**A Comparison of Solving the Poisson Equation Using Different Numerical Methods in MATLAB**

**MECE 5397- Scientific Computing**

**Project A – Poisson Equation AP02-1**

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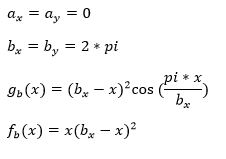
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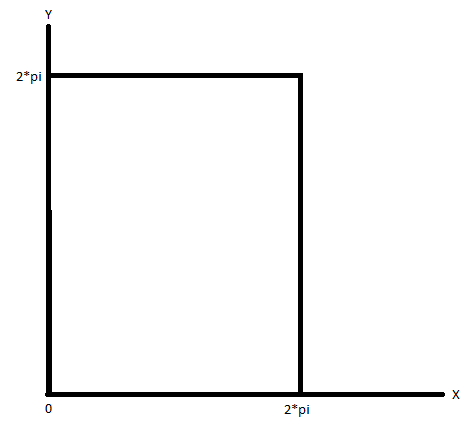
**Abstract**

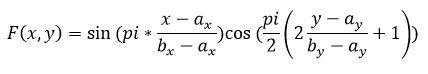
**Mathematical Statement of Problem**

In this report, we will test various numerical methods to solve the Poisson Equation. The Poisson equation is an elliptic Partial Differential Equation (PDE) that is linear and has constant coefficients. The Poisson equation is used to model phenomena such as the potential field caused by a given charge or mass density distribution.

We will test the numerical methods on a Poisson equation with 3 nonhomogeneous, Dirichlet boundary conditions, 1 homogenous, Neumann boundary condition, and a right-hand side function of F(x,y).







**Discretized Version of the Equation**

The partial derivatives in the PDE are approximated by linear combinations of function values at the grid points. The second-order center difference approximation is applied to both the x and y second derivatives at all points in the mesh.



As a result, the approximated x and y second derivatives of u at a given mesh point (i, j) are given below through the evaluation of u at (i+1, j), (i-1, j), (i, j+1), and (i, j-1).

After rearranging the above equation, the discretized Poisson equation is,

Where ∆x=∆y=h is the grid spacing between nodes. This equation will be rearranged for ui,j=… later depending on the numerical method.

**Description of Numerical Methods Analyzed**

**Technical Specifications of Computer Used**