DALHOUSIE UNIVERSITY

Faculty of Science Course Syllabus

Department of Mathematics & Statistics
&
Department of Oceanography

STAT 4390/5390, OCEAN 4210/5210
Time Series Analysis
Winter 2019

Instructor:

Michael Dowd

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Lectures:

MW 16:00-17:30, CHEMISTRY 226

Office Hours: MW 1730-1830, or by appointment

Course Description

Time series analysis in both the time and frequency domain is introduced. The course is targeted at applications, as well as introducing the relevant theory. Illustrative examples are drawn primarily from the marine sciences. Topics covered include the nature of time series, stationarity, auto- and cross- covariance functions, auto-regressive moving-average models, and auto- and cross- spectra. Modern state space methods are also covered and include the state and parameter estimation with the Kalman filter and particle filter.

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Course Prerequisites

The formal pre-requistes are:

- **STAT 3340 - Regression Analysis**
- **STAT 3360 - Probability**

or *Permission of the Instructor*.

It is understood that many of the Oceanography students taking the course will not have these courses. Note, however, that there is fairly high level of mathematical and statistical skill required to successfully complete the course. The specific knowledge required is:

- Basic concepts in Statistics including: random variables, probability distributions, expectation, matrix-based regression
- Familiarity with calculus, matrix algebra, and complex numbers

If you are unsure if you have a suitable background for successful completion of the course, please see me beforehand, or as soon as the course starts.

Course Objectives & Learning Outcomes

This class deals with the analysis of systems characterized by dependence structure, such as variables recorded over time (but this feature also applies to spatial data). The emphasis is on both theory and application. The main objective of this course is to provide a solid practical grounding in time series analysis. The Learning Outcomes are:

- Develop an understanding of the theory underlying time series in the time and frequency domain, as well as for state space models.
- Provide an understanding of the practice of time series analysis, including the ability to apply methods to real data sets and to interpret the results.
- Provide experience in technical writing skills, and also with the use of modern statistical software (R) for time series analysis.

Course Materials

- The textbook for the course is "*Time Series Analysis and Its Applications With R Examples*" by Robert H. Shumway and David S. Stoffer. I will be following this textbook in a broad sense, and it is a useful reference. It is my opinion that any edition should be OK for use.
- There is a password protected website for the course where all announcements, selected class notes, assignments, and computer code will be posted. This site will be used for all course management. *The URL and username/password will be given in class.*

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- A Brightspace site will also be available, but will only be used only for the purpose of disseminating the assignment and exam marks.
- We will be using the R statistical software extensively in the course. R is available for download at http://www.r- project.org/ . This is state-of-the-art free, open source software for statistical computing. It is available for all platforms.

Course Assessment (*NOTE: tentative exam dates - subject to change***)**

Component	Weight (% of final grade)	Tentative Date
Midterm 1	*20%*	*Feb 5, in class*
Midterm 2	*20%*	*March 12, in class*
Midterm 3	*20%*	*April 9, in class*
Assignments	*40%*	*weekly to bi-weekly*

- There will be three in-class exams worth a total of 60% (each worth 20% of your grade).

- There will be regular assignments worth 40% of the total mark. The will involve theoretical questions, development of computer code (R), as well as reports emphasizing the analysis and interpretation of real time series and designed to develop your technical writing skills. Your marks will reflect both the technical correctness of your answers, as well as clarity and organization of your written presentation.

Conversion of numerical grades to Final Letter Grades follows the Dalhousie Common Grade Scale

A+ (90-100)	**B**+ (77-79)	**C**+ (65-69)	**D** (50-54)
A (85-89)	**B** (73-76)	**C** (60-64)	**F** (<50)
A- (80-84)	**B-** (70-72)	**C-** (55-59)	

Course Policies

- This course will NOT be using the new Student Declaration of Absence form

- *Assignments:* Assignments are due at the beginning of class on their due date. Late assignments will receive a zero grade.

- *Midterms:* non-attendance at a midterm will result in a zero grade unless a legitimate excuse is provided, or an arrangement made with me well in advance of the scheduled midterm date. At the instructor's discretion, a makeup may be scheduled or an adjustment made so that the midterm is not counted toward the final grade.

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- Note that any disputes over grading will be resolved by a re-grading of the entire assignment or exam.

- All information relevant to class logistics (class cancellation, due date changes, etc) will be communicated via messages posted on the course website

Course Content

Listed below are the topics to be covered.

- Introduction to Time Series and their main statistical properties, as well as practical exploratory data analysis
- The time domain: time series models, links with dynamical systems, auto-regressive moving average models
- The frequency domain: Spectral Analysis including auto-spectra and cross-spectra
- State space models: linear and nonlinear methods including the Kalman filter, the particle filter and parameter estimation

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ACCOMMODATION POLICY FOR STUDENTS

Students may request accommodation as a result of barriers related to disability, religious obligation, or any characteristic protected under Canadian Human Rights legislation. The full text of Dalhousie's Student Accommodation Policy can be accessed here: http://www.dal.ca/dept/university_secretariat/policies/academic/student-accommodation-policy-wef-sep--1--2014.html

Students who require accommodation for classroom participation or the writing of tests and exams should make their request to the **Advising and Access Services Centre (AASC)** prior to or at the outset of the regular academic year. More information and the ***Request for Accommodation*** form are available at www.dal.ca/access.

ACADEMIC INTEGRITY

Academic integrity, with its embodied values, is seen as a foundation of Dalhousie University. It is the responsibility of all students to be familiar with behaviours and practices associated with academic integrity. Instructors are required to forward any suspected cases of plagiarism or other forms of academic cheating to the Academic Integrity Officer for their Faculty.

The Academic Integrity website (http://academicintegrity.dal.ca) provides students and faculty with information on plagiarism and other forms of academic dishonesty, and has resources to help students succeed honestly. The full text of Dalhousie's ***Policy on Intellectual Honesty*** and ***Faculty Discipline Procedures*** is available here:

http://www.dal.ca/dept/university_secretariat/academic-integrity/academic-policies.html

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STUDENT CODE OF CONDUCT

Dalhousie University has a student code of conduct, and it is expected that students will adhere to the code during their participation in lectures and other activities associated with this course. In general:

"The University treats students as adults free to organize their own personal lives, behaviour and associations subject only to the law, and to University regulations that are necessary to protect

- the integrity and proper functioning of the academic and non – academic programs and activities of the University or its faculties, schools or departments;
- the peaceful and safe enjoyment of University facilities by other members of the University and the public;
- the freedom of members of the University to participate reasonably in the programs of the University and in activities on the University's premises;
- the property of the University or its members."

The full text of the code can be found here:
http://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

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SERVICES AVAILABLE TO STUDENTS

The following campus services are available to help students develop skills in library research, scientific writing, and effective study habits. The services are available to all Dalhousie students and, unless noted otherwise, are free.

Service	Support Provided	Location	Contact
General Academic Advising	Help with - understanding degree requirements and academic regulations - choosing your major - achieving your educational or career goals - dealing with academic or other difficulties	**Killam Library Ground floor** Rm G28 ***Bissett Centre for Academic Success***	In person: Killam Library Rm G28 By appointment: - e-mail: advising@dal.ca - Phone: (902) 494-3077 - Book online through MyDal
Dalhousie Libraries	Help to find books and articles for assignments Help with citing sources in the text of your paper and preparation of bibliography	**Killam Library Ground floor** Librarian offices	In person: Service Point (Ground floor) By appointment: Identify your subject librarian (URL below) and contact by email or phone to arrange a time: http://dal.beta.libguides.com/sb.php?subject_id=34328
Studying for Success (SFS)	Help to develop essential study skills through small group workshops or one-on-one coaching sessions Match to a tutor for help in course-specific content (for a reasonable fee)	**Killam Library 3rd floor** Coordinator Rm 3104 Study Coaches Rm 3103	To make an appointment: - Visit main office (Killam Library main floor, Rm G28) - Call (902) 494-3077 - email Coordinator at: sfs@dal.ca or - Simply drop in to see us during posted office hours **All information can be found on our website: www.dal.ca/sfs**
Writing Centre	Meet with coach/tutor to discuss writing assignments (e.g., lab report, research paper, thesis, poster) - Learn to integrate source material into your own work appropriately - Learn about disciplinary writing from a peer or staff member in your field	**Killam Library Ground floor** Learning Commons & Rm G25	To make an appointment: - Visit the Centre (Rm G25) and book an appointment - Call (902) 494-1963 - email writingcentre@dal.ca - Book online through MyDal We are open six days a week **See our website: writingcentre.dal.ca**