Clemson University
Department of Mathematical Sciences

MATH 4340-241 / 6340-241, Advanced Engineering Mathematics
Summer Session II, 2019

Instructor: Prof. Matthew Macauley, Martin O-325, 656-1838 (no voicemail)

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Course Description: This course is an introduction to Fourier Series and Partial Differential Equations. Throughout the country, these topics are taught in a variety of contexts – from a very theoretical course on PDEs and Applied Analysis for senior math majors, to a more computational course geared torwards engineers, e.g., a "Differential Equations II" class. My goal in this course is to strike a balance between these two extremes. I have included enough basic linear algebra (vector spaces, independence, basis, inner products, self-adjoint operators) so the students can see the mathematical structure behind the scenes. However, I have omitted advanced details such as Hilbert spaces, and different types of norms and convergence (pointwise, uniform, and in norm). My goal is for this to be useful to math, science, and engineering majors alike.

Topics include vector spaces, inner products, orthogonality, linear differential operators, linear ODEs, power series solutions and the method of Frobenius, Bessel's equation, real and complex Fourier series, Fourier sine and cosine series, Fourier transforms, Parseval's and Plancherel's identities, boundary value problems, self-adjoint linear operators, Sturm-Liouville theory, generalized Fourier series, Fourier's law, the heat equation, the wave equation, Schrödinger equation, Cauchy problems, the reflection method for semi-infinite domains, solving PDEs with Laplace and Fourier transforms, harmonic functions, Laplace's equation, PDEs in higher-dimensions, PDEs in polar coordinates.

Prerequisite: Math 2080 (Differential Equations).

Office Hours & Communication Strategy:

"Office hour meetings" can happen by appointment through Google Hangouts. I can attach my iPad to my computer and use it as a "whiteboard." Please send an e-mail for an appointment time, giving me block(s) of time in which you are available. Several minutes before the scheduled meeting, I will send you a Google Hangout invite, which will send you an email with the URL.

Email is the best way to reach me. I have not set up voicemail on my phone (as a way to encourage you to use email instead!), and I may be physically in my office during parts of the class. I strongly recommend that you put Math 4340 in the subject line of any email – I will set up a Gmail filter for this.

Students are responsible for checking their Clemson email regularly, as that address will be the one subscribed to the class email list. I am not responsible if you miss important messages because you use a different email account.

Useful websites:

Course webpage: `http://www.math.clemson.edu/~macaule/classes/m19_math4340/` (all relevant links posted here)

Canvas: `http://www.clemson.edu/canvas/` (homework will be submitted through Canvas)

Texts: The course will not follow one particular textbook, but there are several high-quality books that are freely available online that will be helpful resources. Links to the pdfs can be found on the MATH 4340 website, or via Google. The following are listed in (approximate) increasing order of technical difficulty.

John Douglas Moore. *Introduction to Partial Differential Equations.* Kendall Hunt, 2005.

Peter J. Olver. *Introduction to Partial Differential Equations.* Springer Undergraduate Texts in Mathematics, 2014.

Marcus Pivato. *Linear Partial Differential Equations and Fourier Theory.* Cambridge University Press, 2010.

Required technology:

A computer on which you can watch the YouTube lecture videos and view pdf files.

Access to Canvas at `http://www.clemson.edu/canvas/` is required.

Google Hangouts - recommended for 'office hour meetings'.

Hardware - a scanner that can scan to pdf is required. All homework MUST be submitted as pdf files with multiple pages in one document (not one document per page). A traditional scanner is preferred, but free apps such as CamScanner or GeniusScan will suffice.

Hardware – headset microphone - recommended, not required for meeting through Google Hangouts.

Calculators/Other Technology: A calculator is not required nor needed for this course.

Schedule: This course is being offered in an entirely ONLINE asynchronous format through Blackboard. The course calendar can be found on the course website.

Lectures: There will be 38 lectures, ranging in length from 26 to 56 minutes, that are be available on YouTube. Students will be required to watch approximately 2 lectures each day. The lecture schedule is listed on the course calendar.

Homework: Homework assignments are posted on the course webpage. Students will be required to upload and submit each assignment on Canvas as a single pdf file with multiple pages (*not* one document per page). Students can either hand-write and scan their assignment, or typeset them using LaTeX. Homework assignments must be submitted by 11:59pm on the day they are due. Late assignments will NOT be accepted. However, students will get ONE free 1-hour extension, no questions asked.

Course Format: This course is being offered in one summer semester so EVERYTHING GOES QUICKLY.

You should expect to spend *at least* 4 hours per day on this course:

Listening to (usually) two online lectures.

Working written homework problems.

You will prepare for two tests and a cumulative Final Exam.

Because this is an online course, our chief means of communication is through Canvas and e-mail. It is important that you check your Clemson e-mail on a regular basis - at least once a day.

Attendance: Because this is an asynchronous online course, a zero on a written homework assignment that is not turned in will be counted as 2 missed class. Any student who accumulates 4 'missed classes' before Mon. Jul 2 (the last day to drop the course without a *W* grade) is subject to being dropped from the course.

Exams: There will be 2 exams (closed book and notes) during the semester and a cumulative final exam: Midterm 1 on Wed. July 10, Midterm 2 on Wed. July 24, and the Final Exam on Fri. August 2. All three exams must be taken either at Clemson or at an approved proctored test facility. Guidelines for administration of these exams are given in the separate write-up under the heading Proctored Tests Policy. These guidelines must be followed by all students.

Grading: Your final grade will be computed as follows:

Homework	25%
Midterm 1	25%
Midterm 2	25%
Cumulative Final Exam	50%

I will drop either your lowest midterm grade, OR half of the weight of the final exam; whichever is lowest. Also, if you get at least an A or B on the final exam, then you get at least that grade in the course, *assuming you have a passing grade on the homework.*

Make-Up Policy: No make-up exams will be given. I will drop your lowest midterm, which means that if you miss a midterm, then your final exam grade will replace it. The homework deadlines will not be extended for individual students, and assigned homework must be turned in by the deadline. PLAN AHEAD: If you submit assignments minutes before the deadline, you take the risk of bad luck, e.g., a power outage, computer freeze or crash, personal emergency, zombie attack, etc., that could make you miss the deadline.

Student Learning Outcomes: Upon successful completion of MATH 4340, students will be able to

- Understand the basic theory of differential operators and linear ordinary differential equations (ODEs) from a high-level perspective. In particular, understand the beautiful linear algebra hiding behind the scenes.
- Solve ODEs whose solutions are generalized power series and understand the convergence of these solutions.
- Derive the Fourier series expansions of periodic functions, and understand the theory behind the construction in terms of inner product spaces.
- Understand boudary value problems of ODEs and solve the corresponding Strum-Louiville equations.
- Construct, interpret, and utilize solutions to one-dimensional partial differential equations (PDEs), such as the heat and wave equation. Understand the difference between different boundary and initial conditions.
- Solve the standard PDEs (heat, wave, and Laplace's equation) in two-dimensions, both in rectangular and polar coordinates.
- Explain in simple terms, e.g. to grandparents or to younger siblings, how ordinary and partial differential equations are relevant to several familiar settings in your major.

Key Dates

June 26 (Wed)	Classes begin; late enrollment fee applies
June 27 (Thu)	Last day to register or add a class
July 1 (Mon)	Last day to drop a class or withdrawfrom the University without a W grade
July 4 (Thu)	Holiday
July 10 (Wed)	Midterm 1
July 19 (Thu)	Last day to drop a class or withdraw from the University without final grades
July 26 (Wed)	Midterm 2
July 31 (Wed)	Last day of class
Aug 2 (Fri)	Final Exam
Aug 6 (Tue)	Deadline to submit grades

Academic Integrity: "As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning'. Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

Special Accommodations: Students with disabilities who need accommodations should make an appointment with Dr. Arlene Stewart, Director of Disability Services, to discuss specific needs within the first week of classes. Students should present a Faculty Accommodation Letter from Student Disability Services when they meet with instructors. Student Disability Services is located in Suite 239 Academic Success Building (656-6848; sds-l@clemson.edu). Please be aware that accommodations are not retroactive and new Faculty Accommodation Letters must be presented each semester.

Copyright Statement: Some of the materials in this course are possibly copyrighted. They are intended for use only by students registered and enrolled in this course and only for instructional activities associated with and for the duration of the course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the Teach Act. Refer to the Use of Copyrighted Materials and "Fair Use Guidelines" policy on the Clemson University website for additional information: http://clemson.libguides.com/copyright

Statement Included for Certification Purposes: In this online course, you will interact with the content, instructor and classmates on at least a weekly basis through course assignments, asynchronous discussions and/or synchronous sessions as indicated in this syllabus.