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Jianfeng Zhang

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Math 509, Stochastic Differential Equations, Fall 2023

Time and location: MWF 1:00pm – 1:50pm, KAP 113

Instructor: Jianfeng Zhang, KAP 248E, (213)7409805

Email: jianfenz@usc.edu Homepage: dornsife.usc.edu/jianfeng-zhang/

Office hours: M: 9:30-11:00am, W: 2:00-3:30pm or by appointment, KAP 248E

Textbook: *Backward Stochastic Differential Equations — from linear to fully nonlinear theory*, by Jianfeng Zhang.

Additional reading (optional):

- Brownian Motion and Stochastic Calculus, by Ioannis Karatzas and Steven Shreve
- Continuous Martingales and Brownian Motion, by Daniel Revuz and Marc Yor

Course Contents:

The course will cover the basic materials of Ito's stochastic calculus, and the standard theory of Stochastic Differential Equations. Moreover, I will introduce the basic materials of Backward Stochastic Differential Equations, which is closely related to standard SDEs and has been proved more and more important in applications. A tentative list of contents is as follows:

Chapter 1. Preliminaries

Chapter 2. Basics of stochastic calculus

- 2.1 Brownian motion
- 2.2 Stochastic integration
- 2.3 Ito's formula
- 2.4 Martingale representation theorem
- 2.5 Girsanov theorem

Chapter 3. Stochastic differential equations

- 3.1 Linear SDEs
- 3.2 A priori estimates for SDEs
- 3.3 Wellposedness of SDEs
- 3.4 Basic properties of SDEs
- 3.5 Weak solutions of SDEs

Chapter 4. Backward SDEs

- 4.1 Introduction
- 4.2 Linear BSDEs
- 4.3 A priori estimates of BSDEs
- 4.4 Wellposedness of BSDEs
- 4.5 Basic properties of BSDEs

Chapter 5. Markovian BSDEs, PDEs, and Probabilistic numerical methods

- 5.1 Nonlinear Feynman-Kac formula
- 5.2 Regularity of solutions
- 5.3 Time discretization of SDEs and BSDEs
- 5.4 Monte Carlo methods for BSDEs and PDEs

Grading and Examination Policies

40% of the grade will be based on homework assignments, 20% on the midterm exam, and 40% on the final exam.

Homework will be assigned in class approximately every two weeks. You are encouraged to discuss homework problems with classmates. However, you are not allowed to copy other people's work. Solutions to homework problems can be provided upon students' request.

The (50 minutes) midterm exam will be given in regular class time on **Oct. 6**, **Friday**. It will be open book, open notes, but noncooperative.

The final exam will be take-home, which will be handed out two weeks before the semester ends. You are not permitted to discuss the problems with others.

Feedback and Questions

It is very useful to get feedback and questions, both inside and outside class. You are very welcome to visit me during my office hours. You can also make appointments to see me (in person or in zoom) at other time.

Academic Integrity: The University of Southern California is foremost a learning community committed to fostering successful scholars and researchers dedicated to the pursuit of knowledge and the transmission of ideas. Academic misconduct is in contrast to the university's mission to educate students through a broad array of first-rank academic, professional, and extracurricular programs and includes any act of dishonesty in the submission of academic work (either in draft or final form).

This course will follow the expectations for academic integrity as stated in the <u>USC</u> <u>Student Handbook</u>. All students are expected to submit assignments that are original work and prepared specifically for the course/section in this academic term. You may not submit work written by others or "recycle" work prepared for other courses without obtaining written permission from the instructor(s). Students suspected of engaging in academic misconduct will be reported to the Office of Academic Integrity.

Other violations of academic misconduct include, but are not limited to, cheating, plagiarism, fabrication (e.g., falsifying data), knowingly assisting others in acts of academic dishonesty, and any act that gains or is intended to gain an unfair academic advantage.

The impact of academic dishonesty is far-reaching and is considered a serious offense against the university and could result in outcomes such as failure on the assignment, failure in the course, suspension, or even expulsion from the

university.

For more information about academic integrity see the <u>student handbook</u> or the <u>Office of Academic Integrity's website</u>, and university policies on <u>Research and</u> <u>Scholarship Misconduct</u>.

Students and Disability Accommodations: USC welcomes students with disabilities into all of the University's educational programs. <u>The Office of Student Accessibility Services</u>(OSAS) is responsible for the determination of appropriate accommodations for students who encounter disability-related barriers. Once a student has completed the OSAS process (registration, initial appointment, and submitted documentation) and accommodations are determined to be reasonable and appropriate, a Letter of Accommodation (LOA) will be available to generate for each course. The LOA must be given to each course instructor by the student and followed up with a discussion. This should be done as early in the semester as possible as accommodations are not retroactive. More information can be found at <u>osas.usc.edu</u>. You may contact OSAS at (213) 740-0776 or via email at <u>osasfrontdesk@usc.edu</u>.



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