

Course: 10641: Application of Mathematical Methods in Electrical Engineering

Instructor: Dr. Walid Gomaa

Lectures: Sat 10am-1:30pm

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Course description: The course is divided into four parts. The first part covers approximation and interpolation techniques, in particular trigonometric interpolation and its application to Fourier analysis to obtain efficient algorithms for discrete Fourier transform: Fast Fourier Transform. The second part covers numerical quadrature and numerical differentiation using finite differences. It also covers solutions of ordinary differential equations using Taylor series, finite differences, and single and multipoint methods. We study the the general properties of these methods such as consistency, order, stability, and convergence. The third part covers a spectrum of combinatorial optimization techniques and the study of their convergence properties. Such techniques include gradient-descent methods, simulated annealing, Tabu search, and evolutionary computing. In the fourth part we present some applications of numerical methods such as inpainting and feature selection.

Course outline:

1. Approximation and interpolation:
 - Lagrange interpolation and Neville's algorithm.
 - Newton's difference formulas.
 - Error analysis of polynomial interpolation
 - Trigonometric interpolation and its application in Fourier analysis.
2. Numerical quadrature and numerical differentiation:
 - Taylor series approach to numerical differentiation.
 - Difference formulas approach to numerical differentiation.
 - Error analysis of these approaches.
 - Newton-Cotes formulas for numerical integration.
3. Numerical solutions of ordinary differential equations:
 - Taylor series method.
 - Finite differences method.
 - Consistency, order, stability, and convergence.
 - Single point methods.
 - Multipoint methods.
4. Combinatorial optimization:
 - Tabu search.
 - Simulated annealing.
 - Evolutionary computation.
 - Ant colonies.
5. Applications of numerical methods:
 - Inpainting.
 - Contrast enhancement for image.
 - Feature selection techniques.

References:

1. Numerical Methods for Engineers and Scientists, Second Edition, by Joe D. Hoffman.
2. Introduction to Numerical Analysis (Hardcover) J. Stoer (Author), R. Bulirsch (Author), R. Bartels (Translator), W. Gautschi (Translator), C. Witzgall (Translator).

Grading: Presentations, term papers, exams, and class participation.