Stochastic Processes

COURSE TIMES + LOCATION:
Tu 12:30 PM – 2:20 PM
AQ 5015, Burnaby

Th 12:30 PM – 1:20 PM
AQ 5015, Burnaby

EXAM TIMES + LOCATION:
Dec 20, 2021
7:00 PM – 10:00 PM
AQ 5046, Burnaby

INSTRUCTOR:
Jean-Francois Begin
jbegin@ sfu.ca

PREREQUISITES:
Dependent on the topic covered.

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CALENDAR DESCRIPTION:
Topics in areas of probability and statistics not covered in the regular undergraduate curriculum of the department.

COURSE DETAILS:
Prerequisties: None. Students should have some knowledge of option pricing and undergraduate nonmeasure theoretic probability.

Cross-listing: This course is cross-listed with ACMA 830.

Student Learning Objectives:
As a result of taking STAT 490, students should be able to:

1. Understand the probabilistic foundations needed for stochastic calculus (e.g., sample space, probability measure, sigma-algebra, measurable space).
2. Understand what are stochastic processes as well as the notion of iltration.
3. Compute expectations and conditional expectations (as well as other relevant moments).
4. Understand the notion of independence.
5. Describe what are martingales.
6. Describe and construct the Brownian motion.
7. Apply stochastic integration.
8. De ine stochastic differential equation.
9. Apply Ito's lemma.
10. Understand how to construct jump processes.
11. Understand the stylized facts of asset returns.
12. De ine and construct the main models used in inancial econometrics.
13. Understand the main parameter estimation strategies for asset models.
14. Describe the main features of economic scenario generators.
15. Describe the risk-neutral pricing.

16. Understand the binomial option pricing model.

17. Design advanced discrete-time market model.

18. Apply the Radon-Nikodym theorem.

19. Apply Girsanov's theorem.

20. Explain and employ replication.

21. Understand the martingale representation theorem.

22. Apply option pricing to realistic scenarios.

Course Outline:

This course is divided into ifteen chapters.

<u>**Part 1: Stochastic Processes**</u>

Chapter 1, Probabilistic Foundations: Sample space, Random variable, Probability measure, Distribution, Sigma-algebra, Measurable space, Probability triple.

Chapter 2, Stochastic Processes: Stochastic process, Filtration.

Chapter 3, Expectations: Independence, Conditional probability, Expectation, Moments, Conditional expectation.

Chapter 4, Martingales: De inition, Examples.

Chapter 5, Brownian Motion: Scaled random walks, Construction of the Brownian motion.

Chapter 6, Stochastic Integral: Riemann integration, Ito integration.

Chapter 7, Stochastic Di♂fferential Equations and Ito's Lemma: Ordinary differential equations, Ito's lemma, Product rule, Multidimensional Ito's lemma.

Chapter 8, Jump Processes: Poisson process, Compound Poisson process, Jump processes and their integrals, Stochastic calculus for jump processes.

<u>**Part 2: Financial Econometrics Models**</u>

Chapter 9, Asset Models: Stylized facts of returns, Continuous-time models (the Black-Scholes-Merton model, the Merton model, the Heston model, the Bates model, the Duf ie, Pan, and Singleton framework), Discretization, Discrete-time models (Regime-switching models, Autoregressive conditional heteroskedasticity, generalized ARCH, the stochastic vol ↕ ticit tochasticdels babi :R   a i

Course material, references, links and messages will be posted on the course website (Canvas). Students are e $\frac{1}{2}$ in
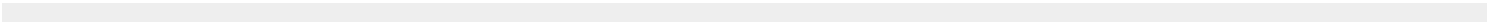
RECOMMENDED READING:

Hull, J. C. (2006). Options, Futures, and Other Derivatives. Pearson.

Lyaso, A. (2017). Stochastic Methods in Asset Pricing. The MIT Press.

McDonald, R. L. (2006). Derivatives Markets. Pearson.

Shreve, S. (2012). Stochastic Calculus for Finance I: The Binomial Asset Pricing Model. Springer Science & Business Media.

Shreve, S. (2004). Stochastic Calculus for Finance II: Continuous-Time Models. Springer Science & Business Media.

Many other references will be provided throughout the semester.

DEPARTMENT UNDERGRADUATE NOTES:

Students with Disabilities:
Students requiring accommodations as a result of disability must contact the Centre for Accessible Learning 778-782-3112 or csdo@sfu.ca

Tutor Requests:
Students looking for a tutor should visit hhttps://www.sfu.ca/stat-actsci/all-students/other-resources/tutoring.html. We accept no responsibility for the consequences of any actions taken related to tutors.

REGISTRAR NOTES:

ACADEMIC INTEGRITY: YOUR WORK, YOUR SUCCESS

SFU's Academic Integrity web site http://www.sfu.ca/students/academicintegrity.html is illed with information on what is meant by academic dishonesty, where you can ind resources to help with your studies and the consequences of cheating. Check out the site for more information and videos that help explain the issues in plain English.

Each student is responsible for his or her conduct as it affects the University community. Academic dishonesty, in whatever form, is ultimately destructive of the values of the University. Furthermore, it is unfair and discouraging to the majority of students who pursue their studies honestly. Scholarly integrity is required of all members of the University. http://www.sfu.ca/policies/gazette/student/s10-01.html

TEACHING AT SFU IN FALL 2021

Teaching at SFU in fall 2021 will involve primarily in-person instruction, with approximately 70 to 80 per cent of classes in person/on campus, with safety plans in place. Whether your course will be in-person or through remote methods will be clearly identi ied in the schedule of classes. You will also know at enrollment whether remote course components will be "live" (synchronous) or at your own pace (asynchronous).

Enrolling in a course acknowledges that you are able to attend in whatever format is required. You should not enroll in a course that is in-person if you are not able to return to campus, and should be aware that remote study may entail different modes of learning, interaction with your instructor, and ways of getting feedback on your work than may be the case for in-person classes.

Students with hidden or visible disabilities who may need class or exam accommodations, including in the context of remote learning, are advised to register with the SFU Centre for Accessible Learning (caladmin@sfu.ca or 778-782-3112) as early as possible in order to prepare for the fall 2021 term.