University of St.Gallen

# Course and Examination Fact Sheet: Spring Semester 2021

# 6,252: Stochastic Methods in Finance

# ECTS credits: 3

## Overview examination/s

(binding regulations see below)
Decentral - Written examination (100%, 90 mins.)
Examination time: term time

## Attached courses

Timetable -- Language -- Lecturer
6,252,1.00 Stochastic Methods in Finance -- Englisch -- Ortega Lahuerta Juan-Pablo

## Course information

### Course prerequisites

Some previous exposure to probability and statistics will help in the learning process. The course is nevertheless fully self contained.

### Learning objectives

After this course, the student will be familiar with...

.... the basics of probability theory and stochastic calculus

.... no-arbitrage pricing techniques

.... elementary portfolio optimization techniques

**Learning goals of the course:**

**Learning goal 1:** The student is familiar with the basics of probability theory and stochastic calculus.

Learning goal 1a: The student is able to work with several standard probability distributions.

Learning goal 1b: The student is able to use Ito's lemma and the associated rules.

Learning goal 1c: The student is able to identify and to manipulate stochastic differential equations.

**Learning goal 2:** The student is familiar with no-arbitrage pricing techniques.

Learning goal 2a: The student understands vanilla European style contracts and its different elements (strike, maturity, price).

Learning goal 2b: The student is able to price vanilla European style derivatives using the binomial model.

Learning goal 2c: The student is able to price vanilla European style derivatives using the Black-Scholes model.

**Learning goal 3:** The student is familiar with elementary portfolio optimization techniques.

Learning goal 3a: The student is able to use the Markowitz approach for portfolio optimization.

Learning goal 3b: The student is able to formulate the portfolio optimization problem with various constraints (minimum return, risk, shortfall, etc).

Learning goal 3c: The student is able to formulate similar portfolio optimization problems in continuous time.

## Course content

The course introduces the fundamental stochastic tools for derivative asset pricing and portfolio theory.

The ability to price and hedge derivative products and to properly manage asset portfolios is of paramount importance in the financial industry. The existing techniques to carry this out require a good command of the concepts in stochastic calculus that will be presented in this course.

Qualifications associated to the course:

The material that will be presented is the first step that needs to be taken by any student interested in quantitative finance. This course is a good educational block both for future practitioners in the financial industry and also for those who want to pursuit further studies in the applications of stochastic methods in finance and in financial econometrics.

Methods applied in the course:

The two main mathematical methods used in this course are probability theory and stochastic calculus. These tools allow for a mathematically rigorous formulation of the hypotheses underlying the no-arbitrage approach to asset pricing and that yield explicit quantitative results that can be easily used in practice.

## Course structure

**1. Probability Theory**

- Introduction
- Distribution functions
- Normal distribution
- Multivariate normal distribution
- Lognormal distribution
- Binomial distribution

**2. Pricing and No-arbitrage**

- Binomial model
- Fundamental asset pricing theorem

**3. Ito's lemma and Stochastic Integrals**

- Random walk and Brownian motion
- Ito processes and Ito lemma
- Derivative pricing
- Partial differential equations
- Stochastic differential equations

**4. Risk Neutral Valuation**

- Discrete model
- Lognormal model
- Extensions

**5. Markowitz Portfolio Theory**

- Markowitz approach
- Asset liability approach
- Shortfall constraint

**6. Arbitrage Pricing Theory Model**

- Discussion of the model
- Mathematics properties of the model

**7. Portfolio Theory in Continuous Time**

- Definition
- Extensions

## Course literature

Lamberton, D. and Lapeyre, B. "Introduction to stochastic calculus applied to finance". Chapman and Hall/CRC, 2008.

Neftci, S. N. "An Introduction to the Mathematics of Financial Deriva- tives". Academic Press, 2000.

Watsham, T. J. and Parramore, K. "Quantitative Methods in Finance". International Thomson Business Press, 1997.

## Additional course information

In the case of the President's Board having to implement new directives due to the SARS-CoV-2 pandemic in SpS2021, the course information listed above will be changed as follows:

- The course is conducted online via the zoom platform and using recordings that will be made available to the students until the date of the final exam.

The examination information listed below would be changed as follows:

- The oral exam could be transformed into a 90 minutes online written examination that will be recorded and for which the participants have the obligation to keep the camera on.
- The specific modalities of the examination will be communicated via e-mail in due time.

# Examination information

## Examination sub part/s

## 1. Examination sub part (1/1)

### Examination time and form
Decentral - Written examination (100%, 90 mins.)
Examination time: term time

### Remark
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### Examination-aid rule
Examinations with electronic aids - on campus or online

For examinations with electronic aids, students may be asked to install a predefined software on their own computer. The procurement and financing of the necessary technical aids, hardware and software as well as ensuring their functionality is the responsibility of the students, unless they are explicitly provided by the University.

If the examination is conducted with the candidates' own laptop or computer, the private device must meet the following requirements:

- Operating system: Windows or macOS
- Software: Microsoft Excel (minimum: Office 2016 or Microsoft Office 365) and current internet browser;
- All necessary updates for the controlled functioning of the operating system and the required software must be installed;
- HSG login: The HSG account must be functional and the access data must be known;
- Network and power: The device must be WLAN capable and have a stable internet connection. For examinations written

outside the University premises, a stable internet connection with a sufficiently high transmission rate as well as the availability of a power supply must be ensured at the user's own responsibility;

- Battery life: Operation must be guaranteed during the entire examination period. The device must have a battery life of at least 90 minutes. It is recommended to carry a working power supply;
- Video and audio capability: For examinations which are not held on University premises, the equipment must have a functioning webcam and a functioning, correctly adjusted microphone.

Participants are responsible for ensuring that their equipment is working properly and allows the partaking in the examination. Any deficiencies in the personal infrastructure are the responsibility of the students. Any deficiencies due to the students' own technology or a lack of an uninterrupted internet connection will not be recognized as procedural errors in the execution of the examination.

The examination is to be taken exclusively by the candidate and only with the help of the permitted aids. The use of additional software, in particular of another internet browser or communication software, is strictly forbidden during the entire examination. Any use of software other than the specified software requires the express prior written permission of the examination administration.

When using a LockDown browser, all applications (internet browser, Office, file explorer, etc.) are blocked and the documents on the computer are therefore not accessible. Any other aids and documents permitted in this leaflet must therefore be printed and/or physically available.

In the case of examinations with electronic aids on the premises of the University, the following shall apply in particular

- After the corresponding request of the examination administration, all connections of the device with networks or other devices (mobile network, WLAN, Bluetooth, etc.) must be disconnected.

For online examinations that do not take place on the University campus, the following applies in particular:

- The identity of the examinee will be verified via webcam before the examination begins. Photographs can be taken. The HSGcard or identity card must be kept ready for this purpose.
- Any unannounced unauthorized removal from the recording area of the webcam may be punished as a culpable violation of the examination conditions.
- Oral examinations may be recorded. The recording may be used for evaluation purposes and documents the examination in the event of appeal and/or disciplinary proceedings. The recordings shall be deleted after the appeal period or any proceedings have expired.
- The use of a headset is only permitted during an oral examination.

### Supplementary aids

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### Examination languages

Question language: English
Answer language: English

## Examination content

Contents presented in the lectures and reading assignments.

## Examination relevant literature

Lecture slides and reading assignments.

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## Please note

Please note that only this fact sheet and the examination schedule published at the time of bidding are is binding and takes precedence over other information, such as information on StudyNet (Canvas), on lecturers' websites and information in lectures etc.

Any references and links to third-party content within the fact sheet are only of a supplementary, informative nature and lie outside the area of responsibility of the University of St.Gallen.

Documents and materials are only relevant for central examinations if they are available by the end of the lecture period (CW21) at the latest. In the case of centrally organised mid-term examinations, the documents and materials up to CW 12 are relevant for testing.

Binding nature of the fact sheets:

- Course information as well as examination date (organised centrally/decentrally) and form of examination: from bidding start in CW 04 (Thursday, 28 January 2021);
- Examination information (regulations on aids, examination contents, examination literature) for decentralised examinations: in CW 12 (Monday, 22 March 2021);
- Examination information (regulations on aids, examination contents, examination literature) for centrally organised mid-term examinations: in CW 12 (Monday, 22 March 2021);
- Examination information (regulations on aids, examination contents, examination literature) for centrally organised examinations: two weeks before the end of the registration period in CW 14 (Thursday, 8 April 2021).