AOE/CS/ME 6444 Verification and Validation in Scientific Computing
Spring 2020
Instructor: Dr. Chris Roy

Homework #4
Due Wednesday April 22, 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_**HW4**.pdf. If you have problems getting your homework into PDF format, then let me know. If you are working as a team on the semester project, please have only one of the team members submit this homework (but list both members' names on the homework submission).

Perform solution verification studies for your chosen scientific computing application. These simulations should be for an actual, realistic case on which you plan to perform your later uncertainty quantification studies. Quantify the effects of discretization error and, where applicable, iterative error, for the System Response Quantities (SRQs) of interest. If possible, also estimate the effects of round-off error, possibly by examining SRQ differences between double precision and single precision computations (note: both of these cases should be iteratively converged to machine zero).

For the discretization error estimation study, use *at least* four systematically-refined grids to estimate both the discretization error (e.g., via Richardson extrapolation) and the uncertainty due to the discretization error (e.g., via the GCI). Estimate the reliability of your discretization error estimate by computing the observed order of accuracy and modify the factor of safety F_s accordingly.

Estimate the total uncertainty due to numerical approximations in 1) your fine grid solution and 2) the solution on a computational mesh and iterative convergence level appropriate for performing parametric studies (i.e., likely a coarser grid and looser iterative convergence tolerance for which you could conceivably run 100s to 1000s of cases). Combine your numerical uncertainty sources additively as:

$$U_{NUM} = U_{DE} + U_{IT} + U_{RO}$$

where each uncertainty estimate above is a positive quantity. Where appropriate, you may use the one-sided numerical uncertainty approach we discussed in class.