ME 353 M.M. Yovanovich

Methodology: Analysis of Heat Transfer Problems

The solution of all heat transfer problems should follow a systematic approach to ensure good results which are consistent with the physics of the problem. A systematic approach (methodology) to problem solving will ensure that you will find the desired answer in a direct and efficient manner. The methodology should proceed according to the following steps:

Schematic: Draw a simple schematic of the physical system showing clearly the inputs and outputs at the boundaries. The physical system may be a differential control volume and/or it may be a macro-control volume. Represent the relevant control volume (CV) by dashed lines. Identify the heat transfer processes (conduction, convection, radiation) by appropriately labeled arrows.

Known: Show on the schematic or list in a table in a clear, concise manner what is known about the problem from a reading of the problem statement.

Unknown: State briefly and concisely what must be found and what may be unknown.

Assumptions: List all pertinent simplifying assumptions which may be based on some physical criterion. Use good physics and common sense. Be bold and creative.

Properties: Compile a list of the thermophysical properties and identify their source.

Analysis: Whenever possible take advantage of symmetry. Find the smallest *element* in the system. Use appropriate conservation laws (continuity, momentum and energy) and rate equations (Newton's law of viscosity, Fourier's rate equation) to derive the governing differential equations which may be either second-order ordinary or partial differential equations. Specify the intial condition and boundary conditions. Find the solution to the differential equations. Develop the analysis as completely as possible in symbolic form before substituting numerical values. You are encouraged to use Computer Algebra Systems such as *Maple*, *Mathematica*, *MathCad*, *Matlab*, *Macsyma*, and spread sheets such as *Excel*. Perform the calculations required to obtain the desired results.

Summary: Summarize briefly and concisely your results which may appear in equation form, tabular form, or in plots. Discuss your results. The discussion may include key observations, an inference of observed trends, and a critique of the original assumptions.

The importance of following steps 1 through 4 should not be underestimated. These steps provide the opportunity to systematically think about the problem before commencing the solution procedure.