MATH 4052 Partial Differential Equations

Course Outline- Fall 2024

1. **Instructor(s)**

   Name: Huai Liang Chang

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2. **Teaching Assistant(s)**

   Name: LIU, Xinyu

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3. **Meeting Time and Venue**

   Lectures:

   Date/Time: L1: Mon 13:30 - 14:50, Fri 09:00 - 10:20

   Venue: Classroom 1410

   Tutorials:

   Date/Time: Fri 18:00 -18:50

   Venue: 1104

4. **Course Description**

   Credit Points: 3

   Pre-requisite: MATH 2023/MATH 3043 and MATH 2111/MATH 2121/MATH 2131/MATH 2350 and MATH 2350/MATH 2351/MATH 2352

   Exclusion: NIL

   Brief Information/synopsis:

Derivations of the Laplace equations, the wave equations and diffusion equation; Methods to solve equations: separation of variables, Fourier series and integrals and characteristics; maximum principles, Green's functions.

Intended Learning Outcomes

Upon successful completion of this course, students should be able to:

No.	ILOs
1	Recognize and use appropriately important technical terms and definitions.
2	Learn the background of basic partial differential equations, and their types.
3	Learn techniques to solve elementary partial differential equations.
4	Find particular solutions to well-posed problems to some PDEs.

6. **Assessment Scheme**

   a. Examination duration: 2 hrs

   b. Percentage of coursework, examination, etc.:

Assessment	Assessing Course ILOs
35% by homework	1, 2, 3, 4
10% quiz	2, 3, 4
55% by exam	1, 2, 3, 4

c. The grading is assigned based on students' performance in assessment tasks/ activities.

Letter Grades: Students should aim at getting a course total of 85% or above for A-/A/ A+, and about 60% or above for B-/B/B+.

Grade Descriptors:

Grades	Short Description A	Elaboration on subject grading description
A	Excellent Performance	The student has mastered almost all concepts and techniques of partial differential equations taught in the course, has excellent understanding of the deepest content of the subject, and acquired workable knowledge for further studies of differential equations approached via functional analysis or related to field theory, relativity, and related fields.
B	Good Performance	The student has mastered most computational techniques of solving differential equations taught in the course, yet the understanding of some challenging concepts may not be deep enough for further studies on related advanced subjects.
C	Satisfactory Performance	The student meets the minimum expectation of the instructor, has acquired some basic computational techniques of the subject, yet some concepts were not clearly understood.
D	Marginal Pass	The student is only able to recall some fragments of topics and is able to complete some of the easiest computations.
F	Fail	The student does not have sufficient understanding of even some fragments of topics, and is not even able to complete some of the easiest computations.

Course AI Policy

Students are allowed to consult any person (including the instructor, TA, classmates, friends outside HKUST) in any homework for ideas and hints, but are required to write up the solutions by themselves. You are required to **list the persons and references** you have consulted in every homework.

The use of ChatGPT or other generative AI is allowed, and they are regarded as "persons" you have consulted, and therefore must be listed in your homework.

However, please be warned that at the current stage of development of AI, the response to problems in advanced courses – especially those in pure mathematics – is not quite reliable. Students should be critical of the response generated by AI and do not blindly copy the generated responses to your homework.

7. Student Learning Resources

Note: Online lecture notes on canvas,

Textbook: Differential Equations: An Introduction, Walter A. Strauss, 2nd edition, JohnWiley, Sons, Hoboken

8. Teaching and Learning Activities

Scheduled activities: 4 hrs (lecture + tutorial)

9. Course Schedule

Keyword Syllabus:

- PDEs in History, types of second order PDEs.
- characteristic curve method: Transport equation, first-order linear equations solved by characteristics, The wave equation in 1D, D'Alembert's formula, and Causality/ Energy
- Boundary problems, separation method.
- Fourier analysis, wave and heat(diffusion) equation with 1d bounded domain and boundary conditions.
- Laplace's equation and fundamental solution, Harmonic functions, equivalence to Mean value property, Maximum principle and uniqueness of solutions.
- Green function as integral kernel to solve Laplace equations, explicit formula of Green function on ball and half plane.
- Concept of Delta function as Distributions, introduction to Green kernel of linear differential operators.
- Heat equations and heat kernels, 1 D real line(unbounded) heat equation.
- Advanced materials such as functional integral and propagators.