Tennessee Technological University
Mathematics Department

MATH 4550/5550-4560/5560: Mathematics of Investment I-II

I. COURSE DESCRIPTION FROM CATALOG:

MATH 4550/5550
Topics include examination of annuities, loans, bonds and other securities, portfolio, immunization, interest rate swaps. Lec. 3. Cr. 3.
MATH 4560/5560
Topics include derivative securities, mathematical models of financial risk management, and corporate finance. Lec. 3. Cr. 3.

II. PREREQUISITE(S):

MATH 4550/5550: C or better in MATH 1920 or consent of instructor.
MATH 4560/5560: C or better in both MATH 4550/5550 and MATH 4470/5470, or consent of instructor.

III. COURSE OBJECTIVE(S):

The main objective of this sequence is to introduce basic investment mathematical tools and models in finance and economics.

IV. STUDENT LEARNING OUTCOMES:

MATH 4550/5550
Upon successful completion of this course students will be able to manipulate and solve problems concerning time value of money; evaluate the value of different types of annuities certain at a given time point; loan amortization schedules and related calculations including final drop and balloon payments, depreciation; perform calculations related to bonds and other securities; yield curves, rates of return including dollar and time weighted rate of return; acquire the skill to find duration, convexity, and immunization of a set of cash flows; understand and interpret the terminologies related to stock; key concepts regarding interest rate swaps.

MATH 4560/5560
Upon successful completion of this course students will develop the theoretical basis of certain actuarial models and the application of those concepts to financial risk analysis; derivative securities – forwards and futures; option pricing models - binomial and Black-Sholes; option Greeks and quantitative risk management; arbitrage-free models; perform mean variance portfolio analysis; valuation (pricing) of different assets including Capital Asset Pricing and Factor models; behavioral finance and market efficiency; different measures of investment risk including simulation; effect of capital structure of a company.

V. TOPICS TO BE COVERED:

MATH 4550/5550 Topics

1. Interest Theory: Accumulation function, discount function, interest rate, discount factor, discount rate, time value of money, force of interest, equation of value.
2. Non-contingent Annuities: Annuities immediate, annuities due, perpetuities, deferred annuities, continuous annuities, annuities with general payments, annuities with different payment and conversion periods.
3. Loan Repayment: Amortized loans and amortization schedules, sinking fund method, loan repayment with other patterns, final drop and balloon payments, replacement of capital.
4. Bonds and Stocks: Bond pricing formulas, bond amortization schedules, valuing a bond, callable bounds, floating-rate bonds, yield rate, coupon and coupon rate, stocks and terminologies.
5. Advanced Analysis: Rate of return, yield curves, rates, arbitrage, duration, convexity, measures of price sensitivity, immunization, determinants of interest rates.
6. Interest Rate Swaps: Swap rate, market value of a swap, deferred swap, amortizing swap, and related calculations.

MATH 4560/5560 Topics

1. Risk and Return: project analysis, competitive and efficient markets, capital markets and pricing of risk, portfolio optimization and capital asset pricing models, cost of capital, capital market efficiency, behavior of investor, sensitivity analysis, simulation, real options.
2. Capital Structure: Perfect market, the interest tax deduction, valuing the interest tax shield, financial distress, managerial incentives and information.
3. Long Term Financing: Raising equity capital, debt financing.
4. Basic Derivatives: Forwards, Futures, Options, Put-Call Parity, Properties of Option Prices, Margin, Insurance, Spreads and Collars, Volatility.
5. Discrete Model: Binomial trees - One-period Binomial Tree, Multi-period Binomial Tree, Risk-neutral Pricing, American Options, Early Exercise.
6. Continuous Model: Black-Scholes Formula - Lognormal Distribution, Calculating Greeks, Hedging; Exotic Options - Asian Options, Barrier Options, Compound Options, Gap Options, Exchange Options; Generating Lognormal Random Variables, Simulating Derivatives.

VI. ADDITIONAL INFORMATION:

1. These two courses directly prepare students to the two actuarial professional exams Exam FM: Financial Mathematics and Exam IFM: Investment and Financial Markets administrated by the Society of Actuaries.
2. Graduate credit is earned on the basis of additional work required by the instructor.

VII. POSSIBLE TEXTS AND REFERENCES:

MATH 4550/5550

Required:

1. Kellison, S.G., The Theory of Interest (Third Edition), 2009, Irwin/McGraw-Hill.

Supplementary:

1. Broverman, S.A., *Mathematics of Investment and Credit* (Seventh Edition), 2017, ACTEX Publications.
2. Vaaler, L.J.F., Harper, S.K., and Daniel, J.W., *Mathematical Interest Theory* (Third Edition), 2019, The Mathematical Association of America.

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1. McDonald, R.L., *Derivatives Markets* (Third Edition), 2013, Pearson Education.
2. Berk, J. and DeMarzo, P., *Corporate Finance* (Fourth Edition), 2017, Pearson Education.

VIII. ANY TECHNOLOGY THAT MAY BE USED:

R and R Studio which can be run on a Windows, Mac, or Linux platform.

IX. STUDENT ACADEMIC MISCONDUCT POLICY:

Maintaining high standards of academic integrity in every class at Tennessee Tech is critical to the reputation of Tennessee Tech, its students, alumni, and the employers of Tennessee Tech graduates. The Student Academic Misconduct Policy describes the definitions of academic misconduct and policies and procedures for addressing Academic Misconduct at Tennessee Tech. For details, view the Tennessee Tech's Policy 217 – Student Academic Misconduct at Policy Central.

X. DISABILITY ACCOMMODATION:

Students with a disability requiring academic adjustments and accommodations must contact the Accessible Education Center (AEC). AEC is located in the Roaden University Center, Room 112; phone 372-6119. For more information see TTU Policy 340 - Services for Students with Disabilities at Policy Central.