Notes for Signals and Systems

0.1 Introductory Comments

What is "Signals and Systems?" Easy but perhaps unhelpful answers include

- the α and the ω,
- the question and the answer,
- the fever and the cure,
- calculus and complex arithmetic for fun and profit,

More seriously, signals are functions of time (continuous-time signals) or sequences in time (discrete-time signals) that presumably represent quantities of interest. Systems are operators that accept a given signal (the input signal) and produce a new signal (the output signal). Of course, this is an abstraction of the processing of a signal.

From a more general viewpoint, systems are simply functions that have domain and range that are sets of functions of time (or sequences in time). It is traditional to use a fancier term such as *operator* or *mapping* in place of *function,* to describe such a situation. However we will not be so formal with our viewpoints or terminologies. Simply remember that signals are abstractions of time-varying quantities of interest, and systems are abstractions of processes that modify these quantities.

These notes are about the mathematical representation of signals and systems. The most important representations we introduce involve the *frequency domain* – a different way of looking at signals and systems, and a complement to the time-domain viewpoint. Indeed engineers and scientists often think of signals first in terms of frequency content, and systems in terms of their effect on the frequency content of the input signal. Some of the associated mathematical concepts and manipulations involved are challenging, but the mathematics leads to a new way of looking at the world!