MECE 5397: Scientific Computing for Mechanical Engineers

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Solving Poisson’s Equation on a Rectangle

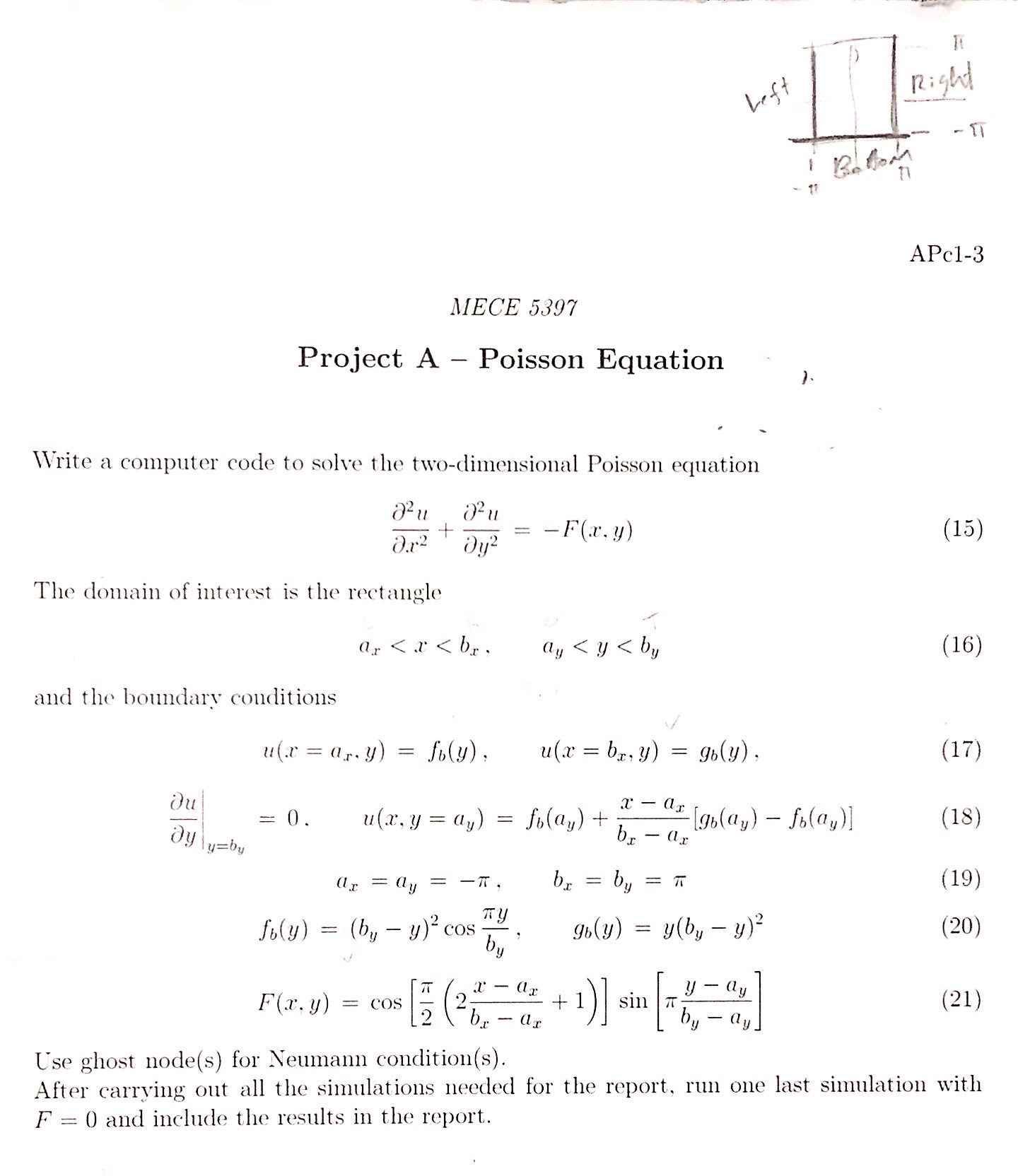
Project ID: **APc1-3**

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# Abstract

# Mathematical Statement of the Problem



# Discretization of the Equations

## Discretizing Poisson Equation

Rearranging for ui,j

For Gauss-Seidel Method

For Successive Over Relaxation Method

# Description of Numerical Methods Used

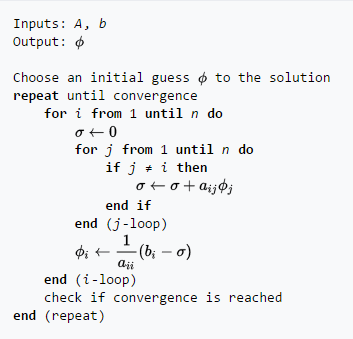
## Gauss-Seidel Method

The Gauss-Seidel Method is an iterative linear technique for solving square systems. It is defined by the form

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where the procedure is generally continued until the changes between x and the next iteration of x are below a set tolerance.

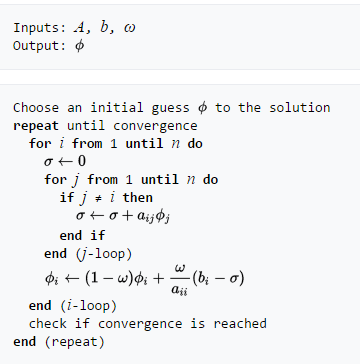
Convergence for Gauss-Seidel method are dependent on the matrix A. It converges if A is symmetric positive-definite or A is strictly diagonally dominant. Even if conditions are not satisfied, Gauss-Seidel converges sometimes.



## Successive Over Relaxation

The successive over-relaxation (SOR) is a variant of the Gauss-Seidel method for solving a linear system of equations, resulting in faster convergence. C:\Users\nkiwaich\Pictures\4.PNG where w is the relaxation factor, thusC:\Users\nkiwaich\Pictures\Capture1.PNG

Where w is the choice for relaxation, and depends of the coefficient matrix. Usually, w is greater than 0 and smaller than 2.



# Technical Specifications of Computer Used

* Processor – Intel Core i7-3770S CPU @ 3.10GHz
* RAM - 8 GB
* Hard Drive - 500 GB
* Graphics Card - any with DisplayPort/HDMI or DVI support - desktop only
* Monitor – Dell OptiPlex widescreen LCD with DisplayPort/HDMI or DVI support

# Results

## Graphs

For the Project given, we obtained a contour plot as shown

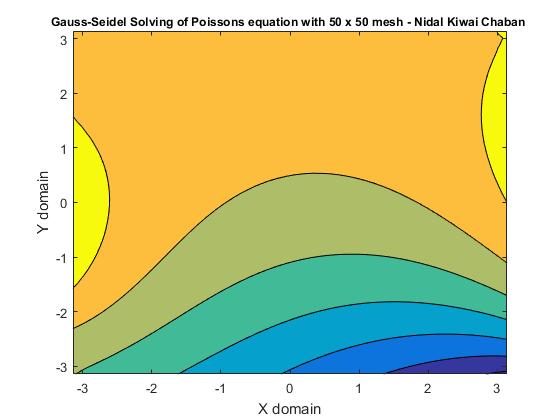


Figure 1-Contour Plot

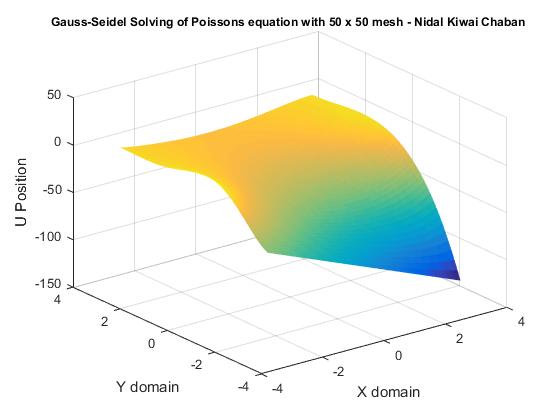


Figure 2-Surface Plot

## Parameters used in simulations

* Input Parameters
  + Number of nodes n for n x n mesh size
  + ax = ay = -π
  + bx = by = π
  + Boundary Conditions as stated
* Output Parameters
  + Number of iterations
  + Elapsed time
  + Mean of u (for grid independence)