

UNIVERSITY OF TORONTO
DEPARTMENT OF STATISTICAL SCIENCES
STA457H1S LEC0101/LEC0201/LEC2001; STA2202H S LEC0201
(Time Series Analysis), Winter 2024

1 COURSE DESCRIPTION

Syllabus: An overview of methods and problems in the analysis of time series data. Topics include: descriptive methods, filtering and smoothing time series, theory of stationary processes, identification and estimation of time series models, forecasting, seasonal adjustment, spectral estimation, bivariate time series models.

The learning objectives of this course are: By the end of this course, all students should have a sound understanding of theory, methods and problems in analyzing time series data with a primary application in Economics, Business, Finance, Physical and Environmental Sciences. The course will cover theoretical and practical aspects of time series analysis, making extensive use of R statistical software.

- Understand and reason with the basic time series concepts.
- Interpret and compare different time series models.
- Identify and model different types of time series data.
- Perform time series modelling/forecasting and present the results.
- Use R to construct time series models and conduct analysis.

Note: Important announcements, modules, and other course information will be regularly posted on the course web page of Quercus. It is an online platform to learn effectively this course.

Prerequisite: STA302H1/ STAC67H3/ STA302H5; MAT235Y1/ MAT237Y1/ MAT257Y1/(MATB41H3, MATB42H3)/(MAT232H5, MAT236H5)/(MAT233H5, MAT236H5).

Exclusion: STAD57H3, STA457H5

Breadth Requirements: The Physical and Mathematical Universes (5)

2 COURSE SCHEDULE

We will use the scheduled lecture times for each section.

Activity	Section	
	LEC0101	LEC0201/LEC2001/STA2202H S LEC0201
Lecture time	Tuesday 9am - 11am, Thursday 9am - 10am	Tuesday 1pm - 3pm Thursday 2pm - 3pm

3 INSTRUCTOR

Selvakadunko Selvaratnam (Selva)

Email for this course: sta457@utoronto.ca

PhD in Statistics, Memorial University of Newfoundland

Assistant Professor (teaching stream), Department of Statistical Sciences, University of Toronto.

4 OFFICE HOURS

Office hours will be posted on Quercus, held via Microsoft Teams or Zoom and links will be provided on Quercus.

5 TEXTBOOKS

- (1) Time Series Analysis and Its Applications, with R examples, 4th ed. 2017, by Robert H. Shumway and David S. Stoffer, *Springer*.

You can access a digital textbook from the online library of the University of Toronto by clicking <https://link-springer-com.myaccess.library.utoronto.ca/book/10.1007/978-3-319-52452-8>

- (2) Forecasting: Principles and Practice, 2021, by Rob J Hyndman and George Athanasopoulos.

You can access a digital textbook from the online by clicking <https://otexts.com/fpp3/>

- (3) Introduction to Time Series and Forecasting, 3rd Edition 2016, by Peter J. Brockwell and Richard A. Davis, *Springer*.

You can access a digital textbook from the online library of the University of Toronto by clicking <https://link-springer-com.myaccess.library.utoronto.ca/book/10.1007/978-3-319-29854-2>

6 COURSE STRUCTURE

Quercus Page: All lecture slides, assignments, and other course materials will be posted on Quercus under Modules. Course materials provided on Quercus are for the use of students currently enrolled in this course only. Distributing course materials to anyone outside of the course is considered unauthorized use.

Assignments/Course Reflections: Answers for Assignments/Course Reflections must be submitted on Crowdmark.

- Assignments and course Reflections submitted in other ways (e.g. over email) will not be accepted. There are no make-up assignments/course Reflections.
- A penalty of 5% for every hour will be applied for a late assignment/course reflection. For example, if an assignment is submitted 10 minutes after the due date and time, there would be a penalty of 5% on the assignment grade (i.e. 90% \rightarrow 85.5%).

Course Reflections: There will be 10 weekly course reflections. The course reflections will have short-answer questions and will be distributed to the students via Crowdmark. Students will upload their answers on the Crowdmark platform. You are expected to handwrite the proofs and use R software for computations.

Assignments: The assignments will have short-answer questions and will be distributed to the students via Crowdmark. Students will upload their answers on the Crowdmark platform. You are expected to handwrite the proofs and use R software for computations. Students must upload answers for each question of an assignment on the appropriate section of Crowdmark by 5:00pm on their respective due dates. If you upload answers for all questions of an assignment as one file on a particular section of Crowdmark page, 15% points of total assigned points will be deducted for the assignment.

Midterm exam: The midterm exam will be in-person test during class time on the test day. The test will have short-answer questions including computations and proofs. Short answers may require you to interpret R output and

use them to answer. The midterm exam will cover course materials that we would learn before the midterm exam. The duration of the midterm exam will be 90 minutes. The midterm exam will be held during the class time and details can be found under the section “**Evaluation**”.

Final exam: The final exam will be in-person. The exam will have short-answer questions including computations and proofs. Short answers may require you to interpret R output and use them to answer. There will be a 3-hour cumulative final exam. Also, the final exam will be scheduled and conducted by the Faculty of Arts and Science during the final assessment period (i.e., April).

7 EVALUATION

The final course marks will be computed by the following methods.

Type of assessment	Weight of total marks	Due date
Assignment 1	7%	Friday, February 2 at 5.00pm
Assignment 2	7%	Friday, March 15 at 5.00pm
Assignment 3	8%	Friday, April 5 at 5.00pm
Course Reflections (Best 8 out of 10)	$(8 \times 1\% = 8\%)$	Due each Sunday at 11:59pm
Midterm Exam	25%	Tuesday, Feb. 13, 9am - 11am for LEC0101, Room: TBD Tuesday, Feb. 13, 1pm - 3pm for LEC0201/LEC2001 Room: TBD Tuesday, Feb. 13, 1pm - 3pm for STA2202H S LEC0201 Room: TBD
Final Exam	45%	TBD, will be held during the final assessment period

8 TENTATIVE LECTURE GUIDE

	Dates (2024)	Modules	Topics
1	Jan. 8 - 12	Module 1	Characteristics of Time Series
2	Jan. 15 - 19	Module 2	Time Series Regression and Exploratory Data Analysis
3	Jan. 22 - 26	Module 2	Time Series Regression and Exploratory Data Analysis
4	Jan. 29 - Feb. 2	Module 3	ARIMA Models
5	Feb. 5 - 9	Module 3	ARIMA Models
6	Feb. 12 - 16	Module 3	ARIMA Models
7	Feb. 26 - Mar. 1	Module 3	ARIMA Models
8	Mar. 4 - 8	Module 4	Spectral Analysis and Filtering
9	Mar. 11 - 15	Module 4	Spectral Analysis and Filtering
10	Mar. 18 - 22	Module 4	Spectral Analysis and Filtering
11	Mar. 25 - 29	Module 5	Additional Time Domain Topics
12	Apr. 1 - 5	Module 5	Additional Time Domain Topics

9 MISSED ASSESSMENTS

Guidelines: If you miss the midterm/assignment for a legitimate reason, you can submit a request for accommodation for a missed assignment or midterm. You must complete the “Missed STA457H1S Assessment Form” (available on Quercus) within one week of missing the assignment or midterm. In this form, you will need to upload/submit one of the following supporting documents that covers the date(s) of your missed assessments:

- Absence declaration via ACORN - see (<https://www.artsci.utoronto.ca/current/academics/student-absences>)
- U of T Verification of Illness or Injury Form (VOI) - see <http://www.illnessverification.utoronto.ca>
- College Registrar's letter
- Letter of Academic Accommodation from Accessibility Services

Midterm Exam: There will be no make-up midterm exam. If you miss the midterm exam for a legitimate reason, then you should complete and submit the "Missed STA457H1S Assessment Form" to transfer the weight of the midterm exam to the final exam.

Assignments: Assignments must be submitted on Crowdmark by the deadlines and that there are no extensions or make-ups for assignments. If you miss an assignment for a legitimate reason, then you should complete and submit the "Missed STA457H1S Assessment Form", in which case, its weight will be equally distributed across your midterm and final exam.

Note: At most the weight of one missed assessment (either an assignment or a midterm) can be added to the weight of the final exam.

Course Reflections: Top 8 of 10 course Reflections will be recorded for the calculation of the final grade. There will be no make-ups for course reflections.

Final exam: If students miss the final exam, they will need to submit a petition for a deferred final exam through the Faculty of Arts and Science (see <https://www.artsci.utoronto.ca/current/faculty-registrar/petitions/deferred-exams>).

10 REGRADE POLICY

Midterm/Assignments/Course Reflections: Firstly, you should review marking schemes/solutions before requesting a reread. If you still have concerns about your grading, complete and submit "STA457H1S Regrade Request Form" (available on Quercus) within one week of the date the marks for an assessment are posted on Quercus. Late requests will not be accepted. Note that your grade may increase, stay the same, or it may go down based on the regrade.

Final examination view and regrade: Details can be found in <https://www.artsci.utoronto.ca/current/faculty-registrar/exams-assessments/exam-viewing> and <https://www.artsci.utoronto.ca/current/faculty-registrar/exams-assessments/exam-recheck-or-reread>

11 IMPORTANT DATES

Classes in S courses begin	January 8, 2024
Last day to enrol in S courses	January 21, 2024
Family Day - University closed; no classes	February 19, 2024
Reading week	February 19 - 23, 2024
Last day to drop S courses	March 11, 2024
Good Friday - University closed; no classes	March 29, 2024
Classes end in S courses	April 5, 2024
Study day	April 9, 2024
Final exams in S courses	April 10 - 30, 2024

12 COURSE CONDUCT

- **Quercus Discussions:** Questions regarding course materials and concepts should be addressed by office hours/Quercus Discussions. Any administrative/personal/sensitive questions should be addressed via email (sta457@utoronto.ca).
- **Email:** All students are given a UToronto email address. This email address is available to the course instructor who may distribute relevant course information or announcements via email. The University regularly communicates with students via email. Check your UToronto email regularly or forward it to an email address that you check regularly. If you use email to communicate with your instructor, you must use your UToronto account. This is to protect your privacy: if a non-UToronto account is used, there is no way for the instructor to verify the identity of the sender.
- **Programming Languages:** RStudio (free download from <https://www.rstudio.com/>), statistical software, will be taught. Also, you can use a cloud-based version of RStudio at University of Toronto by using the link: <https://r.datatools.utoronto.ca/> Instructions using RStudio will be provided during lecture sessions, and initial codes will be provided where appropriate. By the end of the course, you are expected to apply RStudio to analysis time series data.
- **Recording and/or Distribution of Course Materials:** Audio or video recording, digital or otherwise, of lectures, or any other teaching environment by students is allowed only with the prior written consent of the instructor or as a part of an approved accommodation plan. Student or instructor content, digital or otherwise, created and/or used within the context of the course is to be used solely for personal study, and is not to be used or distributed for any other purpose without prior written consent from the content author(s).

13 ACCESSIBILITY SERVICES

The University of Toronto provides accommodations through accessibility services to students with diverse learning styles and needs. If you have a disability or health consideration that may require accommodations, please feel free to reach out to Accessibility Services at 416-978-8060 or through accessibility.services@utoronto.ca

14 STUDENT RESPONSIBILITIES

Academic Integrity: Participating honestly, respectfully, responsibly, and fairly in this academic community ensures that the University of Toronto degree that you earn will be valued as a true indication of your individual academic achievement, and will continue to receive the respect and recognition it deserves. Familiarize yourself

with the University of Toronto's Code of Behaviour on Academic Matter <https://governingcouncil.utoronto.ca/secretariat/policies/code-behaviour-academic-matters-july-1-2019>

You are encouraged to visit <https://www.academicintegrity.utoronto.ca/> for more information on Academic Integrity at the University of Toronto.

Potential offences including, but not limited to:

- Obtaining or providing unauthorized assistance on any exam/assignment including:
 - (i) working in groups on individual assessments, including giving hints to the answer
 - (ii) having someone rewrite, edit, or add material to your independent work
 - (iii) researching for inspiration, hints, or answers to any graded problem
 - (iv) posting active assessment questions on discussion boards/private tutoring companies for hints/solutions
- Lending your work to a classmate who submits it as their own with or without your permission. The University of Toronto treats cases of academic misconduct very seriously. All suspected cases of academic dishonesty will be investigated following the procedures outlined in the Code. The consequences for academic misconduct can be severe, including a failure in the course and a notation on your transcript. If you have any questions about what is or is not permitted in this course, please do not hesitate to contact the instructor. If you are experiencing personal challenges that are having an impact on your academic work, please speak to the instructor or seek the advice of your college registrar.
- **Use of Generative AI**

This course policy has been designed to promote your learning and intellectual development. The use of generative artificial intelligence tools or apps in all course assessments of this course, including tools like ChatGPT and other AI writing or coding assistants, is prohibited. Students may not copy or paraphrase from any generative artificial intelligence applications, including ChatGPT and other AI writing and coding assistants, for the purpose of completing assignments in this course. Use of generative AI in this course is considered use of an unauthorized aid, which is a form of cheating.