KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
DEPARTMENT OF MATHEMATICAL SCIENCES

SEMESTER 241/ 2024

MATH 601
Stochastic Differential Equations and Applications

Instructor: Dr. Boubaker Smii

BOOK:

[1] B. Øksendal, Stochastic Differential Equations: An Introduction with Applications. 6th Edition. Springer 2010.

[2] **S.M. Ross*.** Introduction to Probability Models, 10th Edition. Academic Press, 2010.

Course Description: Probability spaces, characteristic functions, stochastic processes, martingales, Markov Chains, Brownian motion, Itô calculus, Itô formula, stochastic differential equations, applications of stochastic differential equations.

Pre-requisite: Graduate standing

COURSE OBJECTIVES

Stochastic processes and stochastic differential equations play a basic and steadily growing role in the description of phenomena occurring in the natural, technical and economical world.

The main objectives of the current course are:

* Provide the students with the basic mathematical instruments for the understanding of this important area of mathematics.

 * Give them access to a very active area of contemporary mathematical research.

* Put them in a position to actively handle problems arising from real world applications.

COURSE OUTCOMES

*Students will be able to analyse and solve some stochastic differential equations.

*They will have the basis for profitably attending future lectures related to more advanced topics and use SDE's in research, both at universities and industrial institutions.

* They will be at ease in handling problems in various areas of science, engineering and technology.

Syllabus:

Week	Date	**Review:** Riemann integrals, Lebesgue's integrals, Finite variation, measurable functions.
1	Aug.25-29	**1.1.** Axioms of Probability, probability measure and probability spaces
2	Sep.1-5	**1.2.** Conditional probabilities, Independent events **2.** Random variables **2.1.** Discrete and continuous random variables
3	Sep.8-12	**2.2.** Probability density function of a random variable **2.3.** Expectation of a function of a random variable **2.4.** Moments generating functions
4	Sep.15-19	**2.5.** Conditional expectation **2.6.** Limit Theorems
<td colspan="3" align="center">National Holiday September 22-23*</td>
5	Sep.24-26	**3.1.** Characteristic functions **3.2.** Properties of characteristic functions
6	Sep. 29- Oct.3	**3.3.** Stochastic processes, Poisson Process, Martingales **3.4.** Markov Chains
7	Oct.6-10	**4.1.** Brownian motion: Defining properties **4.2.** Processes derived from Brownian motion
8	Oct.13-17	**5.1.** The Riemann-Steiltjes integral **5.2.** Itô stochastic integral: A motivating example
<td colspan="3" align="center">Midterm Break November 19-23</td>
9	Oct.20-24	**6.1.** Itô stochastic integral for simple processes
10	Oct.27-Oct.31	**6.2.** Itô formula: A simple version of the Itô **lemma**
11	Nov.3-7	**6.3.** Extended version of Itô lemma
12	Nov.17-21	**7.1.** Stochastic Differential equations (SDEs)
13	Nov.24-28	**7.2.** Solving SDEs
14	Dec.1-5	**7.3.** Linear stochastic differential equations
15	Dec.8-12 **Dec.15**	**7.4.** Applications of SDEs **Review**

Midterm Exam Date: TBA

Attendance: Students are expected to attend all lecture classes.

➢ If a student misses a class, he/she is responsible for any announcement made in that class.

➢ A DN grade will be awarded to any student who accumulates <u>more than</u> 20% (**09**) unexcused absences or 33% (15) excused <u>and</u> unexcused absences.

Note: The student will be warned **twice** by his instructor before he/she is assigned a DN grade.

The Usage of Mobiles in Class: Students are not allowed to use mobiles for any purpose during class time. Students who want to use electronic devices to take notes must take permission from their instructor.

Violations of these rules will result in a penalty decided by the instructor.

Academic Integrity: All KFUPM policies regarding ethics apply to this course. See the Graduate Bulletin.

Cheating in Exams: Cheating or any attempt of cheating by use of illegal activities, techniques and forms of fraud will be reported to the higher university administration.

Cheating in exams includes (but is not limited to):

➢ looking at the papers of other students

➢ talking to other students

➢ using mobiles or any other electronic devices.

No student will be allowed to take the exam if not having his/her KFUPM ID or National/Iqama ID.

 DO NOT BRING YOUR MOBILE, SMART WATCH OR ANY ELECTRONIC DEVICE IN THE EXAM HALL.

Missing an Exam:

 In case a student misses Exam I or Final Exam for a <u>legitimate reason</u> (such as medical emergencies), he/she will be given a make-up exam.