ABSTRACT

The objective of the present thesis pertained to the study and application of the Finite Element Method to the solution of ordinary and partial differential equations. Of paramount importance in any such endeavor is, undoubtedly, the technique of non-dimensionalization or normalization of the mathematical model that characterizes the problem at hand. Through non-dimensionalization, one can extract such important information as the relevant time and length scales, the non-dimensional groupings or parameters (that are intimately familiar to researchers in the fields of fluid mechanics and heat transfer) and the relative orders of magnitude of the pertinent variables. The problems that were examined in this thesis were all non-dimensionalized. The next step in the process relates to the selection of the appropriate computational technique for the solution of the derived differential equations. The present study made use of the Finite Element Method since it is commonly used by both engineers and scientists across all disciplines. The last step involves the analysis and critique of the computational data and the comparison with experimental, analytical or other numerical results whenever it is possible to do so.

To illustrate the aforementioned methodology, two practically-oriented problems were selected. The first pertained to the determination of the steady state temperature distribution along a straight bar with the simultaneous consideration of distributed/point heat sources. The second problem examined the transverse deformation of a prismatic Euler-type beam subjected to distributed and point forces and moments. In both cases, the appropriate MATLAB^{TM} code was designed and developed and the relevant variables were extracted thereof; namely the temperature along the span of the rod and the displacements/slopes along the span of the beam. It would not be remiss to mention that in both cases the developed code adhered to the structure typically encountered in many commercial products; in particular, it consisted of a pre-processor, a processor and a post-processor.

The results stemming from the software developed in this thesis were compared with analytical and/or other numerical results and showed an excellent degree of accuracy and conformance.