School of Interdisciplinary Engineering and Sciences (SINES)
National University of Sciences & Technology (NUST)

Title: Advanced Partial Differential Equations
Course Code: CSE-920
Credit Hours: 3-0

Objectives:

The focus of the course is the concepts and techniques for solving the PDEs (partial differential equation) that permeate various scientific disciplines. The emphasis is on nonlinear PDEs. Applications include problems from fluid dynamics, electrical and mechanical engineering, materials science, quantum mechanics, etc. The specific course objectives are

- To learn the classification of linear and nonlinear PDEs.
- To understand new analytical and numerical tools for the solution of nonlinear PDEs.
- To capture the advantages of applying transform methods for the development of solutions.
- To gain insight into the numerical methods for solving PDEs.

Learning Outcomes:

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

- Classify partial differential equations
- Use the different analytical techniques for solving linear and nonlinear PDEs.
- Use numerical techniques for solving nonlinear PDEs

Course Content

Week 1: Introduction to partial differential equations (PDEs) and classification of PDEs
Week 2: Origin of PDE, First-order PDE.
Week 3,4: Solution methods for first-order PDEs, including characteristic method
Week 5,6: Second-order linear PDEs, including wave equation, heat equation and Laplace equation, Separation of variable method for solving homogenous PDE
Week 7: Separation of variable method for solving nonhomogeneous PDE
Week 8: Midterm Exam
Week 9,10,11: Integral transforms
Week 12,13: Nonlinear PDEs: Some exactly solvable cases.
Week 14,15: Adomian Decomposition method for nonlinear PDE
Week 16,17: Numerical methods for solving nonlinear PDEs
Week 18: Final Exam

Details of the Lab work/ Workshop Practice, if applicable

Different analytical and numerical methods will be implemented in the lab using Matlab.

Reference Books:

1. Zill, D. G., and M. R. Cullen. Differential equations with boundary value problems.
2. Hinch, E. J. Perturbation methods. Cambridge University Press, 1991. ISBN: 0521378974.
3. Debnath, L. Nonlinear partial differential equations for scientists and engineers. Birkhauser, 1997. ISBN: 0817639020.
4. Carrier, G. F., and C. E. Pearson. Partial differential equations: theory and technique. Academic Press, 1988, 2nd ed. ISBN: 0121604519.
5. Myint, Tyn, and Lokenath Debnath. "Linear partial differential equations for scientists and engineers." Birkhuser Boston (2007), 4th Edition.

6. Wazwaz, A.M., 2010. Partial differential equations and solitary waves theory. Springer Science & Business Media.

Grading Policy:

Nature of Exam	**Weightage**
Assignments	05-10 %
Quizzes	10 -15%
Mid Term Exam	30 -40%
Final Exam	40-50%