Project #4 – Fall 2023

Solving Systems of Equations using the Gauss-Seidel SOR algorithm

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Grading:

1. [80%] Complete assignment, input results in webcourses project assignment Quiz as instructed.
2. [20%] and uploaded Matlab code files and output.

You must upload your codes and output to receive credit for this part of the assignment. Failure to upload your Matlab code will result in a loss of 50 points for the assignment.

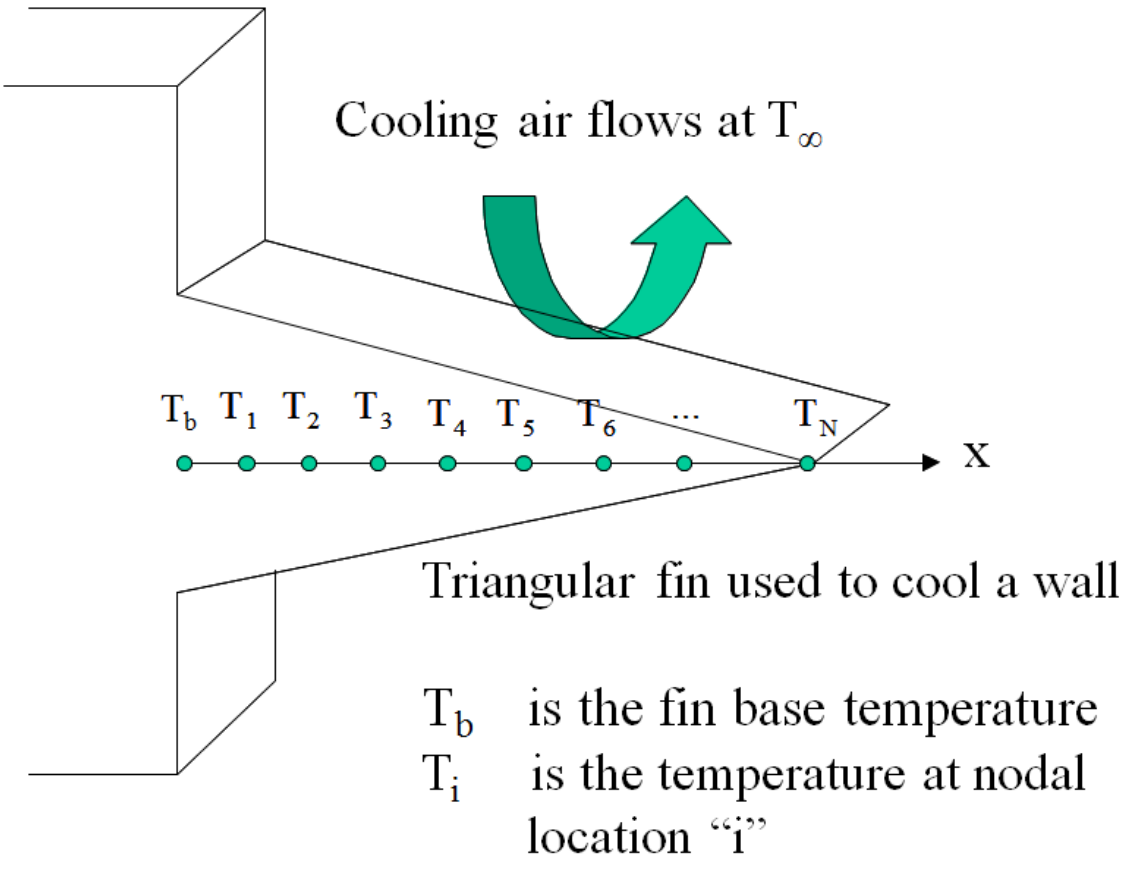
Instructions:
You are to create a Matlab program implementing the Gauss-Seidel iteration method with SOR to solve a system of equations. You do not need to implement pivoting in your routine.

Assignment:

1. Enter your name and the current date in the upper right corner of the worksheet.
2. Enter the title of the course (EML 3034 Modeling Methods in MAE) and the assignment # (Project #4) centered at the top of the page.
3. This assignment deals with implementing the Gauss-Seidel SOR Algorithm to solve a set of simultaneous linear equations that arise in the numerical solution by the finite difference method for the temperature in a triangular profile fin.

   You do not need to know anything about this method which generated these simultaneous at this point, only that the linear system of equations is obtained by an energy balance and that their solution corresponds to the temperature T_i at each nodal location "i" as shown in the sketch. The driving temperature difference is between the base of the fin which is hot and at T_b=250^{o}C and the cooling air which is at T_∞=25^{o}C. Consequently, without knowing the details of heat transfer for this problem, from common sense, you know that the solution should yield a temperature distribution between T_b and T_∞ such that $T_b > T_1 > T_2 > ... T_N > T_\infty$.

   The data are provided in a data file "**fin_data_A_matrix_FA_2023.txt**" that contains the coefficient matrix and in a data file "**fin_data_b_vector_FA_2023.txt**" that contains the RHS vector {b}, both of which are located in the zipped data file. You will need to unzip the file and extract the data and read the [A] and {b} into your Matlab program. Do not retype the matrix [A] which is 151x151 and right-hand-side vector {b} which is 151x1. Reading input data is part of the exercise.



4. Set up a verification example using 3x3 system of equations (you may use the system we discussed in class or make up your own). Make sure that you code works correctly.
5. Now solve the above system of equations using Gauss-Seidel iteration, using an initial guess $x_i = 175$ for $i=1,2, \ldots N$, setting the iterative convergence criterion and the residual norm criterion to $\varepsilon=10^{-4}$ and $\delta=10^{-4}$. Find the:

    a. the solution vector.
    b. the number of iterations to convergence.
    c. a plot the residual norm (use the L_∞-norm) versus the number of iterations.
    d. **Report the requested values in the Webcourses Project 4 Assignment Quiz.**

6. Incorporate SOR into your Gauss-Seidel routine and repeat with relaxation parameters ω = 1.1, 1.2, 1.3, 1.4, 1.5 and 1.6 and plot the residual norm versus iteration for the values of the relaxation parameter on the same plot.
7. Plot the number of iterations to convergence vs ω for values of ω =1,1.1, ...1.9. **Report the values in the Webcourses Project 4 Assignment Quiz.**
8. This completes of your project assignment. **Upload your project files (pdf of your code and pdf of your output) as requested on Webcourses for the project Quiz 4.**

You should be able to use your working code for the Webcourses lab quiz and you should be able to:

a. **Read in data files for the coefficient matrix and right-hand side vector.**
b. **Solve these equations using you Gauss Seidel or SOR code using a specified relaxation parameter and convergence criteria.**
c. **Report the solution and number of iterations to convergence.**