Course Syllabus

ACRS 325: Actuarial Modeling

Description: *A study of actuarial models in the context of insurance. Topics include mathematics of finance (including interest theory, annuities, and loans), bonds, cash-flow, interest rate swaps, financial derivatives and options, and actuarial professional issues.*

Credit Hours: 3

Audience: Required for Actuarial Science majors and minors

Prerequisites: MATH 132

Format: 3 lectures (50 min), per week

Textbook: *Mathematics of Investment & Credit, 7th edition,* by Samuel Broverman, 978-111-63588-221-6

Technology: Texas Instrument BA II plus financial calculator required

Internet: Some course material maintained in Blackboard.

Course Goals:

    A. Students will receive an overview of the actuarial profession.
    B. Students will become familiar with interest theory and annuities.
    C. Students will be introduced to financial derivatives

Topical Objectives:

A. Students will be able to define and recognize the definitions of the following terms: interest rate (rate of interest), simple interest, compound interest, accumulation function, future value, current value, present value, net present value, discount factor, discount rate (rate of discount), convertible monthly, nominal rate, effective rate, inflation and real rate of interest, force of interest, equation of value

B. Given any three of interest rate, period of time, present value, and future value, calculate the remaining item using simple or compound interest. Solve time value of money equations involving variable force of interest.

C. Given any one of the effective interest rate, the nominal interest rate convertible mthly, the effective discount rate, the nominal discount rate convertible monthly, or the force of interest, calculate any of the other items.

D. Write the equation of value given a set of cash flows and an interest rate.

E. Students will be able to define and recognize the definitions of the following terms: annuity-immediate, annuity due, perpetuity, payable monthly or payable continuously, level payment annuity, arithmetic increasing/decreasing annuity, geometric increasing/decreasing annuity, term of annuity

F. For each of the following types of annuity/cash flows, given sufficient information of immediate or due, present value, future value, current value, interest rate, payment amount, and term of annuity, Students will be able to calculate any remaining item
 a. Level annuity, finite term
 b. Level perpetuity
 c. Non-level annuities/cash flows
  i. Arithmetic progression, finite term
  ii. Arithmetic progression, perpetuity
  iii. Geometric progression, finite term
  iv. Geometric progression, perpetuity
  v. Other non-level annuities/cash flows
G. Students will be able to define and recognize the definitions of the following terms: principal, interest, term of loan, outstanding balance, final payment (drop payment, balloon payment), amortization, sinking fund
H. Students will be able to:
 a. Given any four of term of loan, interest rate, payment amount, payment period, principal, calculate the remaining item.
 b. Calculate the outstanding balance at any point in time.
 c. Calculate the amount of interest and principal repayment in a given payment.
 d. Given the quantities, except one, in a sinking fund arrangement calculate the missing quantity.
 e. Perform similar calculations to a-d when refinancing is involved.
I. Students will be able to define and recognize the definitions of the following bond terms: price, book value, amortization of premium, accumulation of discount, redemption value, par value/face value, yield rate, coupon, coupon rate, term of bond, callable/non-callable
J. Given sufficient partial information about the items listed below, Students will be able to calculate the any of the remaining items.
 a. Price, book value, amortization of premium, accumulation of discount
 b. Redemption value, face value
 c. Yield rate
 d. Coupon, Coupon rate
K. term of bond, point in time that a bond has a given book value, amortization of premium, or accumulation of discount Students will be able to define and recognize the definitions of the following terms:
 a. yield rate/rate of return,
 b. dollar-weighted rate of return,
 c. time-weighted rate of return,
 d. current value,
 e. duration (Macaulay and modified),
 f. convexity (Macaulay and modified),
 g. portfolio,
 h. spot rate,
 i. forward rate,
 j. yield curve,

       k.   stock price,
       l.   stock dividend.

L.   Students will be able to calculate:
    a.   The dollar-weighted and time-weighted rate of return,
    b.   the duration and convexity of a set of cash flows,
    c.   either Macaulay or modified duration given the other,
    d.   the approximate change in present value due to a change in interest rates,
       i.   using 1_{st}-order linear approximation based on modified duration.
      ii.   using 1_{st}-order approximation based on Macaulay duration,
    e.   the price of a stock using the dividend discount model,
    f.   the present value of a set of cash flows, using a yield curve developed from forward and spot rates

M. Students will be able to define and recognize the definitions of the following terms:
    a.   swap rate,
    b.   swap term or swap tenor,
    c.   notional amount,
    d.   market value of a swap,
    e.   settlement dates,
    f.   settlement period,
    g.   counterparties,
    h.   deferred swap,
    i.   amortizing swap,
    j.   accreting swap,
    k.   interest rate swap net payments.

N. Given sufficient information students will be able to calculate:
    a.   the market value,
    b.   notional amount,
    c.   spot rates or swap rate of an interest rate swap, deferred or otherwise, with either constant or varying notional amount

O. Students will be able to:
    a.   Describe the characteristics and terms of the main derivatives instruments (including forwards and futures).
       i. Distinguish between long and short positions for both assets (including short selling of stocks) and derivatives on assets.
      ii.   Recognize the transaction costs affecting profit calculations for both assets and derivatives on assets (including commissions and bid-ask spread).
    b.   Describe the characteristics and terms relating to both forward contracts and prepaid forward contracts.
       i. Define and recognize the following terms relating to the timing of stock purchases: outright purchase, fully leveraged purchase, prepaid forward contract, and forward contract.
      ii. Determine payoffs and profits for both long and short positions on forward contracts.

       iii. Calculate prices for both forward contracts and prepaid forward contracts on stocks with no dividends, continuous dividends, and discrete dividends.
       iv. Construct a synthetic forward from the underlying stock and a risk-free asset and identify arbitrage opportunities when the synthetic forward price is different from the market forward price.
  c. Describe the characteristics and terms relating to both futures contracts and the associated margin accounts.
       i. Define and recognize the following terms relating to the mark-to-market process: Marking to market, margin balance, maintenance margin, and margin call
       ii. Evaluate an investor's margin balance based on changes in asset values.