# ME685 Programming Assignment-2

Vardhan Gupta

October 2018

## 1 Formulation report

### 1.1 The Problem

Solve the following nonlinear ordinary differential equation for the temperature distribution:

$$\frac{\partial^2 T}{\partial x^2} - 5 * 10^{-8} = 1; 0 < x < L = 5 \tag{1}$$

$$T(x = 0) = 300; T(x = L) = 100; \tag{2}$$

Show linearization with respect to the guessed value of temperature, discretization and the construction of the algebraic equations in matrix form. Solve the resulting algebraic equations using the Gauss-Seidel method (relaxation factor=unity).

The computer program should clearly show individual loops for nonlinearity as well as the GS iterations. A convergence (stopping) criterion of 0.001% in relative error should be used for GS iterations and 0.01% for nonlinearity . The program should accept the number of nodal points as input ,varying from 11-1001.

### 1.2 The Solution

Equation (1) may be written numerically as:

$$1 + 5 * 10^{-8} * (T_i^{t+1})^4 = \frac{T_{i+1}^{t+1} - 2T_i^{t+1} + T_{i-1}^{t+1}}{\Delta x^2}$$

the term $(T_i^{t+1})^4$ may be linearised using taylor series approximation;

following this its easy to make a matrix of the form $Ax = B$: where A is $\begin{bmatrix} 1 & 0 & 0 & \dots & 0 \\ -1 & d & -1 & \dots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & \dots & 0 & 0 & 1 \end{bmatrix}$, where d the coefficient of the $T_i^{t+1}$ term
Since, A is a diagonally dominant matrix, it is easy to see that we can iteratively solve the problem using gauss seidel method. I have written the code to solve this problem in C++.