



WINTER 2019

ECE 7210 – Fractal & Chaos Engineering

COURSE DESCRIPTION:

This course presents foundations of fractal (polyscale) and chaos theory, with applications to engineering. A unified approach to fractal dimensions provides tools for polyscale analysis of time series, images, video, and other objects. Other topics include analysis and synthesis of mono- and multifractal noise, stability analysis of chaotic systems, characterization of chaos using Lyapunov exponents, and reconstruction of strange attractors from experimental data.

COURSE OBJECTIVE:

- To master techniques of multifractal polyscale analysis and synthesis;
- To understand techniques of dynamical systems, together with chaos analysis and synthesis; and
- To apply those techniques in engineering.

PRE-REQUISITES:

- Differential and difference equations
- Signal processing
- Linear time-invariant systems
- Foundation of nonlinear systems

CONTACT HOURS:

3-hours per week

COURSE CONTENT:

The following topics will be discussed:

1. Introduction
2. Overview of fractals and chaos
3. Fractal dimensions
4. Noise and spectral power laws
5. Fractional Brownian noise
6. Chaotic dynamics
7. Stability analysis in 1D
8. Reconstructing chaos from data
9. Characterizing chaos through Lyapunov metrics
10. Applications (throughout the course)

Additional advanced research topics as determined by the instructor.

HOMEWORK:

1. Assignments/MiniProject: (Distributed in class. Reports required.)
2. Project (Select one or propose one (a sample list will be distributed in class). Completion of a project requires:
 - i. Submission of a project proposal two (2) weeks after the commencement of this course;
 - ii. Submission of a project progress report six (6) weeks after the commencement of this course;
 - iii. Submission of a written project report in the IEEE format (as used in The Proceedings of the IEEE main journal) one week before the end of this course; and
 - iv. Oral project presentation at the end of the course (date set in class)

TEXTBOOK:

1. W. Kinsner. Fractal & Chaos Engineering. Lecture Notes. Winnipeg, MB: University of Manitoba, 2012, 941 pp. (required).
2. H.-O. Peitgen, H. Jürgens and D. Saupe. Chaos and Fractals: New Frontiers of Science. New York (NY): Springer-Verlag. 1992 (1st ed.), 984 pp.; 2004 (2nd ed.), 864 pp {TA1632.P45 1992; ISBN 0-387-97903-4 1st; 0-387-20229-3, 2nd}
3. Steven H. Strogatz, Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Cambridge MA: Westview / Perseus Books Group, 1994, 498 pp. {ISBN 0-7382-0453-6 pbk}
4. Research papers.

EVALUATION:

Your final course grade is determined by your performance in assignments, project, and a final examination. The weighting of each of these components is as follows:

COMPONENT	VALUE %	DETAILS / ADDITIONAL INFO
Homework	20%	Four assignments and one mini-project
Project	50%	One major project. Proposal in two weeks from commencement of course
Final Examination	30%	Closed book, two-hour exam.
TOTAL	100%	

INSTRUCTOR INFO:

Name: W. Kinsner, Ph.D., P.Eng., FEIC, FEC

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Office Hours: After each lecture or by appointment

VOLUNTARY WITHDRAW:

Wednesday, 20 March 2019

REQUIREMENTS/REGULATIONS

Student Responsibilities: It is the responsibility of each student to contact the instructor if he/she is uncertain about his/her standing in the course and his/her potential for receiving a failing grade. Students should also familiarize themselves with Sections 4 and 6 of the Regulations dealing with, among others, incomplete term work, deferred examinations, attendance and withdrawal, etc..

Lectures: Attendance at lectures is essential for successful completion of this course. Students must satisfy each evaluation component in the course.

ACADEMIC INTEGRITY

Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the General Academic Regulations and Requirements of the University of Manitoba, Section 7.1, students are reminded that plagiarism* or any other form of cheating is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university) regardless of media

- examinations
- assignments
- laboratory reports
- term exams

A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty

Please refer any questions regarding Academic Integrity to your course instructor.

***Plagiarism:** to steal and pass off (the ideas or words of another) as one's own; use (another's production) without crediting the source