# SNS COLLEGE OF TECHNOLOGY

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## Department of Biomedical Engineering

**Course Name: Control Systems**

**III Year : V Semester**

**Unit II –Time Response Analysis**

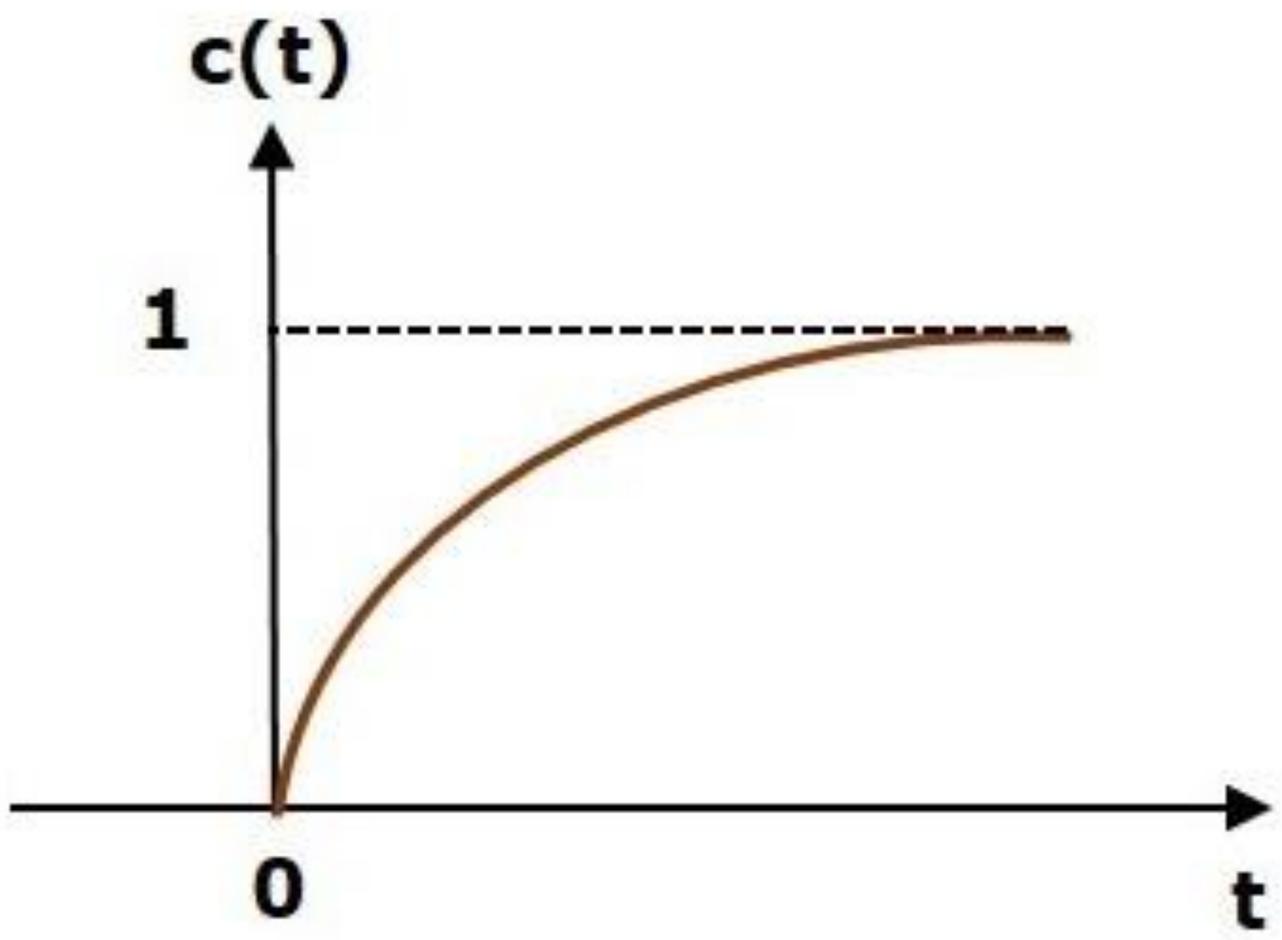
**Topic :** Stability of Control system

# Introduction

- The ability of any given system to attain the steady state condition after passing through transients successfully is called stability.
- **Bounded-Input, Bounded-Output (BIBO) Stability:**
- A linear time invariant system is said to be stable if it produces a bounded response to a bounded input.
- Thus for an unstable system, the response will increase without bounds or will never return to the equilibrium state.

# Introduction

- Response of first order control system for unit step input. This response has the values between 0 and 1. So, it is bounded output.
- We know that the unit step signal has the value of one for all positive values of t including zero. So, it is bounded input.
- Therefore, the first order control system is stable since both the input and the output are bounded.



# Classification of Stability

System stability is classified as follows:

- **Absolutely stable system**
  - ➢ If the system is stable for all the range of system component values, then it is known as the absolutely stable system.
  - ➢ The open loop control system is absolutely stable if all the poles of the open loop transfer function present in left half of s plane.
  - ➢ Similarly, the closed loop control system is absolutely stable if all the poles of the closed loop transfer function present in the left half of the s plane.

# Classification of Stability

- **Conditionally or Marginally stable system**
  - If the system is stable for a certain range of system component values, then it is known as conditionally stable system.
  - If the system is stable by producing an output signal with constant amplitude and constant frequency of oscillations for bounded input, then it is known as marginally stable system.
  - The open loop control system is marginally stable if any two poles of the open loop transfer function is present on the imaginary axis.
  - Similarly, the closed loop control system is marginally stable if any two poles of the closed loop transfer function is present on the imaginary axis.

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# Stability Analysis

- **General form of the transfer function :**

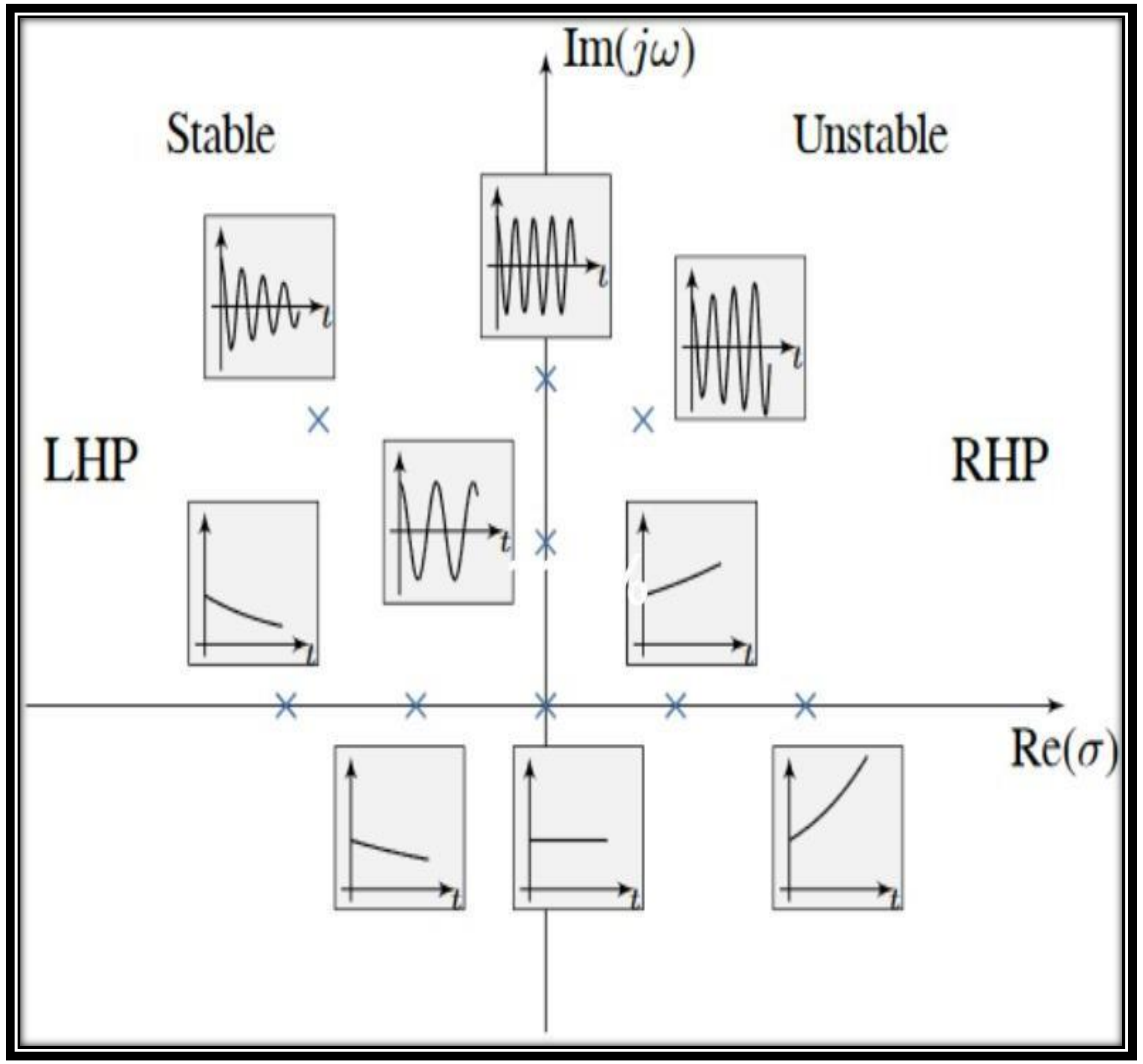
$$G(s) = \frac{X(s)}{Y(s)} = \frac{b_m s^m + b_{m-1} s^{m-1} + \dots + b_1 s + b_0}{a_n s^n + a_{n-1} s^{n-1} + \dots + a_1 s + a_0} = \frac{N(s)}{D(s)}$$

**n : order of the system (n ≥ m ),**

**D(s) : characteristic polynomial**

**Characteristic equation : D(s)=0**

$$D(s) = a_n s^n + a_{n-1} s^{n-1} + \dots + a_1 s + a_0 = 0$$



# *Thank You*