, Forward contracts, Futures contracts, Options, Types of traders, Hedging, Speculation, Arbitrage, No Arbitrage principle, Short selling, Forward price for an investment asset.

Unit - II: Properties of Options and the Binomial Model (15 hours)

Types of options, Option positions, Underlying assets, Factors affecting option prices, Bounds for option prices, Put-call parity (in case of non-dividend paying stock only), Early exercise, Trading strategies involving options (except box spreads, calendar spreads and diagonal spreads), Binomial option pricing model, Risk-neutral valuation (for European and American options on assets following binomial tree model).

Unit - III: The Black-Scholes Model and Hedging Parameters (15 hours)

Brownian motion (Wiener Process), Geometric Brownian Motion (GBM), The process for a stock price, Itô's lemma, Lognormal property of stock prices, Distribution of the rate of return, Expected return, Volatility, Estimating volatility from historical data, Derivation of the Black-Scholes-Merton differential equation, Extension of risk-neutral valuation to assets following GBM (without proof), Black−Scholes formulae for European options, Hedging parameters - The Greek letters: Delta, Gamma, Theta, Rho and Vega; Delta hedging, Gamma hedging.

Essential Readings

1. Hull, John C., & Basu, S. (2022). Options, Futures and Other Derivatives (11th ed.). Pearson Education, India.
2. Benninga, S. & Mofkadi, T. (2021). Financial Modeling, (5th ed.). MIT Press, Cambridge, Massachusetts, London, England.

Suggestive Readings

- Luenberger, David G. (2013). Investment Science (2nd ed.). Oxford University Press.
- Ross, Sheldon M. (2011). An elementary Introduction to Mathematical Finance (3rd ed.). Cambridge University Press.
- Day, A.L. (2015). Mastering Financial Mathematics in Microsoft Excel: A Practical Guide for Business Calculations (3rd ed.). Pearson Education Ltd.

Note: Use of non-programmable scientific calculator is allowed in theory examination.

Practical (30 hours)- Practical/Lab work using Excel/R/Python/MATLAB/MATHEMATICA

1. Computing simple, nominal, and effective rates. Conversion and comparison.
2. Computing price and yield of a bond.
3. Comparing spot and forward rates.
4. Computing bond duration and convexity.
5. Trading strategies involving options.
6. Simulating a binomial price path.
7. Computing price of European call and put options when the underlying follows binomial model (using Monte Carlo simulation).
8. Estimating volatility from historical data of stock prices.
9. Simulating lognormal price path.
10. Computing price of European call and put options when the underlying follows lognormal model (using Monte Carlo simulation).

11. Implementing the Black-Scholes formulae.
12. Computing Greeks for European call and put options.

DISCIPLINE SPECIFIC ELECTIVE COURSE – 4(ii): INTEGRAL TRANSFORMS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Integral Transforms	4	3	1	0	Class XII pass with Mathematics	DSC-6,15: ODE's, PDE's DSC-8, 10: Riemann Integration, Sequences & Series of Functions

Learning Objectives: Primary objective of this course is to introduce:

- The basic idea of integral transforms of functions and their applications through an introduction to Fourier series expansion of a periodic function.
- Fourier transform and Laplace transform of functions of a real variable with applications to solve ODE's and PDE's.

Learning Outcomes: The course will enable the students to:

- Understand the Fourier series associated with a periodic function, its convergence, and the Gibbs phenomenon.
- Compute Fourier and Laplace transforms of classes of functions.
- Apply techniques of Fourier and Laplace transforms to solve ordinary and partial differential equations and initial and boundary value problems.

SYLLABUS OF DSE-4(ii)

UNIT-I: Fourier Series and Integrals (18 hours)

Piecewise continuous functions and periodic functions, Systems of orthogonal functions, Fourier series: Convergence, examples and applications of Fourier series, Fourier cosine series and Fourier sine series, The Gibbs phenomenon, Complex Fourier series, Fourier series on an arbitrary interval, The Riemann-Lebesgue lemma, Pointwise convergence, uniform convergence, differentiation, and integration of Fourier series; Fourier integrals.

UNIT-II: Integral Transform Methods (15 hours)

Fourier transforms, Properties of Fourier transforms, Convolution theorem of the Fourier transform, Fourier transforms of step and impulse functions, Fourier sine and cosine