King Fahd University of Petroleum and Minerals
Department of Mathematics and Statistics
SYLLABUS
Semester II: 2017-2018 **(172)**

Coordinator: Dr. A. Bonfoh
Course #: MATH 470
Title: Partial Differential Equations

Textbook: Beginning Partial Differential Equation. by P. O'Neil. (Second Edition, 2008)

Objectives: The course aims to introduce basic concepts of existence, uniqueness and properties of solutions to first and second-order linear and quasilinear partial differential equations. Applications to the wave equation, the heat equation and the Laplace equation are considered.

Course description: First order quasilinear equations. Lagrange method and Characteristics. Classification of linear second order PDEs. Brief review of separation of variables. The one dimensional wave equation: its solution and characteristics. Cauchy problem for the wave equation. Laplace's equation: The maximum principle, uniqueness theorems. Green's function. Neumann's function. The heat equation in one dimension.

Prerequisites: MATH 301

Learning outcomes: Upon successful completion of this course, a student should be able to:

- Recognize and solve quasilinear first order equation.
- Recognize and classify the second order PDE's.
- Solve the wave equation and analyze the well-posedness.
- Describe and prove the maximum principle for heat equation; and solve the IBVP.
- Reproduce the proofs of the representation theorems, MVP, and maximum principles for Laplace equation.
- Apply Green's function method and method of images to solve the Dirichlet and Neumann problems for the Laplace equation.

Week	Date	Sec.	Topics	Suggested Homework Problems
1	Jan 21 – 25	1.1 1.2	Notation and terminology The linear first-order equation	2, 4, 7, 8 p3-4 10, 11, 12 p11
2	Jan 28 – Feb 1st	1.3 1.4	The significance of characteristics The Quasilinear equations	1, 3, 5 p15-16, 1, 3, 5, 7, 9, p22
3	Feb 4 – 8	2.1 2.2 2.3 2.4 2.5 2.6	Second order PDEs in two variables: classification The hyperbolic canonical form The parabolic canonical form The elliptic canonical form Some equations of mathematical physics The second-order Cauchy problem	1, 3, 5, 7, 9 p25 2(a, c), 3 p29 2, 3 p32-33 1, 3, 5, 6, 7, 9 p36-37 1 p45 1, 2, 6, 7 p48-49
4	Feb 11 – 15	2.7 4.1 4.2 4.3 4.4	Characteristics and the Cauchy problem The wave equation : d'Alembert's solution of the the Cauchy problem d'Alembert solution as a sum of waves The characteristic triangle The wave equation on a half-line	1, 2, 3, 4 p55 3,5,9,10,13 p116-117 1, 2, 3, 4 p125-126 1, 2 p130 1, 2, 3,7, 8 p133-134

5	Feb 18– 22	4.6 4.8 4.9 4.10	A nonhomogeneous problem on half real line Fourier series solutions on a closed interval A nonhomogeneous problem on a closed interval The Cauchy problem by Fourier integral	1, 2, 5, 10 p140 1 , 5, 11, 14, 15 p157-159 2, 3, 7, 10, 11 p164-167 1, 2, 3, 7, 8, 9 p171-172
First Exam: Wednesday, February 28, 2018 [1.1-4.4]				
6	Feb 25 – March 1st	4.11 4.12 4.13	A wave equation in two space dimensions The Kirchoff-Poisson solution Hadamard's method of descent	1, 2, 3 p176 2, 3 p181 1 p183
7	March 4 – 8	5.1 5.2 5.3	The Cauchy problem and Initial conditions The weak maximum principle Solutions on bounded intervals	1, 4 p187-188 2 p192 1, 3, 8, 9, 10, 11, 16 p205-208
8	March 11 – 15	5.4 5.5	The heat equation on the real line The heat equation on the half-line	4, 5, 9, 12 p215-217 1, 4, 8, 12 p222-223
9	March 18 – 22	5.7 5.8	The nonhomogeneous heat equation The heat equation in two space variables	6, 8p233-234 1, 3, 5p236-237
10	March 25 – 29	6.1 6.2	Setting of Dirichlet and Neumann problems Some harmonic functions	1, 2, 8 p246 3, 4, 5, 6 p250
Second Exam: Wednesday, April 4, 2018 [4.6-5.8]				
11	April 1st – 5	6.3 6.4	Representation theorems Maximum principle, Mean value property	1, 2 p257 2, 4, 4, 5, 6 p261-262
12	April 8 –12	6.5 6.6 6.7 6.8	Existence, Uniqueness and Well-posedness Dirichlet problem for a rectangle Dirichlet problem for a disk Poisson's integral representation for a disk	1 p266 1, 2, 6 p268-269 4, 6, 7, 8 p271 3, 4, 7 p275
13	April 15–19	6.9 6.10 6.11	Dirichlet problem for the upper half-plane Dirichlet problem for the right quarter-plane Dirichlet problem for a rectangular box	1, 4 p279 1 p282 1 p284
14	April 22–26	6.12 6.13 6.14 6.15	The Neumann problem Neumann problem for a rectangle Neumann problem for a disk Neumann problem for the upper half-plane	4, 5, 7 p287 1, 4 p290 1, 4 p293-294 1, 3, 5 p295
15	April 29 – May 3	6.16	Green's function for a Dirichlet problem Review and catch-up	1, 2, 5, 6, 12, 16 p300-302
Final Exam: Sunday, May 6, 2018 [comprehensive]				

Grading:

Exam I, II	20% each
Homework assignments	20%
Presentation of Projects	10%
Final Exam	30%