1. Course Information

Medical Biophysics 3505F:
Mathematical Transform Applications in Medical Biophysics
Fall Term 2018

The role of mathematical transforms in biomedical research. Application of Fourier Transforms for magnetic resonance spectroscopy. Applications of linear systems analysis and Laplace Transforms to model physiological processes.
Antirequisite(s): The former Medical Biophysics 3303E.
Prerequisite(s): One of Calculus 1000A/B or 1100A/B plus one of Calculus 1301A/B or 1501A/B , or Applied Mathematics 1413 ; 1.0 course from Physics 1020 , 1024 , 1028A/B and 1029A/B , 1301 and 1302, 1501 and 1502, or the former Physics 022 or 025.
Extra Information: 2 lecture hours, 2 tutorial hours, 0.5 course. Although typically taken in third year, this course is available to second-year students with an overall average of 70% in first year.
Lectures: 9:30-10:20 a.m. - Tuesdays & Thursdays - Room M190
Tutorials: Two groups: One group meets Mondays, 1:30 -3:30 pm in The North Campus Building room 105; The other group meets Thursdays 2:30-4:30 pm in Somerville House room 1310.

Senate regulation regarding the student's responsibility regarding requisites:
Unless you have either the requisites 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.

Accessibility Statement
Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

2. Instructor Information

Instructors	Email	Office	Phone	Office Hours
Dr. Neil Gelman (Course Coordinator)	ngelman@lawsonimaging.ca	LHRI	64279	Email for appointment
Dr. Keith St. Lawrence	kstlaw@lawsonimaging.ca	LHRI	65737	Email for appointment
Peter Yongseuk Jeon	yjeon4@uwo.ca	LHRI	64538	
Androu Abdalmalak (TA topic 2)	aabdalma@uwo.ca	LHRI	64186	

Internet Access to Course Web Site: Students with OWL issues should see:
https://owl.uwo.ca/portal/site/owldocs

3. Course Syllabus

COURSE STRUCTURE:

This Term will cover two different topics involving the application of mathematical and physical concepts to biology and medicine:

Topic 1: Fourier Transform Nuclear Magnetic Resonance
Instructor: Dr. Neil Gelman LHRI – Grosvenor Site: ngelman@lawsonimaging.ca
Lecture Dates: Thursday Sept 6 to Thurs Oct 25

The Fourier Transform is a powerful mathematical tool that has extensive applications in biophysics and medical physics. In particular, it forms the foundation for creating medical images and for analyzing the biomedical information provided by these images. In this section of the course we will introduce the one dimensional Fourier Transform operation and its application in Magnetic Resonance Spectroscopy, a technique that is used to provide biochemical information in-vivo from humans and animals. We will also briefly consider how the one-dimensional Fourier Transform is applied to create a one-dimensional Magnetic Resonance Image. This section will provide a solid background for further courses involving medical imaging which often involve the application of two-dimensional and three-dimensional Fourier Transform operations.

Topic 2: Introduction to mathematical modeling in physiology and medicine
Instructor: Dr. Keith St. Lawrence
Lecture Dates: Tuesday Oct 30 to Thurs Dec 6

The objective is to understand linear system analysis and its application to modelling physiological processes. Topics will include predicting drug distribution and clearance from the body, measuring tissue blood flow, and applications of simple feedback systems to physiology. This section will include an introduction to linear systems, Laplace Transforms and the convolution operator. We look forward to having you with us in 3305F.

The course consists of 25 lectures and 6 problem assignments.
To assist you in grasping the course material we have formal tutorial sessions (room: M190), during which you can consult with the tutorial leader and with each other while working on the assignments or exercises. Some of the early tutorial sessions will be devoted to instruction in the use of MATLAB. One section (002 LA UW) is Mondays 1:30 to 3:30 pm, and the other (003 LA UW) is Thursdays 2:30 to 4:30. This means you have protected time for consulting and doing much of the work, and you can count Biophysics 3305F as a laboratory course.

We have always encouraged students to work together, but you take total responsibility for what you submit to be marked. Note on Plagiarism: “Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence” (see Scholastic Offence Policy in the Western Academic Calendar).

Your progress will be assessed chiefly by the fall term exam of 3 hour duration as well as class tests and assignments as indicated below.

4. Learning Outcomes

Knowledge

- Students will develop an understanding of Fourier and Laplace Transforms along with related properties, which provide powerful mathematical tools in biomedical research
- Students will develop an understanding of the role of the Fourier transform in magnetic resonance spectroscopy and magnetic resonance imaging
- Students will learn Laplace Transforms, systems analysis and their application to physiology and medicine
- Students will develop an appreciation for the way in which magnetic resonance spectroscopy can provide information about pathological changes in-vivo within clinical and research area
- Students will develop an appreciation for the way in which mathematical modeling can enhance our understanding of measuring how physiological processes are regulated

Literacies and Interdisciplinarity

- Students will become comfortable with terminology utilized in signal analysis, particularly Fourier and Laplace analysis
- Students will develop skill in applying the basic properties of the Fourier Transform to solving problems, such as related to extracting information from magnetic resonance spectroscopy signals
- Students will develop the skills to apply linear systems analysis to physiological problems.
- Students will become familiar with utilizing symmetry properties to simplify problem solving. This will provide encouragement for use of symmetry properties in other mathematic scientific endeavours.
- Students will further develop written problem solving skills with special attention to solution organization and visualization (also relating to communication)

Communication

- Students will further develop their writing communication skills especially those pertain to communication of mathematical ideas in problem solving. This will occur through assignments, tutorials and in class problem solving sessions

Critical Inquiring and Creative Thinking

- Students will have the opportunity to apply creative thinking in solving problems, especially those in which there are multiple pathways to solutions.

5. Course Materials

There is no single text which suits us for most of the course. There is one computer software package that you may wish to purchase: MATLAB student version. This software will be available on the student computers in the class lab and MATLAB can be used online http://myvlab.uwo.ca/.

We wish to encourage you to come and discuss any problems arising from the course, whether general or specific. We are always pleased to help. If you cannot meet us during the tutorial hours, please make an appointment. If you have any concerns about the class or tutorial. If you have any concerns about the tutorial please contact Peter Yongseuk Jeon (yjeon4@uwo.ca) for topic 1 or Androu Abdalmalak (aabdalma@uwo.ca) for topic 2.

6. Evaluation:

The final grade will be determined based on a 50% contribution from each of the two topics (see "Course Syllabus" section above). The mark for each topic will be obtained from problem assignments, one midterm test for each topic (i.e., two mid-terms in total) and an examination. Note that the exam will have two equal sections, one for each topic. The mark breakdown for each topic is as follows:

Assignments contribution	= 15%
Test contribution	= 10%, if test grade > grade on exam section (for that topic)
	= 0%, otherwise
Exam contribution	= 25%, if test grade > grade on exam section (for that topic)
	= 35%, otherwise

The exam and test will be in hand written format. Questions will include problems to be solved and may also include short answer questions as well as short "essay" questions. The only electronic devices permitted for use during the tests and exam are standard calculators (programmable calculators not allowed).

Assignments that are submitted late will receive a penalty of 2% per day for the first two days following the submission deadline and 5%/day for each day thereafter. For example, an assignment which is 3 days late will receive a penalty of $2\times2\% + 5\% = 9\%$. An extension for assignment submission will be granted by the instructor for submission of a single assignment which is delayed due to medical reasons. Students are advised to inform the instructor as soon as possible regarding such delays. Non-medical reasons will be considered if the instructor is notified prior to the due date. However, if the submission of more than one assignment from a given student is delayed (for medical or non-medical reasons) the student will be required to contact the Academic Counselling office of their home Faculty as described below.

Midterm Test Schedule:
Test 1: Oct. 25
Test 2: Nov 20

Assignment Schedule

	Assignment Handed out	Completed Assignments Submission Date
Assignment 1	Sept 13	Sept 27
Assignment 2	Sept 27	Oct 18
Assignment 3	Oct 16	Oct 30
Assignment 4	Nov 1	Nov 13
Assignment 5	Nov 13	Nov 27
Assignment 6	Nov 27	Dec 4

7. Additional Information/Statements

Statement on Use of Electronic Devices:

Please see section 5.

Statement on Academic Offences

"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 website: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf ."

Absence from course commitments

A. Absence for medical illness:

Students must familiarize themselves with the Policy on Accommodation for Medical Illness for Undergraduate Students, located at:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf
The policy is also accessible from the Medical Accommodation Policy link at
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_illness.pdf

Statement from the Academic Counselling Office, Faculty of Science (for Science and BMSc students)

If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Academic Counselling Office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved by the Academic Counselling Office and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Academic Counselling Office immediately.

Students seeking academic accommodation on medical grounds for any missed tests, or exams must apply to the Academic Counselling office of their home Faculty and provide documentation. Regulations regarding accommodations for late assignments are described in section 5.

For further information please see:
http://www.uwo.ca/sci/counselling/procedures/special_examination.html

A student requiring academic accommodation due to illness, should use the Student Medical Certificate when visiting an off-campus medical facility or request a Record's Release Form (located in the Dean's Office) for visits to Student Health Services.
The form can be found at:
http://www.uwo.ca/sci/counselling/pdf/medicalform.pdf

B. Absence for non-medical reasons:

Students seeking academic accommodation on non-medical grounds for any missed tests, or exams must apply to the Academic Counselling office of their home Faculty and provide documentation. Regulations regarding accommodations for late assignments are described in section 5.

Students who are in emotional/mental distress should refer to Mental Health@Western http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.

C. Special Examinations

A Special Examination is any examination other than the regular final examination, and it may be offered only with the permission of the Dean/Academic Counselling Office of the Faculty in which the student is registered, in consultation with the instructor and Department Chair. Permission to write a Special Examination may be given on the basis of compassionate or medical grounds with appropriate supporting documents. A Special Examination must be written at the University or an Affiliated University College no later than 30 days after the end of the examination period involved. To accommodate unusual circumstances, a date later than this may be arranged at the time permission is first given by the Dean/Academic Counselling Office of the Faculty. The Dean/Academic Counselling Office will consult with the instructor and Department Chair and, if a later date is arranged, will communicate this to the Office of the Registrar.
If a student fails to write a scheduled Special Examination, permission to write another Special Examination will be granted only with the permission of the Dean/Academic Counselling Office in exceptional circumstances and with appropriate supporting documents. In such a case, the date of this Special Examination normally will be the scheduled date for the final exam the next time the course is offered.
When a grade of Special (SPC) or Incomplete (INC) appears on a student's record, the notations will be removed and replaced by a substantive grade as soon as the grade is available.

Support Services:

Registrarial Services: http://www.registrar.uwo.ca
Academic Counselling (Science and Basic Medical Sciences):
http://www.uwo.ca/sci/undergrad/academic_counselling/index.html
USC Student Support Services: http://westernusc.ca/services/
Student Development Services: http://www.sdc.uwo.ca
Student Health Services: http://www.shs.uwo.ca/
Students who are in emotional/mental distress should refer to Mental Health@Western
http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.