Course Code: MEE- S404 T Breakup: 3 – 0 – 0 – 3

Course Name: MEASUREMENT AND CONTROLS

Course Details:

Similarity , errors , dynamic response , pitot tube , hot wire anemometer,Laser doppler velocimeter , optical tecniques for field measurement,image processing, volume averaged measurment ,uncertanity analysis signal processing and compensation for probev characteristics. Laplace transform , Inverse Laplace transform.Block diagrams, Transfer functions ,Signal flow graphs , state variable characterization of dynamic systems. Modeling of mechanical system elements, error sensing devices in control systems.stability,routh hurwitz criterion , Ny quist criterion.Root locus techniques , frequency domain analysis,Brief Introduction of Mecatronics.

Text Books and References:

Turbomachienry, Kadambi and prasad

Automatic control Engineering, Ogatta

Automatic control Engineering , Kuo Mecatronics,HMT

1. Basic Concept of Control System

Control Engineering is concerned with techniques that are used to solve the following six problems in the most efficient manner possible.

(a)The identification problem :to measure the variables and convert data for analysis.

(b)The representation problem:to describe a system by an analytical form or mathematical model

(c)The solution problem:to determine the above system model response.

(d)The stability problem: general qualitative analysis of the system

(e)The design problem: modification of an existing system or develop a new one

(f)The optimization problem: from a variety of design to choose the best.

The two basic approaches to solve these six problems are conventional and modern approach. The electrical oriented conventional approach is based on complex function theory. The modern approach has mechanical orientation and based on the state variable theory.

Therefore, control engineering is not limited to any engineering discipline but is equally applicable to aeronautical, chemical, mechanical, environmental, civil and electrical engineering. For example, a control system often includes electrical, mechanical and chemical components. Furthermore, as the understanding of the dynamics of business, social and political systems increases; the ability to control these systems will also increase.

Basic terminologies in control system

System: A combination or arrangement of a number of different physical components to form a whole unit such that that combining unit performs to achieve a certain goal.

Control: The action to command, direct or regulate a system.

Plant or process: The part or component of a system that is required to be controlled.

Input: It is the signal or excitation supplied to a control system.

Output: It is the actual response obtained from the control system.

Controller: The part or component of a system that controls the plant.

Disturbances: The signal that has adverse effect on the performance of a control system.

Control system: A system that can command, direct or regulate itself or another system to achieve a certain goal.

Automation: The control of a process by automatic means

Control System: An interconnection of components forming a system configuration that will provide a desired response.

Actuator: It is the device that causes the process to provide the output. It is the device that provides the motive power to the process.

Design: The process of conceiving or inventing the forms, parts, and details of system to achieve a specified purpose.

Simulation: A model of a system that is used to investigate the behavior of a system by utilizing actual input signals**.**

Optimization: The adjustment of the parameters to achieve the most favorable or advantageous design.

Feedback Signal: A measure of the output of the system used for feedback to control the system.

Negative feedback: The output signal is feedback so that it subtracts from the input signal.

Block diagrams: Unidirectional, operational blocks that represent the transfer functions of the elements of the system.

Signal Flow Graph (SFG): A diagram that consists of nodes connected by several directed branches and that is a graphical representation of a set of linear relations.

Specifications: Statements that explicitly state what the device or product is to be and to do. It is also defined as a set of prescribed performance criteria.

Open-loop control system: A system that utilizes a device to control the process without using feedback. Thus the output has no effect upon the signal to the process.

Closed-loop feedback control system: A system that uses a measurement of the output and compares it with the desired output.

Regulator: The control system where the desired values of the controlled outputs are more or less fixed and the main problem is to reject disturbance effects.

Servo system: The control system where the outputs are mechanical quantities like acceleration, velocity or position.

Stability: It is a notion that describes whether the system will be able to follow the input command. In a non-rigorous sense, a system is said to be unstable if its output is out of control or increases without bound.

Multivariable Control System: A system with more than one input variable or more than one output variable.

Trade-off: The result of making a judgment about how much compromise must be made between conflicting criteria.

- **System:** A combination or arrangement of a number of different physical components to form a whole unit such that that combining unit performs to achieve a certain goal.
- **Control:** The action to command, direct or regulate a system.

Open-loop control system: It is a control system where its control action only depends on input signal and does not depend on its output response

An open-loop system

Examples: traffic signal, bread toaster, Automatic washing machine ,Coffee or Tea making machine ,Volume on the stereo system , Electric hand drier , Bread toaster
Inkjet printers , Servo motor/Servo motor ; Electric bulb; Clothes drier based on a timer ,Light switch ,TV (remote control) Water faucet , Door lock system etc.

Advantages:

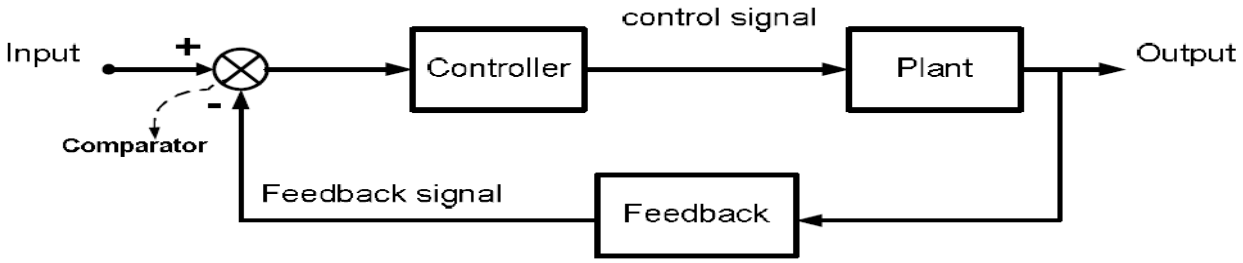
- ✓ Simple design and easy to construct
- ✓ Economical
- ✓ Easy for maintenance
- ✓ Highly stable operation

Dis-advantages:

- ➢ Not accurate and reliable when input or system parameters are variable inNature
- ➢ Recalibration of the parameters are required time to time

Closed-loop control system:

It is a control system where its control action depends on both of its input signal and output response



A closed-loop system

Examples:

automatic electric iron, missile launcher, speed control of DC motor, etc

Advantages:

- ✓ More accurate operation than that of open-loop control system
- ✓ Can operate efficiently when input or system parameters are variable in nature
- ✓ Less nonlinearity effect of these systems on output response
- ✓ High bandwidth of operation
- ✓ There is facility of automation
- ✓ Time to time recalibration of the parameters are not required

Dis-advantages:

- ❑ Complex design and difficult to construct

Comparison between open loop system and closed loop system

Open loop system	Closed loop system
these are not reliable	these are reliable
it is easier to build	it is difficult to built
if calibration is good they perform accurately	they are accurate because of feedback
operating systems are generally more stable	these are less stable
Optimization is not possible	Optimization is possible