**Department of Statistical and Actuarial Sciences**

**FM4521B/9521B Course Outline**

**1. Course Information**

**Course Information**

**Course Name:** Advanced Financial Modelling

**Course Number:** FM4521B/9521B

**Academic Term:** Winter, 2024

**Lecture Hours:** Tuesday 11:30 AM – 12:30 PM Thursday 11:30 AM -1:30 PM

**Lecture Room**: AHB 1B02

**List of Prerequisites**

A minimum mark of 60% in either Financial Modelling 3520A/B, or Financial Modelling 3613A/B and a minimum mark of 60% in Statistical Sciences 2857A/B.

Unless you have either the requisites for this course or written special permission from your Dean’s Designate (Department/Program Counsellors and Science Academic Advisors) to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

**2. Instructor Information**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Instructors** | **Email** | **Office** | **Phone** | **Office Hours** |
| Dr. Ankush Agarwal  (Course Coordinator) | aagarw93@uwo.ca | WSC 227 | 519-661-2111 (x89731) |  |
| TA (TBA) |  |  |  |  |

Students must use their Western (@uwo.ca) email addresses when contacting their instructors.

Office hours: in-person at the specified time or via Zoom by appointment.

**3. Course Syllabus, Schedule, Delivery Mode**

In this course, you will learn continuous-‐time models, Brownian motion, stochastic integrals, Ito’s lemma, Black-‐Scholes-‐Merton model, arbitrage, and market completeness, Black-‐Scholes PDE, risk‐neutral pricing and martingale measures. Other topics include Greeks and hedging, extensions of Black‐Scholes model, implied volatility, American option valuation, Vasicek and Cox-‐Ingersoll-‐Ross interest rate models.

**Learning Outcomes**

Upon successful completion of this course, students will be able to:

* Use stochastic integral (SDE) to represent underlying risk assets.
* Use Ito’s lemma to work out various SDE forms.
* Explain the concepts underlying the risk-neutral approach to valuing derivative securities.
* Implement the risk-neutral pricing formula using Monte Carlo simulation.
* Interpret and compute option Greeks (Delta, Gamma, Theta, Vega, and Rho).

Classes begin: January 6, 2025

Spring Reading Week: February 15 – 23, 2025

Classes end: April 4, 2025

Exam period: April 7 – 30, 2025

**Contingency plan**

Although the intent is for this course to be delivered in person, should any university-declared emergency require some or all of the course to be delivered online, either synchronously or asynchronously, the course will adapt accordingly. The grading scheme will **not** change. Any assessments affected will be conducted online as determined by the course instructor.

**4. Course Materials**

**Main textbook**: John Hull (2022). Options, Futures, and Other Derivatives, 11th edition. Pearson Prentice ($66).

**Reference**: Jaksa Cvitanic and Fernando Zapatero (2004). Introduction to the Economics and Mathematics of Financial Markets. MIT Press, Cambridge, Massachusetts.

Specific Topics to covered with text and reference readings: **H = Hull text**; **CZ = Cvitanic and Zaptero reference**

1. Recap of pricing concepts from FM3520. Basic elements of stochastic processes, Brownian motion, Ito’s lemma, risk-‐neutral and martingale measures, Black-‐Scholes PDE, risk-‐neutral valuation, the connection between PDE and conditional expectation under the risk neutral measure pricing approaches. **Readings**: H Chapters 13, 14, 15 and CZ Section 7.2.

2. Extension of Black-‐Scholes to the pricing of options on stock indices, currencies, and futures. **Readings**: H Chapter 17 and CZ Sections 7.4.2,7.5.1,7.5.2.

3. Introduction to the basics of Monte Carlo Methods in Finance. **Readings**: H Section 21.6 and CZ Section 11.2.1.

4. American Options and their valuation using binomial trees. **Readings**: H Section 13.5 and CZ Section 7.3.

5. The Greeks and hedging in practice. **Readings**: H Chapter 19, CZ Sections 9.3.1-‐9.3.5, 9.3.7 and 9.3.8.

6. Implied Volatilities; volatility smiles, smirks, skews, and surfaces. **Readings**: H Chapter 20.

7. ARCH and GARCH. **Readings**: H Chapter 23 and CZ Section 7.8 (when time permits).

8. Exotic Options. **Readings**: H Chapter 26, CZ Sections 7.5.3 and 7.6.

9. Introduction to stochastic interest rate models (Vasicek/CIR) and term structure derivatives. **Readings**: H Sections 31.1-‐31.2.

All course material will be posted to OWL: https://westernu.brightspace.com/

Students are responsible for checking the course OWL site (https://westernu.brightspace.com/) regularly for news and updates. This is the primary method by which information will be disseminated to all students in the class.

If students need assistance with the course OWL site, they can seek support on the [OWL Brightspace Help](https://brightspacehelp.uwo.ca/) page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

**5. Methods of Evaluation**

**Grading Scheme and Assessment Dates**

The overall course grade will be calculated as listed below:

Assignments (4) 20% [Given out roughly every three weeks]

Midterm (2) 35% [In-class Exam 1: February 6, 2025 & In-class Exam 2: March 13, 2025] 2h closed book

Final Exam 45% [To be determined by the Registrar’s Office]

**Assignments**: There are 4 assignments, given out roughly one every three weeks. All assignments must be done electronically (all assignments must be prepared using RStudio Markdown/Notebook (PDF)) and be submitted to OWL before deadline. No late assignment is allowed unless a coupon(s) is used. See details below. For graduate students, per SPGS requirements, there is an extra question to work on in each assignment.

**Accommodated evaluations for midterms:** If you miss a midterm due to an excused absence (see also below) then the weight of that assessment will be moved to the final exam. If the absence is not excused, then you will receive a grade of zero with no option to submit late or alternate work.

**General information about missed coursework**

**For students enrolled in FM4521B**, if you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

Undergraduate Students must familiarize themselves with the University Policy on Academic

Consideration – Undergraduate Students in First Entry Programs posted on the Academic Calendar:

<https://www.uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration_Sep24.pdf>

This policy does not apply to requests for Academic Consideration submitted for **attempted or completed work**, whether online or in person.

The policy also does not apply to students experiencing longer-term impacts on their academic responsibilities. These students should consult [Accessible Education](http://academicsupport.uwo.ca/accessible_education/).

For procedures on how to submit Academic Consideration requests, please see the information posted on the Office of the Registrar’s webpage:

<https://registrar.uwo.ca/academics/academic_considerations/>

All requests for Academic Consideration must be made within 48 hours after the assessment date or submission deadline.

All Academic Consideration requests must include supporting documentation; however, recognizing

that formal documentation may not be available in some extenuating circumstances, the policy allows

students to make **one** Academic Consideration request without supporting documentation in this

course. However, the following assessments are excluded from this, and therefore always require

formal supporting documentation: **Midterm 2**

When a student *mistakenly* submits their one allowed Academic Consideration request **without supporting documentation** for the assessments listed above or those in the **Coursework with Assessment Flexibility** section below, the request cannot be recalled and reapplied. This privilege is forfeited.

**For students enrolled in FM9521B**, they must provide valid documentation for medical-related absences or adequate supporting documentation for non-medical absences to the instructor as soon as possible and no later than 48 hours after the missed assessment. Documentation for medical illness must include the completion of a Western Student Medical Certificate (SMC) or, where that is not possible, equivalent documentation, by a health care practitioner. The SMC is available online here:

<https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform>

**Evaluation Scheme for Missed Assessments**

**Assignments**: Each student has two coupons that can be used for handling assignments after passing the deadline. Each coupon allows up to 24 hours after deadline. That is, if an assignment is due on Feb 24, 11:55 pm, you can handle in your assignment before Feb 25, 11:55 pm with one coupon used. You can stack two coupons together so that you can handle in your assignment on Feb 26, 11:55 pm.

Late Submissions if two coupons are already used up.

* Assignments that are submitted late will be subject to a 20% penalty per day or portion thereof, including weekends and holidays.
* Assignments that are submitted 5 or more days late will not be graded.

Academic consideration requests will be denied if the two coupons are not used up. Further accommodation beyond late coupons and late penalty must be approved via Dean’s Office/ Academic Counselling unit of your Home Faculty. Students who obtain appropriate accommodation will have the weight of the missed assignment distributed to further assessments.

**Midterm**: No makeup midterm is given. If you miss a midterm, you must request accommodation from Academic Counselling in your Faculty’s Dean’s Office. The weight may be redistributed to other categories by the instructor.

**Final Exam**: When a student misses the Final Exam and their Academic Consideration has been granted, they will be allowed to write the Special Examination (the name given by the University to a makeup Final Exam). See the Academic Calendar for details (under [Special Examinations](https://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=5&SelectedCalendar=Live&ArchiveID=#SubHeading_70)), especially for those who miss multiple final exams within one examination period.

**6. Additional Statements**

**Religious Accommodation**

When conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request an accommodation for their absence in writing to the course instructor and/or the Academic Advising office of their Faculty of Registration. This notice should be made as early as possible but not later than two weeks prior to the writing or the examination (or one week prior to the writing of the test).

Please visit the Diversity Calendars posted on our university’s EDID website for the recognized religious holidays:

[https://www.edi.uwo.ca](https://www.edi.uwo.ca/).

**Accommodation Policies**

Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

[https://www.uwo.ca/univsec/pdf/academic\_policies/appeals/Academic Accommodation\_disabilities.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic%20Accommodation_disabilities.pdf).

**Academic Policies**

The website for Registrar Services is <https://www.registrar.uwo.ca/>.

In accordance with policy,

<https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf>,

the centrally administered e-mail account provided to students will be considered the individual’s official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

No electronic devices will be permitted on the midterm exam.

**Scholastic offences** are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

<https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf>.

**Support Services**

Please visit the Science & Basic Medical Sciences Academic Advising webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic-related matters: <https://www.uwo.ca/sci/counselling/>.

Students who are in emotional/mental distress should refer to Mental Health@Western (<https://uwo.ca/health/>) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

<https://www.uwo.ca/health/student_support/survivor_support/get-help.html>.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at

<http://academicsupport.uwo.ca/accessible_education/index.html>

if you have any questions regarding accommodations.

Learning-skills counsellors at Learning Development and Success ([https://learning.uwo.ca](https://learning.uwo.ca/)) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Additional student-run support services are offered by the USC,  <https://westernusc.ca/services/>.