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## **COURSE SYLLABUS**

### **FOR FULL-TIME UNDERGRADUATE PROGRAMS**

*(Issued under Decision No.1380/QĐ-ĐHKTQĐ on 15/8/2016 by the University President)*

#### **1. COURSE NAME:** Foundation of Mathematical Finance

Code: TOTC1106

Number of Credits: 03

#### **2. DEPARTMENT IN CHARGE OF INSTRUCTION:**

*Department Mathematical Finance*

**Office:** Faculty of Economic Mathematics

**Office Hours:** Working hours, the working day

**Office Telephone:** (84) 04 3628 3007

#### **3. PRE-REQUISITE:**

Course pre-requisites: Probability Theory, Computer Skills and Microeconomics 1; Macroeconomics 1

#### **4. COURSE DESCRIPTION:**

Foundation of mathematical finance is an optional subject for second-year students majoring in Mathematical Finance.

The subject studies basic knowledge to calculate variation in the price (of the contract, assets,..) in the financial market based on stochastic analysis. Content of this subject consists of 5 chapters. Chapter 1 introduces basic financial calculations in the deterministic environment by Excel tool. The next chapters study modeling the financial assets process in a stochastic environment. Chapter 2 introduces the stochastic process in finance with discrete time. Chapter 3 introduces the stochastic process in finance with continuous time. Stochastic calculation, stochastic differential equation (SDE) and simulation of stochastic processes are introduced in Chapter 4 and Chapter 5.

This course provides the basic knowledge of Mathematical Finance and Stochastic analysis to support students in specialized subjects.

#### **5. COURSE OBJECTIVES:**

✓ The subject provides students with: Basic Financial Calculation, Stochastic calculation in finance, simulation of stochastic processes to study financial markets.

✓ The subject provides learners with skills of deterministic calculation and stochastic calculation in finance, skills in using the softwares: Matlab, Excel... to calculate basic finance, simulation programming of stochastic processes in finance.

## 6. COURSE CONTENT:

### TENTATIVE SCHEDULE

No	Contents	Total hours	In details		Notes
			Theory	Practice, Discussion, Exams	
1	Chapter 1	10	6	4	Practice with computer software and report in group.
2	Chapter 2	8	6	2	
3	Chapter 3	8	6	2	
4	Chapter 4	9	6	3	
5	Chapter 5	10	6	4	
	<b>Total</b>	<b>45</b>	<b>30</b>	<b>15</b>	

## CHAPTER 1- BASIC FINANCIAL CALCULATION

*This chapter introduces some concepts of the structure of financial market and basic calculation of the common financial transactions. Some contents: discounted cash flow method, cost of investment capital, financial analysis of the financial lease contract, internal rate of return (IRR),... are presented in details and practiced on Excel:*

- 1.1. Introduction
- 1.2. Present value (PV) and Net present value (NPV)
- 1.3. Internal rate of return
- 1.4. Future value and application
- 1.5. Salary
- 1.6. Compound interest
- 1.7. Operation of stock exchanges

References:

- 1) Trần Trọng Nguyên (2010), *Foundation of mathematical finance*, Science and Technics Publishing House.
- 2) Trần Hùng Thao (2004), *Introduction of mathematical finance*, Science and Technics Publishing House.
- 3) Y. K. Kwok (1998), *Mathematical Models of Financial Derivatives*, Springer Finance.

## **CHAPTER 2- STOCHASTIC MODEL IN FINANCE WITH DISCRETE TIME**

*This chapter presents the basic concepts of financial markets in the form of stochastic models. For simplicity, in this chapter we consider the stochastic process with discrete time and illustrated by the binominal model. Moreover, this chapter also introduces some financial derivatives such as: Americal option, European option and some pricing methods with discrete time. The detailed contents of this chapter include:*

- 2.1. Binomial model
- 2.2. Discrete-time stochastic process
  - 2.2.1. Conception
  - 2.2.2. Conditional Expectation
  - 2.2.3. Discrete-time Martingale
  - 2.2.4. Markov process
- 2.3. Stopping times and American options
- 2.4. Radon – Nikodym Theorem

### **References:**

- 1) Trần Trọng Nguyên (2010), *Foundation of mathematical finance*, Science and Technics Publishing House.
- 2) Trần Hùng Thao (2004), *Introduction of mathematical finance*, Science and Technics Publishing House.
- 3) Y. K. Kwok (1998), *Mathematical Models of Financial Derivatives*, Springer Finance.

## **CHAPTER 3- STOCHASTIC MODEL IN FINANCE WITH CONTINUOUS TIME**

*This chapter introduces the semi-continuous models, some concepts of stochastic process with continuous time and especially the Brownian motion which is used more in the finance and different fields. The detailed contents of this chapter include:*

- 3.1. Semi-continuous model
  - 3.1.1. Discrete-time Brownian motion
  - 3.1.2. Discrete-time market model
  - 3.1.3. Brownian motion as a Limit of random walks
- 3.2. Continuous - time stochastic process
  - 3.2.1. Conception

- 3.2.2. Adapting process with a filtration
- 3.2.3. Conditional expectation
- 3.2.4. Continuous - time Martingale
- 3.2.5. Markov and Stopping times
- 3.3. Brownian Motion
  - 3.3.1. Conception
  - 3.3.2. Property
- 3.4. Stochastic process simulation

References:

- 1) Trần Trọng Nguyên (2010), *Foundation of mathematical finance*, Science and Technics Publishing House.
- 2) Trần Hùng Thao (2004), *Introduction of mathematical finance*, Science and Technics Publishing House.
- 3) Y. K. Kwok (1998), *Mathematical Models of Financial Derivatives*, Springer Finance.

## **CHAPTER 4- STOCHASTIC INTEGRAL AND APPLICATION**

*This chapter studies the fundamentals of stochastic calculations: Itô integral, Itô formula, Stratonovich integral, ... We approach from reality problems of finance for the construction of stochastic calculations. The detailed contents of this chapter include:*

- 4.1. Itô integral
  - 4.1.1. Process has first variation, quadratic variation
  - 4.1.2. Definition of the Itô integral
  - 4.1.3. Properties of the Itô integral
  - 4.1.4. Connection with financial models
- 4.2. Itô formula
  - 4.2.1. Itô difference
  - 4.2.2. One-dimensional Itô formula
  - 4.2.3. Multi-dimensional Itô formula
  - 4.2.4. Connection with financial model
- 4.3. Stratonovich integral
  - 4.3.1. Definition of the Stratonovich integral
  - 4.3.2. Relationship between the Itô integral and the Stratonovich integral

References:

- 1) Trần Trọng Nguyên (2010), *Foundation of mathematical finance*, Science and Technics Publishing House.

- 2) Trần Hùng Thao (2004), *Introduction of mathematical finance*, Science and Technics Publishing House.
- 3) Bernt Oksendal (2000), *Stochastic Differential Equations, An Introduction with Applications*, Fifth Edition, Springer.
- 4) P. E. Kloeden and E. Platen (1995), *Numerical Solution of Stochastic Differential Equations*, Springer.
- 5) Steven Shreve (1997), *Stochastic calculate and finance*, Lecture.

## **CHAPTER 5- STOCHASTIC DIFFERENTIAL EQUATION AND APPLICATION**

*This chapter introduces stochastic defferential equation which is a common tool for building financial models with continuous time. In addition, we study methods for solving a class of the SDE. Moreover, this chapter also introduces some numerical methods to solve the SDE and simulation for some financial models. The detailed contents of this chapter include:*

- 5.1. Stochastic defferential equation
  - 5.1.1. Conception
  - 5.1.2. Existence and uniqueness of solution
- 5.2. Some SDEs have explicit solution
  - 5.2.1. Linear SDE
  - 5.2.2. Some nonlinear SDEs moves to the linear SDE
  - 5.2.3. Some SDEs moves to the Stratonovich SDE
- 5.3. Markov property and some financial models
  - 5.3.1. Markov property
  - 5.3.2. Black-Scholes Model
  - 5.3.3. Interest rate model
- 5.4. Simulation for some financial models

### References:

- 1) Trần Trọng Nguyên (2010), *Foundation of mathematical finance*, Science and Technics Publishing House.
  - 2) Trần Hùng Thao (2004), *Introduction of mathematical finance*, Science and Technics Publishing House.
  - 3) Bernt Oksendal (2000), *Stochastic Differential Equations, An Introduction with Applications*, Fifth Edition, Springer.
  - 4) P. E. Kloeden and E. Platen (1995), *Numerical Solution of Stochastic Differential Equations*, Springer.
- Steven Shreve (1997), *Stochastic calculate and finance*, Lecture.

## **7. REQUIRED TEXTBOOKS & COURSE MATERIALS**

- 1) Trần Trọng Nguyên (2010), *Foundation of mathematical finance*, Science and Technics Publishing House.
- 2) Steven Shreve (1997), *Stochastic calculate and finance*, Lecture.

## **8. RECOMMENDED TEXTS & OTHER READINGS**

- 1) Trần Hùng Thao (2004), *Introduction of mathematical finance*, Science and Technics Publishing House.
- 2) Bernt Oksendal (2000), *Stochastic Differential Equations, An Introduction with Applications*, Fifth Edition, Springer.
- 3) P. E. Kloeden and E. Platen (1995), *Numerical Solution of Stochastic Differential Equations*, Springer.

## **9. ASSESSMENT & GRADING POLICY:**

- ✓ Attendance (min 80%): 10%
- ✓ Discussion and homework: Complete teacher's requirement
- ✓ Practice and presentation: 30%
- ✓ Final exam: 60%

*Hanoi, 2016*

**HEAD OF DEPARTMENT**

**PRESIDENT**

(signed)

(signed)

**PhD. Hoang Duc Manh**

**Prof.Dr. Tran Tho Dat**