# Partial Differential Equations
## Spring 2016
## MATH 467.01 (3 credits), Tu_Th, 2:35P–3:50P, Wickersham 219

**Prerequisites:** A grade of C- or better in MATH 365 (*Ordinary Differential Equations*) is the prerequisite for this course.

**Instructor:** Dr. Buchanan
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Office Hours: 9:00A-9:50A (M–F), or by appointment
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**Textbook:** *A First Course in Partial Differential Equations*, preliminary edition, J. Robert Buchanan and Zhoude Shao, World Scientific Publishing Company, Hackensack, NJ USA (late 2017).

The following textbook, though not required for this course, provides a good source of reference and review material for this course.

*Elementary Differential Equations and Boundary Value Problems*, 9th edition, William E. Boyce and Richard C. DiPrima, John Wiley & Sons, Inc., New York, NY (2009) ISBN: 978-0-470-38334-6

**Objectives:** MATH 467 provides an introduction to partial differential equations and their applications. Upon completion of this course the student will:

- understand how partial differential equations arise in the mathematical description of heat flow and vibration,
- demonstrate the ability to solve initial boundary value problems,
- express and explain the physical interpretations of common forms of PDEs,
- understand issues related to existence and uniqueness of solutions,
- depict in series and graphical form the solutions to initial boundary value problems,
- appreciate the theory underlying the techniques of solution,
- be conversant with methods of applying partial differential equations in various applications.

**Course Contents:** Topics covered in this course may include the following. The material will be presented in a logical order, though not necessarily in the order shown below. Other topics will be added as time and interests allow.

- Introduction
  - **Extremely** brief review of topics from ordinary differential equations
  - Heat equation as model of heat conduction in a rod
  - Separation of variables
  - Fundamental solutions and superposition of solutions
- Fourier series
  - Orthogonality and Euler-Fourier formulas
  - Periodicity
  - The Fourier Convergence Theorem
  - Even and odd functions; sine and cosine series
  - Extensions of functions to even and odd functions
- The Heat Equation
  - Solution of initial/boundary value problems

- Homogeneous Dirichlet boundary conditions
- Nonhomogeneous boundary conditions and steady-state solutions
- Other boundary conditions
- A Maximum Principle and uniqueness of solution for the heat equation
- The Wave Equation
  - Solution of initial/boundary value problems
  - Characteristic coordinates and a general solution
  - D'Alembert's solution of the initial value problem
  - Energy integrals and uniqueness of solution for the wave equation
- Laplace's Equation
  - Boundary value problems in rectangular coordinates
  - Boundary value problems in polar coordinates
    * Periodic boundary conditions
  - Neumann problems and mixed boundary conditions
    * Lack of uniqueness of solution
    * Necessary conditions for the existence of a solution
  - Uniqueness of solutions
    * Mean Value Property
    * Weak form of the Maximum Principle
    * Uniqueness of solutions of the Dirichlet problem
- Sturm-Liouville Theory
  - General two-point boundary value problem
  - Eigenvalues and eigenfunctions
  - Lagrange's identity and consequences
  - Normalization of eigenfunctions and general eigenfunction expansions
  - Nonhomogeneous boundary value problems

Other topics may be included if time permits.

**Attendance:** Students are expected to attend all class meetings per the University Approved Guidelines. If you know beforehand that you will be absent from class on the day an assignment is due, you must complete and hand in the assignment prior to the absence. If you are unexpectedly absent the day that an assignment is due you must hand in the assignment at the beginning of the class hour on the first day that you return to class, unless the assignment has already been graded and returned to other students in the class in which case the assignment will not be accepted. If you know you will be absent on the day of a test, you must notify me before the time the test is scheduled in order to schedule a make-up test. Students who miss a test should provide a valid excuse, otherwise you will not be allowed to make up the test. No final examination exemptions.

**Homework:** Students are expected to do their homework and participate in class. Homework problems will be assigned from the draft textbook as well as given to students on separate handouts consisting only of homework exercises.

Throughout the semester, homework problems from sources outside the textbook will be assigned for you to work and post in the Discussions found under D2L. Every student is expected to claim and present correct solutions to at least four exercises by the end of the semester. Exercises will be graded on a scale of 0–4.

**0:** student unable to begin exercise.

**1:** student able to begin exercise only (may choose to complete exercise at a future date).

**2:** student able to partially complete exercise, though portions of the solution are missing or unjustified.

**3:** student able to complete exercise, though some details of the solution are missing or unjustified.

**4:** student able to complete exercise with all details presented and full justification.

In addition to the homework exercises there will be a course project on a topic from PDEs. The project will have a written component (a short paper) which you will hand in to me. There will also be a brief (approximately 10 minutes) public presentation of your work to other interested students during Math Awareness Week (during April 2016). You will be graded on both your written work and public presentation.

**Tests:** There will be two tests which are tentatively scheduled for

- Tuesday, February 23, 2016
- Thursday, April 7, 2016

The final examination (Friday, May 6, 2016 from 12:30P-2:30P) will be comprehensive.

If you feel that an error was made in the grading of a test or homework assignment, you should explain the error on a separate sheet of paper and return both it and the test to me within three class periods after the test or homework is returned to you.

**Grades:** Course grade will be calculated as follows.

| | |
|---|---|
| Tests | 40% |
| Homework | 25% |
| Project | 10% |
| Exam | 25% |

I keep a record of students' test, homework, and exam scores. Students should also keep a record of graded assignments, tests, and other materials. The course letter grades will be calculated as follows. I will not "curve" course grades.

| 90-92 | A− | 93-100 | A | | |
|---|---|---|---|---|---|
| 80-82 | B− | 83-86 | B | 87-89 | B+ |
| 70-72 | C− | 73-76 | C | 77-79 | C+ |
| 60-62 | D− | 63-66 | D | 67-69 | D+ |
| | | 0-59 | F | | |

**Course Repeat Policy** An undergraduate student may not take an undergraduate course of record more than three times. A course of record is defined as a course in which a student receives a grade of A, B, C, D, (including + and −) F, U, Z or W. The academic department offering a course may drop a student from a course if the student attempts to take a course more than three times.[1]

The last day to withdraw from a course (receiving the W grade) is April 1, 2016.

**Inclement Weather Policy:** If we should miss a class day due to a school delay or cancellation, any activities planned for that missed day will take place the next time the class meets. For example, if a test is scheduled for a day that class is canceled on account of snow, the test will be given the next time the class meets.

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[1] Memorandum to mathematics faculty from Dr. Charles G. Denlinger, Assistant Chair, Department of Mathematics, August 30, 2004.

**Cell Phones:** Silence (or better yet, turn off) all cellular telephones upon entering the classroom. Leaving class to initiate or receive a telephone call will not be tolerated and students doing so will not be re-admitted to the classroom until the following class meeting. Texting or tweeting during class interferes with the learning process. Students distracted by their cell phones are not engaged in class and will find, over the course of the semester, that learning and course grade will suffer.

**Title IX Reporting Responsibilities:** Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment and to comply with Title IX of the Education Amendments of 1972, 20 U.S.C. §1681, *et seq.*, and act in accordance with guidance from the Office for Civil Rights, the University requires faculty members to report to the University's Title IX Coordinator incidents of sexual violence shared by students. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report to the person designated in the University Protection of Minors policy incidents of sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred.

Information regarding the reporting of sexual violence, and the resources that are available to victims of sexual violence, is available at http://www.millersville.edu/socialeq/title-ix-sexual-misconduct/index.php.

**Final Word:** Mathematics is not a spectator sport. What you learn from this course and your final grade depend mainly on the amount of work you put forth. Daily contact with the material through home-work assignments and review of notes taken during lectures is extremely important. Organizing and conducting regular study sessions with other students in this class will help you to understand the material better.

No one can guarantee you success in this course. Your responsibilities and the instructor's expectation are outlined above. There will be no second chances, "do-overs", or extra credit assignments.