Department of Mathematics
Faculty of Mathematics & Computer Science
PhD, Mathematics

Course Code	AM 505
Course Title	Parallel Iterative Methods for Partial Differential Equations
Course Credits	02

Course objectives:

To equip students with numerical techniques to solve elliptic, parabolic and hyperbolic partial differential equations iteratively on sequential computers. Also, to provide students parallel algorithms enabling them to solve differential equations numerically on parallel computers, which arise in the modeling of real life phenomena.

Minimum Pre-requisites:

Numerical Analysis, Numerics of ordinary and partial differential equations, Matlab codes.

Course structure:

Speedup; efficiency; Amdahl's law; point and block parallel relaxation algorithms (Jacobi, Gauss-Seidel, SOR); triangular matrix decomposition; quadrant interlocking factorisation method; red-black ordering; application to elliptic BVPs; parallel ADI algorithms; parallel multi-grid and domain decomposition method.

The alternating group explicit (AGE) method for two point BVPs (natural, derivative, mixed, periodic) and their convergence analysis; the modified AGE and smart AGE methods; the computational complexity of the AGE method; the Newton-AGE method.

Parabolic equation: AGE algorithm for diffusion-convection equation and its convergence analysis; stability analysis of more general scheme; coupled reduced AGE method; AGE method for fourth order parabolic equation.

Hyperbolic equation: Group explicit method for first and second order hyperbolic equations; stability analysis of Group Explicit method; AGE iterative method for first and second order hyperbolic equations.

Elliptic equation: Douglas-Rachford algorithm; BLAGE iterative algorithm with different boundary conditions; parallel implementation.

Reading suggestions:

- Y. Saad, *Iterative Methods for Sparse Linear Systems*, SIAM, Philadelphia (2003).
- L.A. Hageman and D.M. Young, *Applied Iterative Methods*, Dover publication, New York (2004).
- D.M. Young, *Iterative Solution of Large Linear Systems*, Academic Press, New York (1971).
- Jianping Zhu, *Solving Partial Differential Equations on Parallel Computers*, World Scientific, New Jersey (1994).
- D.J. Evans, *Group Explicit Methods for the Numerical Solution of Partial Differential Equations*, Gordon and Breach Science publisher, Amsterdam (1997).

Evaluation and Weightage:

- 30% for Computer practicals
- 10% for Quiz
- 20% for Mid-Term examination
- 40% for End-Term examination