Derivatives Course

1. Course Description

This course provides an introduction to derivative securities, focusing on forwards, futures, and options. Students will learn the theoretical foundations of pricing, arbitrage relationships, and hedging applications. The course emphasizes pricing models (binomial, Black–Scholes), option strategies, and risk management tools relevant for actuaries and financial professionals.

2. Learning Objectives

- Understand the role of derivatives in financial markets.
- Price futures and options using arbitrage and risk-neutral valuation.
- Apply the binomial model and Black–Scholes formula to option pricing.
- Use put–call parity to detect arbitrage opportunities.
- Interpret and apply Greeks in risk management.

3. Prerequisites

• Probability theory, basic statistics
• Introductory finance (time value of money, bonds, interest rates)
• Basic calculus and linear algebra

4. Course Outline & Weekly Plan

Week 1: Introduction (done)

- Role of derivatives in financial markets.
- Forwards vs. Futures vs. Options.
- Key differences: standardization, clearinghouses, margin.

Weeks 2–3: Futures and Forwards

- Spot-forward relationship, arbitrage.
- Dividend-paying assets, commodities, currencies.
- Exercises: compute fair prices, detect arbitrage.

Weeks 4–5: Options Basics & Payoff Structures

- Option definitions: European vs. American.
- Payoff diagrams: Calls, puts, long/short positions.
- Option strategies: spreads, straddles, strangles, protective put, covered call.
- Exercises: payoff diagrams, profit/loss calculations.

Week 6: Put–Call Parity

- Derivation of parity, arbitrage violations, synthetic positions.
- Applications: synthetic forwards, conversions, reversals.
- Exercises: detect arbitrage, construct equivalent portfolios.

Weeks 7–8: Binomial Model

- One-period binomial model, risk-neutral probabilities.
- Multi-period binomial tree, pricing American options.
- Extensions: trinomial/multinomial models.
- Exercises: price European call, American put.

Weeks 9–10: Black–Scholes Model

- Assumptions & intuition.
- Derivation via delta-hedging or risk-neutral expectation.
- Black–Scholes formula for European options.
- Implied volatility.
- Exercises: implement BS pricing, compute implied vol.

Week 11: Greeks

- Definitions: Delta, Gamma, Theta, Vega, Rho.
- Applications: delta-hedging, gamma hedging.
- Exercises: calculate Greeks, build delta-neutral portfolio.

Weeks 12–13: Advanced Topics & Applications

- Exotic options: Asian, Barrier, Lookback (intro).

7. Recommended References

• Hull, John C. Options, Futures, and Other Derivatives (10th ed)
• McDonald, R. Derivatives Markets