Introduction to Financial Engineering

What is Financial Engineering (FE)?

- The discipline of **financial engineering** includes applications of mathematical, statistical modeling and computational technology to problems in the financial industry and financial management of non-financial organizations.

- FE involves design and development of financial products, strategies, and systems to meet the needs of financial institutions, corporations, governments, and households.
Financial Engineering Application Areas

- Financial risk management for financial institutions, corporations, and public institutions (from hedging risks of individual transactions to enterprise-wide risk management systems)
- Derivative securities (contract design, pricing, market making, and investment, trading, and hedging applications)
- Modeling stochastic dynamics of stock prices, interest rates, foreign exchange rates, commodity and energy prices
- Asset/liability management technology for corporations, banks, pension funds
- Credit risk modeling and management and credit derivatives
- Energy industry and energy derivatives
- Real options: valuing businesses and strategic managerial decisions by applying option pricing technology
Some Factors that Drive the Growth of Financial Engineering

● Increasing Volatility of Global Financial Markets and the Need for Risk Management
  ○ Volatility of equity prices, foreign exchange rates, commodity and energy prices, and interest rates increased dramatically over the past three decades
  ○ Higher volatility increases risk (as well as more opportunities)
  ○ Risk Management is crucial to the survival and competitiveness of organizations

● Global Nature of Financial Markets
  ○ Multinational firms produce, market, and obtain financing globally
  ○ Every multinational firm has significant risk exposures to foreign currencies, domestic and foreign interest rates, energy and commodity prices, and global equity prices
• **Information Technology**
  
  o Advances in information technology drive the growth of financial engineering. Real-time worldwide information and data collection, analysis, decision-making, and trading are made possible.
  
  o Securities trading goes electronic and moves from exchange floors into cyberspace.
  
  o Banks are the biggest users of information technology!

• **Goals of this Course**
  
  o Provide an introduction to the field of financial engineering
  
  o Develop theoretical foundations of financial engineering
  
  o Study some of the most important products and applications of financial engineering
  
  o Develop practical modeling skills
What is a Derivative?

- A derivative is a financial contract between two parties that specifies conditions – in particular, dates and the resulting values of underlying variables – under which payments or payoffs are to be made between the parties (payments can be either in the form of cash or delivery of some specified asset).

Examples

- A **Forward contract** is a contract to buy some pre-specified underlying asset at a predetermined price (delivery price) on a specified date in the future.

- **Call and Put Options**
  - A *call option* is a contract that gives its holder *the right but not the obligation to buy* some specified quantity of an underlying asset (e.g. fixed number of shares of stock of a particular company) at a
predetermined price (strike price) on or before a specified date in the future (option expiration).

- A put option is a contract that gives its holder the right but not the obligation to sell some specified quantity of an underlying asset (e.g. fixed number of shares of stock of a particular company) at a predetermined price on or before a specified date in the future.

### Underlying assets or variables in derivatives

- Stocks and stock market indexes
- Commodities (e.g., oil, gas, coal, gold, silver, aluminum, copper, corn, wheat, soybeans, paper)
- Bonds
- Interest rates
- Exchange rates
- Credit events (defaults)
- Economic variables (e.g., inflation)
There are two types of derivatives:

- **Exchange-traded:**
  - Futures
  - Options

- **Over-the-Counter (OTC):**
  - Forward contracts
  - Swaps
  - CDS
The size of the global derivatives market

The derivative market is huge: the notional outstanding value of derivatives is equal to several hundreds trillions US dollars and it is still growing!

The notional outstanding value of

- **OTC contracts** (4Q 2009): $615 trillions
  - FX contracts: $50 trillions
  - Interest rate contracts: $450 trillions
  - CDS contracts: $33 trillions
  - Equity-linked: $6.5 trillions
  - Commodity-linked: $3 trillions

- **Exchange-traded** (1Q 2010):
  - **Futures**: $346 trillions
  - **Options**: $168 trillions

(Source: [www.bis.org](http://www.bis.org))
Types of Derivatives Traders

- **Hedgers**
  - Objective: reduce risks they already face in the course of their business.

- **Investors/Speculators**
  - Objective: profit from taking directional/speculative positions on the future market direction.

- **Arbitrageurs**
  - Objective: find arbitrage opportunities to realize “riskless” profits.