

**AOE/CS/ME 6444 Verification and Validation in Scientific Computing
Spring 2020**

Instructor: Dr. Chris Roy

Homework #3

Due Wednesday March 18, 2020 at 10pm

Please upload your homework assignments in PDF format to the appropriate assignment section of Canvas. Please also use the following file naming convention: VVSC_Lastname_Firstname_HW3.pdf. If you have problems getting your homework into PDF format, then let me know. NOTE: If you are working on a 2-person team for the project, then the 2-person team just needs to submit a single homework starting with Homework #3.

Option #1: Use the code you have chosen for your semester project to implement the Method of Manufactured Solutions. Choose the form of the manufactured solution according to the guidelines given in the lecture notes. Use your manufactured solution to specify any needed boundary and/or initial conditions (i.e., you do not need to verify your actual boundary and initial conditions in your code).

Option #2: Find an exact solution to the governing equations you have chosen for your semester project. This may require you to search through some basic textbooks in this field or even perform a literature search for journals, conference papers, or reports which describe the exact solution. This solution will likely include some significant simplifications of the governing equations. Also, make sure that your exact solution can be evaluated numerically since you will need to compare it to numerical solutions from your code. Appropriate numerical benchmark solutions may also be used.

All: Compute numerical solutions to this problem on at least four systematically-refined meshes using your code. Examine norms of the discretization error relative to the exact solution (for either a field variable or a surface variable such as pressure, temperature, or skin friction) as well as any appropriate System Response Quantities (SRQs) that will be predicted by your code. Plot the order of accuracy of these discretization error norms and the SRQs as a function of the discretization parameter h . Assess whether or not your code passes the order of accuracy test for this case. Discuss the level of code coverage that

your exact (or manufactured) solution has provided (i.e., has it fully verified the order of accuracy of the code, or are there terms, sub-models, extra dimensions, etc. that were not verified by this test?). Make sure to estimate round-off errors to ensure they are sufficiently small. If your solution involves iterations, then converge your solutions to machine zero so round-off error will not be a factor.

In addition, if possible, put your source code into a version control system such as Git or SVN. Briefly discuss your experiences using this version control system and provide a brief example of its use for examining differences in different versions of the code.