APMTH 202: Physical Mathematics II, Spring 2019

Instructor: Xiaolin Wang (Email: xiaolinwang@seas.harvard.edu)

Class Time / Location: Tues & Thurs 12:00-1:15pm, Cruft 309

Teaching Fellows: Emma Steinhardt (estein@g.harvard.edu)

Office Hours:

Emma: Mon 4:30 – 6:00 PM, Pierce Hall 320

Xiaolin: Wed 3:00 – 4:00 PM, Northwest B150

Textbook:

1. *Partial Differential Equations of Applied Mathematics,* by Erich Zauderer. Any edition is accepted. Electronic copies of the book can be found on AM 202 canvas pages.

2. *Partial Differential Equations, Theory and Technique,* by George Carrier. Second edition. Only Chapter 10 Variational Methods will be used. Electronic copies can be found on canvas page.

Prerequisites: AM 105 (intro to ODEs and PDEs) or equivalent; also useful: AM 104 (complex analysis) or equivalent. Note: AM 201 and 202 are independent courses, and may be taken in any order.

Course Website: Canvas pages

Homework: There will be **six** homework assignments, at roughly two week intervals. Homework assignments will be due at 11:59pm of the due date. The submission of the homework will be done through the dropbox of the course canvas page. You can either hand-write and scan the homework, or type and upload a pdf file. A Latex file containing the original homework problems will be provided on canvas.

Homework policy:

- Discussion and the exchange of ideas are essential to doing academic work. For assignments in this course, you are encouraged to consult with your classmates as you work on problem set. However, after discussions with peers, make sure that you can work through the problem yourself and ensure that any answers you submit for evaluation are the result of **your own efforts**. In addition, you must cite any books, articles, websites, lectures, etc that have helped you with your work using appropriate citation practices. Similarly, you must list the names of students with whom you have collaborated on problem sets.
- Late homework will be evaluated on a case-by-case basis. Any special circumstances should be discussed with the instructor before the deadline.

Exams: Discussions with your classmates are **NOT** allowed in exams. You must cite any books, articles, and online resources that have helped you with the exam appropriately.

- **Midterm Exam:** There will be one 48 hour take-home midterm exam, posted on the canvas website at 1:00pm on **Thursday March 7th** and due at 1:00pm on Saturday March 9th.
- **Final Exam:** There will be one 24 hour take-home final exam, posted on the canvas website at 10:00am on **Monday May 13th** and due at 10:00am on Tuesday May 14th. The final exam time is subject to change. Anyone who has a time conflict should let the instructor know as soon as possible.

Grading Policy: Homework = 65%, midterm = 10%, final exam = 25%

Course Description: AM 202 studies the theory and techniques for finding exact and approximate analytical solutions of partial differential equations. The study of partial differential equations involves the formulation of problems that lead to different type of PDEs, the classification and characterization of equations, and the examination of exact and approximate methods for the solution of these problems. Our focus will be on the linear equations, with a simple discussion on nonlinear case using perturbation theory. We will study each of these aspects in the course with emphasis on the following topics:

- Chapter 1: Random walks and PDEs, physical process that leads to different PDEs.
- Chapter 2: First order PDEs, method of characteristics, initial value problems.
- Chapter 3: Classification of second order linear PDEs.
- Chapter 4: Boundary value problems in bounded region, separation of variables, The Sturm-Liouville eigenvalue problems, inhomogeneous equations, eigenfunction expansion.
- Chapter 5: PDEs on unbounded region, Fourier transform, Hankel transform, Laplace transform, asymptotic approximation for transform solutions.
- Chapter 6: Integral relations – PDEs with discontinuities.
- Chapter 7: Green's function, derivation, fundamental solutions on bounded and unbounded region.
- Chapter 8: Variational methods, derivation, the Rayleigh-Rits method for approximated solution, relation to Galerkin method.
- Chapter 9: perturbation methods (if time permits) .

Tentative schedule for the course

Week 1	1/29 Tuesday • First day of the class • Introduction • Chap. 1 Random Walks and PDEs (1.3)	1/31 Thursday • Chap. 1 Physical process that leads to PDEs. • Chap. 2 Linear 1st order PDEs(2.2).
2	2/5 Tuesday • Chap.2 1st order PDEs (2.3 – 2.4)	**2/7 Thursday** • **1st Homework Due** • Chap.2 1st order PDEs (2.4). • Chap.3 Classification of 2nd order PDEs (3.1-3.3)
3	2/12 Tuesday • Chap.3 Classification of 2nd order PDEs (3.1-3.3)	2/14 Thursday • Chap.3 Classification of 2nd order PDEs (3.1-3.3) • Chap. 4 Boundary value problems(BVP) (4.1-4.2)
4	2/19 Tuesday • Chap. 3 Adjoint operators(3.6) • Chap. 4 The Sturm-Liouville problem (4.3)	2/21 Thursday • Chap. 4 Series solutions (4.4)
5	**2/26 Tuesday** • **2nd Homework Due** • Chap 4. Inhomogeneous problems (4.5-4.6)	2/28 Thursday • Chap 4. Inhomogeneous problems (4.5-4.6)
6	3/5 Tuesday • Chap. 5 Fourier Transform (5.1-5.3)	**3/7 Thursday** • **Take-home Midterm (48 hr) (1.1-5.3)** • Chap. 5 Fourier Transforms, and other Transforms(5.4-5.6)

7	3/12 Tuesday • Chap 5. Asymptotic approximation (5.7)	**3/14 Thursday** • **3rd Homework Due** • Chap. 6 Integral Relations (6.2- 6.3)
8	**Spring Recess**	**Spring Recess**
9	3/26 Tuesday • Integral Relations (6.3- 6.4)	3/28 Thursday • Chap. 6 Integral relations (6.6-6.7)
10	4/2 Tuesday • Chap. 7 Green's Functions(7.1-7.2)	**4/4 Thursday** • **4th Homework Due** • Chap. 7 Green's Functions (7.3-7.4) •
11	4/9 Tuesday • Chap. 7 Green's Functions (7.4-7.5)	4/11 Thursday • Chap. 8 Variational Principle
12	**4/16 Tuesday** • **5th Homework Due** • Chap. 8 Eigenvalue Problems	4/18 Thursday • Chap. 8 The Rayleigh-Ritz Method(8.2)
13	4/23 Tuesday • Chap. 9 Perturbation Methods (9.2)	**4/25 Thursday** • Last day of the class • **6th Homework Due** • Chap. 9 Perturbation Methods(9.3)