COURSE OUTLINE FOR FINANCIAL MODELLING 3520

University Accreditation Program

This course is accredited under the Canadian Institute of Actuaries (CIA) University Accreditation Program (UAP) for the 2020-21 academic year.

Achievement of the established exemption grade in this course may qualify a student from exemptions from writing certain preliminary exams.

Please see the following link for full details:
http://www.cia-ica.ca/membership/university-accreditation-program---home

In addition to the university's internal policies on conduct, including academic misconduct, candidates pursuing credits for writing professional examinations shall also be subject to the **Code of Conduct and Ethics for Candidates in the CIA Education System** and the associated **Policy on Conduct and Ethics for Candidates in the CIA Education System**

1. Course information

Course name and number
FM 3520

Academic term
Fall 2020 (Sep - Dec 2020)

Location
Online via OWL

List of prerequisites
A minimum mark of 60% in one of Business Administration 4413A/B, Financial Modelling 2557A/B; **AND** a minimum mark of 60% in Statistical Sciences 2857A/B.

N.B.
Unless you have either the prerequisites for this course or written special permission from your Dean 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.

Technical requirements for the course
Stable internet connection, computer with working microphone and/or webcam, Microsoft Word and Excel.

2. Instructor's information
Instructor: Dr. Rogemar S. Mamon
Contact Info: rmamon@stats.uwo.ca

Important
Students must use their Western (@uwo.ca) email addresses when contacting the instructor. Email messages from non-UWO account will NOT be read.

The subject of your email should have the format: **FM 3520 (insert "at most 4 words about your query")**; failure to do so will cause a delayed response. The instructor will endeavour to respond to email messages within 48 hours.

Office hours
Zoom format. Links will be provided in the OWL site (when needed). Time/day(s) – TBD.

3. Assumed background of students

Introductory Derivatives – Forwards and Futures

The student, enrolled in FM 3520A, is assumed to have attained the following competencies (learnt from SS 2557B or equivalent) and must be able to:

1. Describe the characteristics and terms of the main derivatives instruments (including forwards and futures), more specifically,
a. Distinguish between long and short positions for both assets (including short selling of stocks) and derivatives on assets.
b. Recognise the transaction costs affecting profit calculations for both assets and derivatives on assets (including commissions and bid-ask spread).

2. Describe the characteristics and terms relating to both forward contracts and prepaid forward contracts:
a. Recognise the definitions of terms relating to both forward contracts and prepaid forward contracts.
b. Determine payoffs and profits for both long and short positions on forward contracts.
c. Calculate prices for both forward contracts and prepaid forward contracts on stocks with no dividends, continuous dividends, and discrete dividends.
d. Construct a synthetic forward from the underlying stock and a risk-free asset and identify arbitrage opportunities when the synthetic forward price is different from the market forward price.

3. Describe the characteristics and terms relating to both futures contracts and the associated margin accounts.
a. Recognise the definitions of the following terms: Marking to market, margin balance, maintenance margin, and margin call.
b. Evaluate an investor's margin balance based on changes in asset values.

4. Course syllabus, learning outcomes, and key sessional dates

Course description: Discrete-time market models, option pricing and replication, risk-neutral valuation and martingale measures, and the fundamental theorem of asset pricing. Discrete-time Black-Scholes. Value-at-risk, mean-variance portfolio analysis, binomial pricing model. Discrete-time interest rate models. Simulation.

NOTE: In consideration of the CIA accreditation, additional topics will be included in this course as per the CIA's IFM syllabus.

Lecture information
Given that registered students are coming from different time zones (e.g., some are 12 hours ahead of Ontario time), this course will be offered in an asynchronous-learning mode. *A pre-recorded video lecture will be posted twice a week (Tuesday and Friday by 12PM).*

Topics to be covered

I. General properties of options
II. Binomial pricing model
III. The Black-Scholes option valuation methodology
IV. Option's Greeks
V. Risk management: Value-at-Risk (VaR) and Conditional VaR
VI. Simulation (and applications involving interest-rate models)

Learning Outcomes

Options and their general properties

1. Explain the cash flow characteristics and terms relating to various options. More specifically,
a. Define and recognise the following terms: call and put options, expiration date, strike price, moneyness, and option style.
b. Calculate the payoff and profit on both long and short positions with respect to both call and put options.
c. Explain the cash flow characteristics of exotic options: Asian (arithmetic and geometric), barrier, compound, gap, exchange, and lookback.
d. Calculate the payoffs on exotic options: lookback, chooser, shout, rainbow, and forward start

2. Apply option strategies in a risk management context.
a. Recognise that a long put can be used as an insurance strategy for a long stock position and a short call can be used as an insurance strategy for a short stock position.
b. Explain how the following option strategies can be used as tools to manage financial risk or speculate on price or volatility: option spreads (bull, bear, ratio), collar, straddle, strangle, and butterfly spread.
c. Evaluate the payoff and profit of the option strategies described above.

3. Understand the general properties of options that affect option prices.
a. Apply put-call parity to European options on stocks with no dividends, continuous dividends, and discrete dividends.
b. Compare options with respect to term-to-maturity and strike price.
c. Identify factors affecting the early exercise of American options and the situations where the values of European and American options are the same.

II. Option valuation via the generalised *n*-period binomial model

4. Understand the concept of no arbitrage and the risk-neutral approach to valuing derivatives securities.
a. Explain the concept of no arbitrage when comparing actual and synthetic calls, or when comparing actual and synthetic puts.
b. Explain the concepts underlying the risk-neutral approach to valuing derivatives securities in the context of the Binomial Option Pricing Model.

5. Use the binomial option pricing model to calculate the value of call and put options:
a. Price options under a one-period binomial model on a stock with no dividends.
b. Extend the binomial model to multi-period settings for pricing European and American call and put options as well as the following option types: Asian, barrier, and gap.
c. Extend the binomial model to other underlying assets, including stock indices with continuous dividends, stocks with discrete dividends, currencies, and futures contracts.

III. Black-Scholes option pricing model

6. Explain the properties of the lognormal distribution and its applicability to option pricing.
a. Calculate lognormal-based probabilities and percentiles for stock prices.
b. Calculate lognormal-based means and variances of stock prices.
c. Calculate lognormal-based conditional expectations of stock prices given that options expire in-the-money.

7. Understand the Black-Scholes formula.
a. Recognise the assumptions underlying the Black-Scholes model.
b. Use the Black-Scholes Formula to value European calls and puts on stocks with no dividends, stock indices with continuous dividends, stocks with discrete dividends, currencies, and futures contracts.
c. Generalise the Black-Scholes Formula to value gap calls, gap puts, and exchange options, chooser options, and forward start options.
d. Estimate a stock's historical volatility from past stock price data.

IV. Option's Greeks

8. Explain the calculation and use of option price partial derivatives.
a. Compute and interpret Option Greeks, including Delta, Gamma, Theta, Vega, Rho, and Psi.
b. Compute the elasticity, Sharpe ratio, and risk premium for both an individual option (call or put) and a portfolio consisting of both options of multiple types and the underlying stock.
c. Approximate option prices using Delta, Gamma, and Theta

9. Explain how to control risk by using options in a hedging context.
a. Perform delta hedging by calculating the quantities of option units, stock shares, and cash to hold, and whether those positions should be long or short.
b. Perform gamma hedging by calculating the quantities of option units (of various types) and stock shares to hold, and whether those positions should be long or short.

V. VaR and CVaR

10. Examine the risk metric widely used by corporate treasurers and fund managers.
a. Provide a single number reflecting the total risk in a portfolio of financial assets.
b. Describe and implement two main approaches for calculating VaR.

VI. Simulation

**11. Apply Monte-Carlo simulation to price derivatives and compute risk measures.**
a. Learn the discretisation of a stochastic process underlying the valuation of risk management of simple derivatives along with generating random numbers for several statistical distributions.
b. Implement the pricing and VaR calculation numerically together with the confidence intervals of the results.

Reminder of key sessional dates

Sep 9	Classes begin
Sep 17	Last day to add a full course or first-term half course
Oct 12	Thanksgiving
Nov 2-8	Fall Reading Week
Nov 9	Date by which students in a first-term half course must receive assessment for work totaling 15% of their final grade
Nov 12	Last day to withdraw from a first-term half course without academic penalty
Nov 27	Date by which students in a full course must receive assessment for work totaling 15% of their final grade
Nov 30	Last day to withdraw from a full course without academic penalty
Dec 9	Last day of classes in Fall Term
Dec 10	Study Days
Dec 11-22	December-2020 examination period

5. Textbooks

[JH] John Hull (2018). *Options, Futures, and Other Derivatives.* 10th edition. Pearson Prentice Hall, New Jersey.
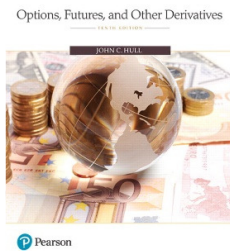
[RM] Robert McDonald (2013). *Derivatives Markets*. 3rd edition. Pearson Prentice Hall, New Jersey.
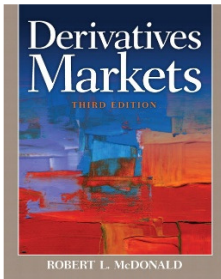
Relevant [RM] chapters: 10-14, 18-22, & 25
Relevant [JH] chapters: 13, 14, 15.1-15.9, 18.6, 19.1-19.11 & 19.13,
21.1-21.3 & 21.6, 22.1-22.8, 26.1-26.15

NOTE: *The relevant readings above are tentative, and they may be subject to modification. Any changes will be posted on the course website.*

6. Related course materials

Students should check OWL (http://owl.uwo.ca) on a regular basis for news and updates. This is the primary method by which information will be disseminated to all students in the class. Students are responsible for checking OWL on a regular basis.

All course materials will be posted on the OWL website: http://owl.uwo.ca.

If students need assistance, they can seek support from the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

7. Methods of evaluation

The overall course grade will be calculated as listed below:

Exam 1   (Fri, 02 Oct 2020 @7:00PM EST)   13%
Exam 2   (Fri, 30 Oct 2020 @7:00PM EST)   13%
Exam 3   (Fri, 27 Nov 2020 @7:00PM EST)   14%
Final Exam (TBD – scheduled by
**   the Registrar's Office)   60%**

One week prior, the coverage of any test and final examination will be posted in the OWL site. Practice exercises will be provided to strengthen students' preparation for the exams.

Missed exams/tests

If you have a conflict, <u>please see me as soon as possible (and **prior** to the test)</u>. <u>There will be no make-up tests or assignments.</u> For those who legitimately miss a test/exam and provide the required supporting documentation, the standard practice will be that the weight of the missed test will be reassigned to the final exam.

8. Accommodation and accessibility

Accommodation policies

Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The Academic Accommodation for Students with Disabilities policy can be found at: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic Accommodation_disabilities.pdf

Academic consideration for student absence

Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the semester, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student's final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student's final grade,
- if a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are *not* met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. **All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.**

For policy on <u>Academic Consideration for Student Absences</u> - Undergraduate Students in First Entry Programs, see:
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Consideration_for_absences.pdf
and for the Student Medical Certificate (SMC), see:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf

Religious accommodation
Students should consult the University's list of recognised religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the Western Multicultural Calendar:
https://multiculturalcalendar.com/ecal/index.php?s=c-univwo

If a student fails to write a scheduled Special Examination in the case of a missed final exam with a valid excuse, the date of the next Special Examination (if granted) normally will be the scheduled date for the final exam the next time this course is offered. The maximum course load for that term will be reduced by the credit of the course(s) for which the final examination has been deferred. See Academic Calendar for details (under Special Examinations).

9. Academic policies
The website for Registrarial Services is http://www.registrar.uwo.ca.

In accordance with policy, http://www.uwo.ca/its/identity/activatenonstudent.html, 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 his/her official university address is attended to in a timely manner.

Remote learning sessions for this course may be recorded. The data captured during these recordings may include your image, voice recordings, chat logs and personal identifiers (name displayed on the screen). The recordings will be used for educational purposes related to this course, including evaluations. The recordings may be disclosed to other individuals participating in the course for their private or group study purposes. Please contact the instructor if you have any concerns related to session recordings.

Participants in this course are NOT permitted to record the sessions, except where recording is an approved accommodation, or the participant has the prior written permission of the instructor.

Any **non-programmable calculators are permitted** during the exam; note that <u>mobile phones</u> and other <u>electronic communication devices</u> are **strictly prohibited.**

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: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf.

Tests and examinations in this course may be conducted using the remote proctoring service, such as Proctortrack. By taking this course, you are consenting to the use of this software and acknowledge that you will be required to provide **personal information** (including some biometric data) and the session will be **recorded**.

Alternatively, tests and examinations in this course may be conducted using Zoom. You will be required to keep your camera on for the entire session, hold up your student card for identification purposes, and share your screen with the invigilator if asked to do so at any time during the exam.

More information about these remote proctoring services is available in the Online Proctoring Guidelines at the following link:
https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf

Completion of this course will require you to have a reliable internet connection and a device that meets the technical requirements for this service. Information about the technical requirements are available at the following link:
https://www.proctortrack.com/tech-requirements/
https://support.zoom.us/hc/en-us

10. Support services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on add/drop courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: https://www.uwo.ca/sci/counselling/

You may also wish to contact Student Accessibility Services (SAS) at (519) 661-2147 if you have any questions regarding accommodations.

We encourage you to check out the Digital Student Experience website to manage your academics and well-being: https://www.uwo.ca/se/digital/. Students who are in emotional/mental distress should refer to Mental Health@Western (http://www.health.uwo.ca/mental_health) for a complete list of options about how to obtain help.