



ENGINEERING
DEPARTMENT OF ELECTRICAL,
COMPUTER, AND SOFTWARE ENGINEERING

ELECTENG 332

Notes on Control Systems

Dear god help me, not another one...

by

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Module 1:

Basics of Signals and Systems

Learning Outcomes

- ▶ Uniqueness of the Exponential Signal
- ▶ Concept of Engineering Infinity
- ▶ Concept of Complex Frequency
- ▶ Classification of Signals: Energy & Power
- ▶ Classification of Systems
- ▶ What is a Control System
- ▶ Classification of a Control System: Open-loop & Closed-loop

1.1 Topic 1: The Importance of the Exponential Function

The Exponential function, written as either e^{ax} or e^{at} depending on whether it is $f(t)$ or $f(x)$, has properties that make it mathematically unique.

1. The derivative (rate of change) of the exponential function is the exponential function itself. More generally, this is a function whose rate of change is proportional to the function itself.

$$\frac{de^{ax}}{dx} = ae^{ax} \quad (1)$$

2. The integral of the exponential function is also the exponential function itself.

$$\int e^{ax} dx = \frac{1}{a}e^{ax} \quad (2)$$

1.2 Topic 2: The Concept of Engineering Infinity

Consider a signal e^{-at} . The time constant for this signal is $T = \frac{1}{a}$. Theoretically, the signal is meant to decay to zero as time approaches infinity, i.e.

$$\lim_{t \rightarrow \infty} e^{-at} = 0 \quad (3)$$

But in practice, this is not the case, as its value will be very, very small after five time constants $5T$ (or 5τ). This is the **Concept of Engineering Infinity**. The signal will never reach zero, but it will be so small that it can be considered zero for all practical purposes. This is a very important concept in control systems, as it allows us to simplify our calculations and analysis.