5.8 Problems

MZ

Problem 5.1 M2 asdf

6 Engineering Computing for Design [Incomplete]

Now that we have a solid foundation in programming and the manipulation of data, we can appreciate how computing can serve as an essential engineering tool. The primary engineering use of computing is to assist in the design of products. Design is a different paradigm than analysis. Analysis breaks a complex problem into manageable parts. Design, also called synthesis, constructs something new from several elements. However, the engineering design process includes analysis as a guide to optimizing its products.

How can we represent and solve design problems computationally? This chapter presents an engineering computing paradigm that answers this question. This will guide the design of our programs in the following chapters.

6.1 Design as Optimization

The early stages of the engineering design process involves the specification of quantitative **requirements** that must be satisfied by the product of the design. Once requirements have been specified, the design process can be considered as the selection of an element from a design space $\mathcal{D}$, comprised of mathematical models of various designs. Design requirements do not fully specify the design, however. Requirements constrain specific quantities of interest, which we call **output variables**; we call the space of all possible output variable quantities $\mathcal{O}$. A set of **governing equations** will determine how each design affects the output variables.

Governing equations relate **input variables**, known varying quantities like force and voltage, to output variables and include **parameters**, quantities like length, mass, and electrical resistance. Several designs will have the same set of governing equations E_i, differing only in their inputs and parameters. Let the corresponding set of designs be a **design set** and be denoted D_i, which is a subset of the design space $\mathcal{D}$. Let the solution of E_i for the output variables be denoted f_i and the output