Session 4: Systems and Their Properties

# 1. Outline and Notes for Lecture Content

## A. Introduction to Systems

A system is a process that produces an output signal in response to an input signal.  
Examples: Audio amplifier, filter, controller, etc.

## B. Classification of Systems

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| --- | --- | --- |
| Property | Description | Example |
| Linear vs Non-linear | Superposition applies or not | Amplifier (linear), diode (non-linear) |
| Time-invariant | System behavior doesn’t change over time | y(t) = x(t–2) |
| Causal vs Non-causal | Depends only on present/past vs future input | Real-time filter (causal) |
| Stable vs Unstable | Bounded input → bounded output (BIBO stability) | y[n] = x[n] + 0.5y[n−1] |
| Memoryless | Output depends only on current input | y[n] = 3x[n] |
| Invertible | Can recover input from output | y[n] = x[n] + 1 |

## C. Examples and Theory

- Linearity Test: Use Additivity + Homogeneity

- Time Invariance Test: Delay in input causes same delay in output

- Causality Test: Output at time n depends only on values ≤ n

- Stability Test: Bounded input produces bounded output