Land Acknowledgement

We wish to acknowledge the land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

Resource: native-land.ca

Course Formats Highlights

This course is an in-person course. Any deviations from this document will be announced on the Quercus. Please keep visited regularly the website link FAS student FAQs.
1. **Course logistics (Instructor and Team, Class time, Office hours)**

   This is an in-person course.

   **Instructor:** Esam Mahdi  
   **Email:** e.mahdi@utoronto.ca  

   **Class Day/Time:**  
<table>
<thead>
<tr>
<th>Section</th>
<th>Lecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEC5101</td>
<td>Tuesday 6-9 pm,</td>
</tr>
<tr>
<td></td>
<td>Room: <strong>MS 3153</strong></td>
</tr>
<tr>
<td></td>
<td>First lecture: September 13, 2022</td>
</tr>
</tbody>
</table>

   We will follow “U of T time” and begin 10 minutes past the hour.

   **Instructor’s Office hour:** Wednesday, 4:30 – 5:30 pm via zoom-link (posted on Quercus). Any change will be decided during the first lecture.

   TAs and their office hours will be announced on Quercus.

   All course content (e.g., lecture slides/PDF etc.) will be available on Quercus. and links therein (https://q.utoronto.ca). For security reasons, please do not copy or share the Zoom links anywhere.

   The majority of course communication and announcements will happen through Quercus. It is your responsibility to check Quercus regularly.

   **Communicating with the Instructor**

   Before emailing your instructor, please:
   - re-read this syllabus to see if the answer is already here,
   - check the announcement and modules posted on Quercus,
   - ask your Teaching Assistant (TA),
   - post your questions to Piazza,
   - meet during office hours

   If your question is not answered after looking through these resources, then please email the instructor.

   **When emailing your instructor, please use the subject line:** STA457 H1F.  
   **If this subject is not included, your email may be missed.**

2. **Course Overview**

   **Course Description:**

   This course provides 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. Further topics, such as long memory, fractional differencing, and ARCH/GARCH models, will be covered. The course will cover both theoretical and practical aspects of time series analysis, making extensive use of the R statistical software.

Intended Learning Outcomes

• Understand the characteristics and nature of time series.
• Perform time series modelling, estimating, forecasting and present the results using real-world problems.
• Build a solid theoretical background for the subject.
• Use statistical software R with time series analysis.

Prerequisites: STA302H1/STAC67H3/STA302H5; MAT235Y1/MAT237Y1/MAT257Y1/(MATB41H3, MATB42H3)/(MAT232H5, MAT236H5)/(MAT233H5, MAT236H5). If you do not have this prerequisite, you should see the undergraduate coordinator in the Department of Statistical Sciences to obtain a waiver form.

Exclusion: STAD57H3, STA457H5

3. Course Materials, Textbooks & Supplementary Learning Resources


• Recommended Textbook: The following books are also good references for this course:

Topics to be covered:

**Characteristics of Time Series:**
• Introduction, Time series data, Time series plots
• Time series statistical models (stationary and non-stationary), Pre-processing and filtering
• Measures of dependence, Autocovariance and Autocorrelation

**Time Series Regression**
• Linear regression model and model selection
• Regression with lagged variables, Regression models involving trigonometric terms, Smoothing, differencing, transformations

**ARIMA Models**
• Autoregressive model, Moving Average model, Mixed autoregressive-moving average (ARMA) models
• MA in an infinite AR representation, AR in an infinite MA representation
• The autocorrelation and partial autocorrelation function of ARMA models, Test for stationarity (Dickey-Fuller test)
• Forecasting ARMA models, Durbin-Levinson algorithm, Yule-Walker equations, Model diagnosis
• Regression with autocorrelated errors, Detecting autocorrelation (Durbin–Watson test), Multiplicative seasonal ARIMA (SARIMA) models

**Additional Time Domain Topics**
• Spectral analysis (spectral density and covariance functions), Long memory ARMA and fractional differencing, ARCH and GARCH models

4. Computations

We will use R for all examples. R is freely available for download at [http://cran.rproject.org](http://cran.rproject.org) for Windows, Mac, and
Linux operating systems. It is strongly recommended that you also download R Studio (www.rstudio.com) to accompany R for a nicer user interface. You can also use the server version of RStudio on https://jupyter.utoronto.ca. All students and faculty have access to this resource. This means that you don’t have to download and install R and RStudio. If you are interested in learning to replicate the work done in the video lectures, there are option R videos that walks you through the syntax and steps in R.

Calculators (for in-person tests/exams)

You will need a calculator. Any calculator that has logarithmic functions will be sufficient. Calculators on phones or other devices equipped to communicate with the outside world (for example, through the internet or cellular or satellite phone networks) will not be permitted during the term tests or final exam.

5. Assessments & Grading

Homework assignment will be completed online. Midterm and final exams will be completed in-person, i.e., on paper under invigilation.

5.1 Marking Scheme

- 30% Homework (HW) assignments (3 assignments, so each worth 10%)
- 30% Midterm Test (in-person during class time at a location that will be specified on Quercus)
- 40% Final Assessment (in-person as specified by the Faculty of Arts and Science later)

5.2 Assessment Details

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Modules covered</th>
<th>Due Date (test duration)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HW 1</td>
<td>1, 2</td>
<td>Sept 30 (Friday)</td>
</tr>
<tr>
<td>HW 2</td>
<td>3, 4</td>
<td>Oct 14 (Friday)</td>
</tr>
<tr>
<td>Midterm Test</td>
<td>1, 2, 3, 4, 5, 6</td>
<td>Oct 25 (Tuesday)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(6:20 – 7:50 pm; 90 mins) Test location: TBA</td>
</tr>
<tr>
<td>HW 3</td>
<td>5, 6, 7, 8, 9</td>
<td>Dec 2 (Friday)</td>
</tr>
<tr>
<td>Final Assessment</td>
<td>1 – 11</td>
<td>TBA</td>
</tr>
</tbody>
</table>

TBA: To be announced (on Quercus).

5.3 Homework assignments

The homework assignments will be posted on Quercus as pdf files. You need to organize your solution, showing your steps clearly and in detail. You have to submit the solution of an assignment as a one pdf file before the due time at 5 pm.

Missed Homework Assignments (due to valid reasons)

There are no make-ups for missed homework assignments. If a homework is missed for a valid reason (e.g., illness or personal emergency), then within one week following the assessment you must fill out the absence declaration form on ACORN and on Quercus. For each such missed assignment, the 50% of the total weight (of 10%) for that homework assignment will be shifted to the other homework assignments (i.e., 5% weight) and the remaining to the final assessment (i.e., 5% weight). Otherwise, a missed homework will be assigned a grade of zero.

5.4 Midterm Test

Midterm and final exams will be completed in-person, i.e., on paper under invigilation. The term test will be written during class time. You will be permitted to bring an 8.5”x11”, two-sided, handwritten aid sheet. For the time, date, and location, see Section 5.2. Students will only be allowed to write the term test in their section. You must bring your student identification to the term test.

Late submission: There is no possibility of submitting Term tests late.

Missed Midterm test

There are no make-ups for missed midterm test. If the test is missed for a valid reason (e.g., illness or personal emergency), then within one week following the assessment you must fill out the absence declaration form on
ACORN and then send me an email. If the midterm test is missed due to illness or personal emergency, its 100% weight will be shifted to the final (i.e., the final will account for 70% of the course grades).

5.5 Final exam
The faculty of arts and science schedules the final exam. You will be permitted to bring a 8.5”x11”, **two-sided, handwritten** aid sheet. You must bring your student identification to the final exam.

**Late submission:** There is no possibility of submitting the final exam **late**.

**Final Exam Absences or Exemptions**
If a student misses the final exam for any reason, then they should contact their College Registrar’s office or work through Accessibility Services if it is a matter of accommodation.

5.6 Minimum passing requirement
In addition to the U of T grading policy, students must complete the final assessment to pass the course.

5.7 Re-mark Requests
Any requests to have a homework assignment or term test re-marked must be made in writing to me within one week of receiving your marks. Note that it is possible for a re-mark to result in a lower grade. Requests to re-mark the final exam will be handled at the department-level.

6. Intellectual Property
Course materials provided on Quercus, such as lecture slides, assignments, tests and solutions are the intellectual property of your instructor and are for the use of students currently enrolled in this course only. **Providing course materials to any person or company outside of the course is an unauthorized use.**

7. Accessibility
Students with diverse learning styles and needs are welcome in this course. If you have a disability/health consideration that may require accommodations, please feel free to approach me and/or Accessibility Services as soon as possible at 416-978 8060; studentlife.utoronto.ca/as. The Accessibility Services staff are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations. The sooner you let them and me know your needs, the quicker we can assist you in achieving your learning goals in this course. More information can be found here: [www.accessibility.utoronto.ca](http://www.accessibility.utoronto.ca).

8. Accommodations
The University of Toronto supports reasonable accommodation of the needs of students who observe religious holy days other than those already accommodated by ordinary scheduling and statutory holidays. As mentioned on the webpage below, please let me know if you require accommodations or expect absences, and I will make reasonable effort to make accommodations at these times. More information: [https://www.viceprovoststudents.utoronto.ca/policies-guidelines/accommodation-religious/](https://www.viceprovoststudents.utoronto.ca/policies-guidelines/accommodation-religious/).

9. Academic Integrity
The University treats cases of plagiarism and cheating very seriously. It is the students’ responsibility for knowing the content of the University of Toronto’s **Code of Behaviour on Academic Matters**. All suspected cases of academic dishonesty will be investigated following the procedures outlined in the above document. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see [https://www.academicintegrity.utoronto.ca/](https://www.academicintegrity.utoronto.ca/)). Here are a few guidelines regarding academic integrity:
- You may consult class notes/lecture slides during homework, however sharing or discussing questions or answers with others is an academic offence.
- Students must complete all assessments individually. Working together is not allowed.
- Paying anyone else to complete your assessments for you is an academic misconduct.
• Sharing your answers/work with others is academic misconduct.
• Copying solutions to homework problems from online or a book is an academic offence.
• All work that you submit must be your own! You must not copy answers from anyone or anywhere else.
  Unacknowledged copying or unauthorized collaboration will lead to severe disciplinary action, beginning with
  an automatic grade of zero for all involved and escalating from there. Please read the UofT Policy on Cheating
  and Plagiarism, and don’t plagiarize.

10. Class Schedule – Tentative
The lectures of this course will be posted on Quercus as a beamer presentation slides. The Module numbers listed in the
table below correspond to the lectures that we will cover. It is highly recommended to read them prior your lecture.
Any changes to the schedule will be announced and posted on Quercus.

<table>
<thead>
<tr>
<th>Week</th>
<th>Lecture (Tuesday)</th>
<th>What’s due/important?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sept 6</td>
<td>no class</td>
</tr>
<tr>
<td>2</td>
<td>Sept 13</td>
<td>Module 1</td>
</tr>
<tr>
<td>3</td>
<td>Sept 20</td>
<td>Module 2</td>
</tr>
<tr>
<td>4</td>
<td>Sept 27</td>
<td>Module 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>HW 1 due Sept 30</td>
</tr>
<tr>
<td>5</td>
<td>Oct 4</td>
<td>Module 4</td>
</tr>
<tr>
<td>6</td>
<td>Oct 11</td>
<td>Module 5</td>
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<tr>
<td></td>
<td></td>
<td>HW 2 due Oct 14</td>
</tr>
<tr>
<td>7</td>
<td>Oct 18</td>
<td>Module 6</td>
</tr>
<tr>
<td>8</td>
<td>Oct 25</td>
<td>Monday: Midterm Test (coverage 1 to 6 modules)</td>
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<tr>
<td></td>
<td></td>
<td>Midterm test, Test location: TBA (Tuesday, October 25, 2022) (6:20 – 7:50 pm; 90 mins)</td>
</tr>
<tr>
<td>9</td>
<td>Nov 1</td>
<td>Module 7</td>
</tr>
<tr>
<td>10</td>
<td>Nov 8</td>
<td>No class (Reading Week)</td>
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<tr>
<td></td>
<td></td>
<td>Rest and relax 😊</td>
</tr>
<tr>
<td>11</td>
<td>Nov 15</td>
<td>Module 8</td>
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<tr>
<td>12</td>
<td>Nov 22</td>
<td>Module 9</td>
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<tr>
<td>13</td>
<td>Nov 29</td>
<td>Module 10</td>
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<tr>
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<td>HW 3 due Dec 2</td>
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<tr>
<td>14</td>
<td>Dec 6</td>
<td>Module 11</td>
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<tr>
<td></td>
<td></td>
<td>Final Assessment date TBD</td>
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</tbody>
</table>