AEE 471 / MAE 561

Homework #2 - Due: Wednesday, February 11th, at the beginning of class

Please submit handwritten and/or printed out answers at the beginning of class. Combine all code you used to solve the problems into a single text file, and upload the text file to Blackboard using the SafeAssign mechanism. No credit will be given, if your code is not uploaded as a text file using SafeAssign. Also ensure that your code contains adequate comments.

Problem 1 (20 points) (AEE471: Core Course Outcomes #1)
Program a function/subroutine that solves a tridiagonal linear system using Gaussian elimination as discussed in class. The function/subroutine must take as input 4 1D vectors (arrays) representing the lower, main, and upper diagonals and the right hand side. As output, the function/subroutine must provide the solution in a vector (array). The function must be able to handle arbitrary number of unknowns either determined inside the subroutine from the length of the vectors, or by passing in an additional argument.

Required submission: printout of function/subroutine; fully commented code of function/subroutine uploaded to SafeAssign.

Problem 2 (60 points) (AEE471: Core Course Outcomes #1)
Consider the function

$$f(x) = \cos 2x$$

defined on the interval $1 \leq x \leq 3$. For equidistant meshes with $M = 2^k$ elements with $k = 2 \ldots 10$, calculate the L_∞, L_1, and L_2 norms of the error for all points including boundaries for the first derivative of f using

a) second-order central differences

b) 4-th order PADE.

At the boundaries use appropriately modified stencils, for example first-order or second-order one-sided differences for a), and the third-order approximations discussed in class for b). To solve the resulting tridiagonal linear system for the PADE scheme, you must use the function/subroutine programmed in problem 1. In a table, provide M and the three error norms (for $k = 2 \ldots 10$) as well as the observed order of accuracy for the three error norms (for $k = 3 \ldots 10$) for both a) and b). Comment on the observed orders of accuracy and explain any potential discrepancies. Provide in writing (legible hand-writing is fine) all finite difference equations used. Finally, for $k = 4$ plot the error $e_i(x) = f'_{exact}(x_i) - f'_i$ vs x for both a) and b) into two separate plots.

Required submission: List of all finite difference equations used; 1 table containing requested information for 2nd-order central differences; 1 table containing requested information for 4th-order PADE; 1 plot of e_i vs x for 2nd-order central method at $k = 4$; 1 plot of e_i vs x for 4th-order PADE method at $k = 4$; printout of used code; fully commented code uploaded to SafeAssign.