PHYS*3130: Mathematical Physics
Fall 2017 (3-0) [0.50]

General information

Course description
This course covers a number of mathematical techniques that are required in all areas of physics. Curvilinear coordinates, special functions, Fourier series and integral transforms, Green's functions, and a number of advanced topics will be discussed. The course emphasizes the application of these techniques to solve a variety of physics problems, providing context to the fundamental tools of the discipline.

Class schedule and location
Monday, Wednesday, Friday, 11:30am to 12:20pm, MacKinnon (MCKN) 225

Midterm exams
1. Wednesday October 4, in class
2. Wednesday November 1, in class

Final examination
Tuesday December 5, from 8:30am to 10:30am. The location of the final exam will be posted in due course.

Final exam weighting
40% (Scheme A) or 50% (Scheme B). See below.

Course website
On Courselink

Instructor information

Instructor
Eric Poisson (epoisson@uoguelph.ca)

Office location and phone number
MacNaughton 452, 519-824-4120 x53653

Office hours
There are no official office hours. I will be generally available in my office. Please schedule an appointment if you have trouble finding me.

I am very much an informal guy, and I prefer to be addressed simply as "Eric". I don't appreciate being subjected to such pompous titles as Doctor, Professor, or His Gracious. My field of research is general relativity, including black holes and gravitational waves. For additional details, please consult my research web page at www.physics.uoguelph.ca/poisson/research/.

Course content

Specific learning outcomes

After taking this course, the student will be able to:

1. Demonstrate a working knowledge of curvilinear coordinates and how they can be involved in vector-calculus operations.
2. Apply special functions (including the Gamma function, Legendre polynomials, spherical harmonics, Bessel functions, and the Dirac delta function) to solve a variety of physics problems.
3. Demonstrate an understanding of Fourier series, Fourier transforms, and other ways of expanding functions in a basis of orthogonal functions.
4. Solve the Laplace and wave equations by separation of variables, and apply these techniques to a host of physics problems.
5. Demonstrate a working knowledge of Green's functions in the context of one-dimensional differential equations, Laplace's equation, and the wave equation.

Lecture and assignment schedule

The following table provides a *rough guide* of the material covered during each week of the semester, as well as key information regarding assignments and midterm exams. *All dates are tentative*; c*heck Courselink regularly to get the most updated information.* Regular attendance at lectures and tutorials is the best way to ensure that you are up to date on the relevant course material.

Week	**Material covered**	**Activity**
0: Sept 8	Introduction	
1: Sept 11, 13, 15	Curvilinear coordinates	
2: Sept 18, 20, 22	Gamma function; Legendre polynomials	
3: Sept 25, 27, 29	Legendre polynomials	Assignment #1 due: 11:30am, Wed Sept 27
4: Oct 2, 4, 6	Spherical harmonics	Midterm #1: in class, Wed Oct 4
5: Oct 11, 13 (no class on Oct 9)	Bessel functions	
6: Oct 16, 18, 20	Bessel functions; Dirac delta function	Assignment #2 due: 11:30am, Wed Oct 18

Week	Material covered	Activity
7: Oct 23, 25, 27	Dirac delta function; Fourier series	
8: Oct 30, Nov 1, 3	Expansion in orthogonal functions	Midterm #2: in class, Wed Nov 1
9: Nov 6, 8, 10	Fourier transforms; Laplace equation	Assignment #3 due: 11:30am, Wed Nov 8
10: Nov 13, 15, 17	Laplace equation	
11: Nov 20, 22, 24	Wave equation	
12: Nov 27, 29, Dec 1	Green's functions	Assignment #4 due: 11:30, Wed Nov 29

Laboratories

There are no labs for this course.

Tutorials

There are no tutorials for this course.

Course evaluation

The final mark for the course will be the highest of the two marks calculated under the following two schemes. No other marking schemes will be considered.

Scheme	Assignments	Midterm 1	Midterm 2	Final exam
A	20%	20%	20%	40%
B	20%	15%	15%	50%

A set of homework assignments will be made available on Courselink, to be returned in class by the assigned due date. The deadline will be enforced strictly, and a penalty will be applied to late assignments. Special arrangements for late submission must be made well ahead of time. No partial credit will be given to unaccepted assignments. Assignments provide 20% of the course's final mark.

In **marking scheme A**, the two midterm exams account for 40% of the final mark (20% each), and the final exam also accounts for 40%. In **marking scheme B**, the midterms account for 30% of the final mark (15% each), while the final exam accounts for 50%.

Midterm and final exams will be closed-book exams, meaning that you will not be allowed to consult your notes nor any other source of information. You will, however, be provided with relevant information and a formula sheet. Calculators may be required; only non-programmable pocket calculators are permitted. Personal communication or entertainment devices (such as smart phones or MP3 players) are not permitted during the exams.

(Not) Working with other students

All work submitted for grading in this course must be each individual student's own work. While students are encouraged to share thoughts and ideas prior to writing

up the solutions to homework assignments, **it is not acceptable to share assignment solutions**. The assignments are not group projects, and it is important that you do not show your final written solutions to other students.

Completing assignments is an essential part of your preparation toward midterm and final exams. A serious attempt to do the work yourself, independently of others, will provide you with a very good preparation. Relying too much on others to provide pieces of solutions will give you a very poor preparation.

Course resources

Lecture notes

A set of lecture notes, designed specifically for this course, are available for download on Courselink.

Recommended texts

Mary L. Boas, *Mathematical Methods in the Physical Sciences*, Third edition (Wiley, 2005)

G.B. Arfken, H.J. Weber, F.E. Harris, *Mathematical Methods for Physicists*, 7th edition (Elsevier, 2012)

The book by Boas contains excellent presentations of most of the topics covered in class, at just the right level for this course. For a longer term, encyclopedic reference, the book by Arfken, Weber, and Harris is an excellent companion.

Course policies

Grading policies

Each homework assignment will be submitted by you before class begins on the day the assignment is due. The deadline will be enforced strictly, and a penalty will be applied to late assignments. Special arrangements for late submission must be made ahead of time. No partial credit will be given to unaccepted assignments.

Midterm and final exams will be closed-book exams, meaning that you will not be allowed to consult your notes nor any other source of information. You will, however, be provided with relevant information and a formula sheet. Calculators may be required; only non-programmable pocket calculators are permitted. Personal communication or entertainment devices (such as smart phones or MP3 players) are not permitted during the exams.

Course policy on group work

You are permitted to discuss the homework problems with your colleagues while trying to solve them. However, and this is important, after the discussions you must write up the solutions yourself, independently of anyone else. Copying will not be

tolerated. Evidence of copying will be considered under the Academic Misconduct section of this document (see below).

Course policy on electronic devices and recording of lectures

What you do with your laptop, smart phone, tablet, etc, during lectures is your own business, so long as it does not create a distraction for your classmates or the instructor. If such a distraction arises you will be asked to leave the classroom.

Electronic recording of classes is expressly forbidden without consent of the instructor. When recordings are permitted they are solely for the use of the authorized student and may not be reproduced, or transmitted to others, without the express written consent of the instructor.

University Policies

Academic Consideration

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor in writing, with your name, id#, and e-mail contact. See the Undergraduate Calendar for information on regulations and procedures for academic consideration.

Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community, faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring.

University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection. Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

The Academic Misconduct Policy is detailed in the Undergraduate Calendar.

Accessibility

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an

open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability or a short-term disability should contact Student Accessibility Services (SAS) as soon as possible.

For more information, contact SAS at 519-824-4120 ext. 56208.

Course Evaluation

The Department of Physics requires student assessment of all courses taught by the Department. These assessments provide essential feedback to faculty on their teaching by identifying both strengths and areas of improvement. In addition, student assessments provide part of the information used by the Department Tenure and Promotion Committee in evaluating the faculty member's contributions in the area of teaching. You are therefore encouraged to take the evaluation procedures seriously, and to provide feedback about this course and its instructor.

Drop date

The last date to drop one-semester courses, without academic penalty, is 3 November 2017. For regulations and procedures for Dropping Courses, see the Undergraduate Calendar.