

**Math 425**  
**Partial Differential Equations (E)**

**Text books:**

- 1- Introduction to partial differential equations and boundary value problems By Rene Dennemeyer.
- 2- Partial Differential equations: An introduction By Walter A. Strauss.
- 3- Introduction to Partial Differential Equations By Peter J. Olver.
- 4- Partial Differential Equations By Lawrence C. Evans.

**Syllabus:**

1. differential equations; classification; solutions; sources.
2. First-order equations. Linear and quasi-linear equations; Lagrange method for solving quasi-linear equations; Cauchy's problem.
3. Linear second-order equations. classification into elliptic, parabolic, and hyperbolic types; solution by operator method and by separation of variables; Cauchy's problem.
4. Laplace's equation. Properties of harmonic functions and the maximum modulus principle; boundary-value problems (Dirichlet, Neumann, mixed); uniqueness of the solution; boundary-value problems in 2 and 3 dimensions; solution by separation of variables and Fourier series using Cartesian, polar, cylindrical, and spherical coordinates; Poisson's integral representation for the solution of Dirichlet's problem in a circle.
5. The wave equation. Mathematical model of a vibrating string; solution by separation of variables; D'Alembert's solution; problems in 2 space dimensions; vibrations under friction and gravity.
6. The heat equation. Physical derivation using the laws of heat transfer; homogeneous and non-homogeneous boundary conditions; solution by separation of variables and Fourier series; boundary-value problems involving special functions; heat transfer in an infinite bar; representation of the solution by a Fourier integral.