Control Systems - 7^{th} Semester

Lecture 1

Course Information

Course Title: Control Systems

Course Code: CSE-310

Credit Hours Theory: 3hr

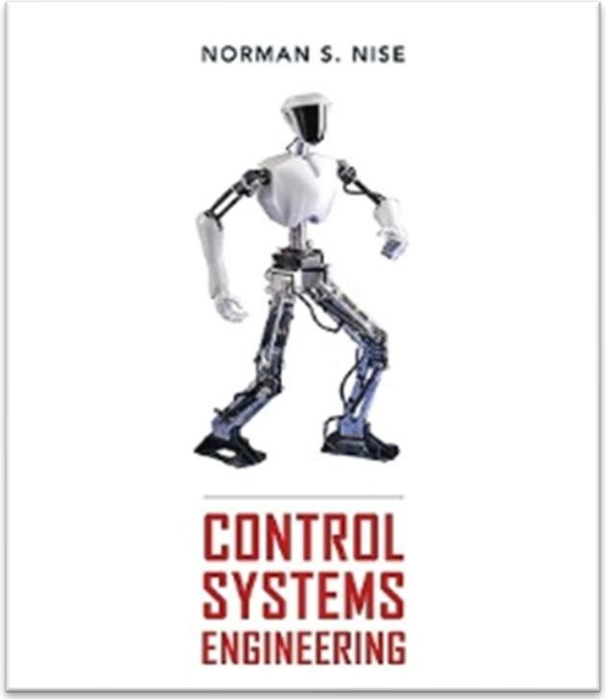
Credit Hours Lab: 1hr

Time Schedule:

- Lectures: Wednesdays and Fridays

Primary Textbook:

- Norman S. Nise, *Control Systems,* 6th Edition



Reference Textbook:

- R. C. Dorf. And R. H. Bishop, *Modern Control Systems,* 12th Edition, Pearson

Tentative Grading Criteria

Exams

- Final exam: **50%**
- Mid Term exam: **30%**

Sessional

- Attendance: **10%**
- Assignments: **5%**
- Quizzes: **5%**

All lectures interrelated

- Each lecture provides base for next lecture
- Missing any lecture would result in problems in understanding subsequent lectures

Warning

No mobile phone usage during Lecture

Control Systems Course Brief

This course is be divided into 3 sub areas:

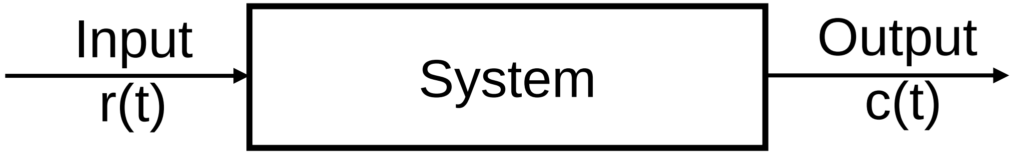
- Understand the language used to model system e.g., $y = mx + c$
- Analyze the model of a system
- If required, design controller for a system, and connect the controller with the system for better performance

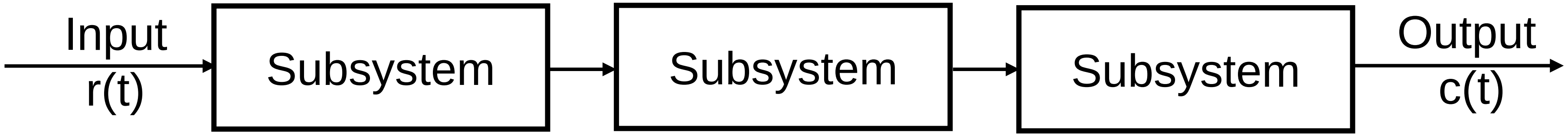
In summary, control course is about modeling, analysis and design of systems

System

What is the definition of System in simple terms?

- Any set of components that accepts input, process it and provides output
- Or a system can be combination of various sub systems





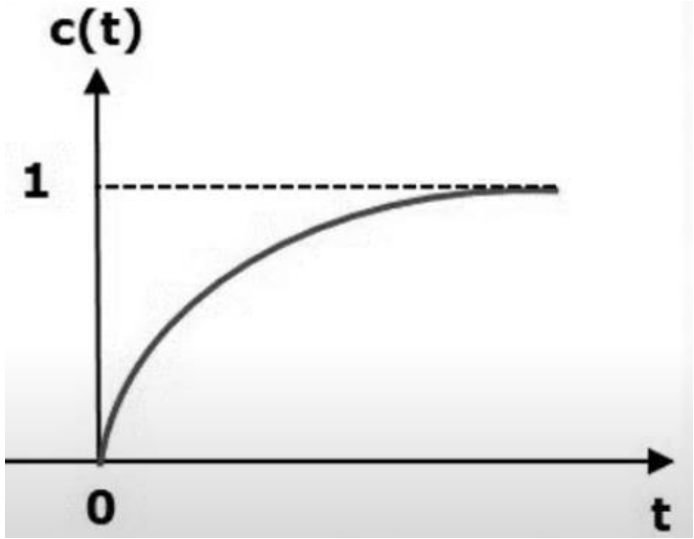
Control System

What is the definition of Control System in simple terms?

- A control system consists of subsystems and processes assembled for purpose of obtaining a desired output with desired performance, given a specified input
- Forcing the output(s) of a system to have specific value(s)
- A system which processes the input to produce an output
- A system which changes in response to an input (or something e.g., time)

A desired input is applied to a system; and

output of the system follows the desired output



Examples from Real-World

The paper that we use to write and make notes

The water that we drink from a tap or purifier (water control systems)

The medicines that a patient consumes (medicine control systems)

Homes:

- Thermostat of air-conditioner to regulate the temperature
- Washing machines to clean dirty clothes
- Water boiler (geyser) to warm water in winter season

Automobiles:

- Speed Control, temperature control
- Stability in terms of shock absorber

Examples from Real-World

Figure: An example of automobile/car manufacturing factory where a network of computers are controlling the factory

Examples from Real-World

Figure: An example of packaging of Pepsi bottles in group of 6, job controlled by a network of computers

Control Systems in DCSE

By now (7th semester), you have studied courses related to programming, networks, signal processing and embedded systems

Why do we need Control Systems or what are the benefits of studying Control Systems?

Let me give you a simple example from programming subject

Addition program

```
#include <iostream.h>

void main()
{
    int x;
    int y;


    std::cin>>x;

    y=x+2;

    std::cout << "The sum is "<<y;
}
```

Figure: An example of addition code

Addition program

In the previous slide, one input was taken as input and the output was sum of input and 2

May be if we are asked to write a program for the following data

Input, x	Output, y
1	-0.5
2	2
3	4.5
4	7

Table: One input one output program

Code for Data in table

```
#include <iostream.h>

void main()
{
    int x;
    std::cin>>x;
    if(x==1)
        std::cout << "The output y is -0.5";
    else if(x==2)
        std::cout<<"The output y is 2";
    else if (x==3)
        std::cout<<"The output y is 4.5";
    else if (x==4)
        std::cout<<"The output y is 7";
}
```

Figure: Code for the data given in table

Code for Data in table

Do we need any Control Systems to write the code/program?

The answer is No. We donot need any Control Systems to write the computer code

Let us add some more data to the table

Adding more data in table

Input, x	Output, y
1	-0.5
2	2
3	4.5
10	22
20	47
33	79.5
35	84.5
39	94.5
44	107

Table: One input variable, one output variable data

Code for More Data in table

Do we still need any Control Systems to write a code/program?

The answer is No. We do not need any Control Systems to write the computer code

What if you have ten thousand (10,000) lines of data or even more

- Is ***if*** and ***else*** an easy approach in programming to solve problems?

What will happen if instead of one input variable, we use two or three input variables or more?

Adding more data in table

Input, x_1	Input, x_2	Output, y
1	2	-2.5
2	4	-2
3	2	2.5
4	5	2
10	9	13
20	1	46
33	0	79.5
33	5	74.5
33	9	70.5

Table: Two input variables, one output variable

The need for Control Systems

The previous data was generated using the following formula:

$$y = mx + c$$

I used the following values to generate the first table (one input variable):

$$y = 2.5x - 3$$

I used the following values to generate the two-variables table ($y = m_1x_1 + m_2x_2 + c$)

$$y = 2.5x_1 - 1x_2 - 3$$

The need for Control Systems

A programmer or computer expert with no knowledge of mathematics would try to write everything using *if* and *else* statements, or arrays

A programmer with little knowledge of mathematics can easily implement $\boldsymbol{y = mx + c}$ equation instead of writing of long codes

If we know equations, then we can easily use equations instead of *if* and *else* statements

Instead of $y = mx + c$, we may have complex equations like trigonometric equations and differential equations

The need for Control Systems

Sometimes in programming and computer sciences, if we have little knowledge of mathematics (equations), then life becomes easier for us

In Control Systems course, we study the mathematics for systems. Let me introduce anther term which is called as cyber-physical systems

Cyber-Physical Systems

Cyber world includes all aspects of computing, including data acquisition, data storage on hard disk (or other mediums), data retrieval, data transmission over a network and data analysis

We live in this physical world which consist of nature, things, human beings, trees, animals, birds and so many other systems

Connecting the cyber world to physical world give rises to another branch of computer engineering which is termed as Cyber-Physical Systems (CPS)

Examples of CPS: Smart grids, medical monitoring of patients, industrial control systems, robotics, driverless cars

Cyber-Physical Systems

If we know the simple mathematics behind every system, we can easily connect them to cyber-world

Infact, we can have decision making process embedded in each CPS