COURSE DURATION

Chapter Number	Number of hours
Basics of control system	15
Time response Analysis	15
Stability of system	7.5
Root locus	9.0
Frequency response analysis	24
State space analysis	7.5
Compensator and controller	4.5

EE SYLLABUS

Mathematical modelling and representation of systems. Feedback principle, transfer function. Block diagrams and Signal flow graphs Transient and Steady-state analysis of linear time invariant systems Stability analysis using Routh-Hurwitz and Nyquist criteria, Bode plots Root loci Lag, Lead and Lead-Lag compensators; P, PI and PID Controllers State space model. Solution of state equations of LTI systems

ECE SYLLABUS

Basic control system components; Feedback principle; Transfer function; Block diagram represent Signal flow graph Transient and steady-state analysis of LTI systems Frequency response Routh Hurwitz and Nyquist stability criteria; Bode and root-locus plots lead and lag-lead compensation State variable model and solution of state equation of LTI systems.

IN SYLLABUS

CONTROL SYSTEMS

Feedback principles, signal flow graphs) (transient response, steady-state-errors, Bode plot, phase and gain margins Routh and Nyquist criteria, root loci. design of lead, lag and lead-lag Compensations, State-space representation of system

PROCESS CONTROL

time-delay systems, mechanical, hydraulic and pneumatic system components, synchro pair, servo and stepper motors, servo valves; on-off, P, PI, PID, cascade, feedforward, and ratio controllers, tuning of PID controllers and sizing of control values

CONTENT FLOW

Content Flow
Basic Control System Component
Transfer Function
Time response analysis
Routh Hurwitz Criteria
Root locus
Frequency Response Analysis
State Space Analysis
Controller and Compensator

TOPIC WISE WEIGHTAGE OF CONTROL SYSTEMS - EE

(9-10 marks)

Chapter	2019	2020	2021	2022	2023	2024
Transfer Function	0	4	1	0	2	1
Time Response Analysis	0	0	2	2	0	2
Stability	1	4	0	1	0	0
Root Locus	0	0	2	0	0	2
Frequency Response Analysis	3	3	1	5	3	4
State Space Analysis	2	0	2	0	2	0
Control System Design	2	0	0	0	3	0
Total	8	11	8	8	10	9

1-2 → Transfer Function
~1 → Time Response Analysis
~1 → Stability
0-1 → Root Locus
3-4 → Frequency Response Analysis
1-2 → State Space Analysis
0-1 → Control System Design

TOPIC WISE WEIGHTAGE OF CONTROL SYSTEMS - ECE

(7-8 marks)

Chapter	2019	2020	2021	2022	2023	2024
Transfer Function	2	0	1	0	2	0
Time Response Analysis	3	2	0	2	2	3
Stability	2	1	0	2	0	0
Root Locus 0	0	2	0	1	0	0
Frequency Response Analysis	1	3	1	1	3	1
State Space Analysis	2	2	2	0	0	2
Control System Design	0	0	2	0	0	2
Total	10	10	6	6	7	8

1-2 → Transfer Function
2-3 → Time Response Analysis
0-2 → Stability
0-1 → Root Locus 0
~2 → Frequency Response Analysis
~2 → State Space Analysis
0-1 → Control System Design

TOPIC WISE WEIGHTAGE OF CONTROL SYSTEMS - IN

(9-10 marks)

Chapter	2019	2020	2021	2022	2023	2024
Transfer Function	1	1	0	2	0	0
Time Response Analysis	2	3	3	1	1	4
Stability	0	0	0	0	1	0
Root Locus 0	2	2	0	0	2	2
Frequency Response Analysis	5	4	3	2	5	1
State Space Analysis	2	2	0	1	0	1
Control System Design	0	2	2	4	0	0
Total	12	14	8	10	10	8

~1 → Transfer Function
~2 → Time Response Analysis
0-1 → Stability
0-2 → Root Locus 0
3-4 → Frequency Response Analysis
1-2 → State Space Analysis
1-2 → Control System Design

Basic Requirement for CONTROL system

- Laplace transform → will be covered in Lecture-02
- No other pre-requisite

STRATEGY

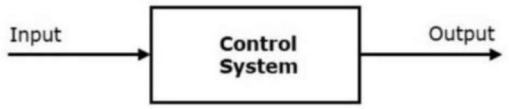
Challenge -01 : Attend all class live

- revise pdf notes & make short notes
- solve assignment problems ← LIVE DISCUSSION
- attempt test on Sundays

PRACTICE ① ASSIGNMENT & CLASS QUES } mandatory
② PYQ ← end of a chapter (at least last 10 years)
③ WORKBOOK
topic wise
or
during revision

WHAT IS A CONTROL SYSTEM?

A control system is a system, which provides the desired response by controlling the output. The following figure shows the simple block diagram of a control system



BASIC COMPONENTS OF A CONTROL SYSTEM

The basic ingredients of a control system can be described by:

1. Objectives of control.
2. Control-system components.
3. Results or outputs.

MAN MADE AND NATURAL CONTROL SYSTEMS

Control systems can be man-made, natural, or a hybrid of the two.

Man-made control systems are systems that people create and develop. Examples include: Cars, Gadgets, Vehicles, Aeroplanes, and DC-motor speed control.

Natural control systems are biological processes, such as the human body's respiratory system and temperature. Other examples of natural control systems include: The human body's temperature and blood pH and Cooking.

Hybrid control systems are a combination of man-made and natural or biological systems.

EXAMPLES OF CONTROL SYSTEM

Robotics

EXAMPLES OF CONTROL SYSTEM

Biomedical

EXAMPLES OF CONTROL SYSTEM

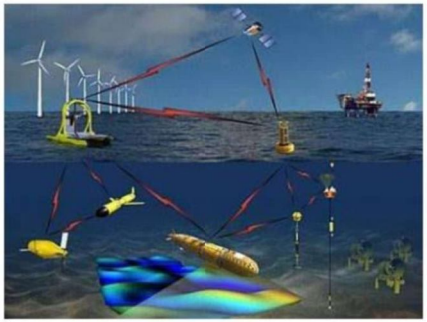
Surgical

EXAMPLES OF CONTROL SYSTEM

Aeronautics

EXAMPLES OF CONTROL SYSTEM

Marine

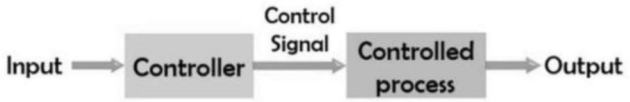


EXAMPLES OF CONTROL SYSTEM

Space Industries

OPEN-LOOP CONTROL SYSTEMS (NON FEEDBACK SYSTEMS)

In the open-loop control system, a reference input is given to the system in order to get the desired output. But the achieved output is not considered by the system for further reference input.
The figure here represents the block diagram of an open-loop control system:



Open Loop Control System

eg Washing machine, traffic signal, fan, tubelight, toaster,

Advantages of Open-loop Control System

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1. These systems possess simplicity in construction and ease of maintenance.
2. Due to the lesser number of units, overall the system is economic.
3. The output provided by the system shows stability.
4. The operation is quite convenient.

Dis-advantages of Open-loop Control System

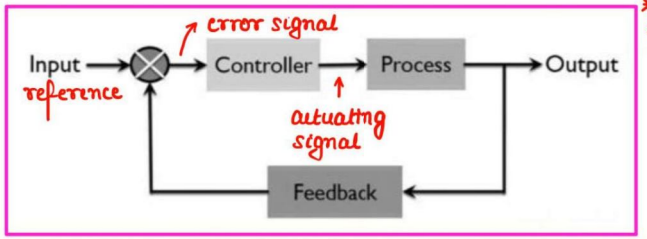
1. These systems require timely recalibration.
2. The systems are more prone to errors.
3. The changes in the desired output can be the result of internal or external disturbances

Applications of Open-loop Control System

1. In the traffic light controlling system,
2. TV remote control,
3. Immersion Rod
4. Automatic washing machines,
5. In room heaters,
6. Automatic door opening and closing systems etc.

CLOSED-LOOP CONTROL SYSTEM

- A closed-loop control system is a type of control system in which the controlling action shows dependency on the generated output of the system. In simple words, in these systems, the output of the system controls the input applied to the system.
- Closed-loop systems are considered as fully automatic control system because it is designed in a way that the achieved output is automatically compared with the reference input to have the required output.



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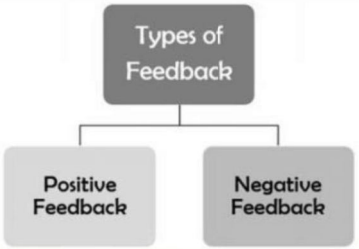
- In a **closed-loop system**, a feedback signal is provided to the input.

WHAT IS FEEDBACK?

- Feedback acts as the characteristic of the system that allows comparison between achieved output and reference input of a system.
- A feedback is generally a part of the output signal which is given back to the input signal so that the two can be compared and the desired output can be achieved if the present output shows variation with the desired output.
- Thus feedback loop is considered as the key parameter of a closed-loop control system.



POSITIVE FEEDBACK?

The type of feedback in a control system in which the input signal and the feedback signal are in phase with each other is known as a positive feedback system.

input signal & the feedback signal get added.

NEGATIVE FEEDBACK?

In the case of negative feedback, the input signal and the feedback signal show out-of-phase relationship with respect to each other.

input signal & feedback signal get subtracted.

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Advantages of Closed-loop Control System (-ve feedback)

1.Closed loop control systems are more accurate even in the presence of non-linearity.
2.Highly accurate as any error arising is corrected due to the presence of a feedback signal.
3.The bandwidth range is large. (gain↓ BW↑)
4.Facilitates automation.
5.The sensitivity of the system may be made small to make the system more stable.
6.This system is less affected by noise.

Dis-advantages of Closed-loop Control System

1.They are costlier.
2.They are complicated to design.
3.Required more maintenance.
4.Feedback leads to an oscillatory response.
5.Overall gain is reduced due to the presence of feedback.
6.Stability is the major problem and more care is needed to design a stable closed loop system.

APPLICATIONS OF CLOSED-LOOP CONTROL SYSTEM

1. Automatic Electric Iron
2. Temperature Control System (AC / Thermostat)

ASSIGNMENT

Question-01

Temperature Control System
(a) Open-loop system
(b) Closed-loop system
(c) Both (a) and (b)
(d) None of these

Question-02

in a control system the use of negative feedback
(a) Eliminates the chances of instability
(b) Increases the reliability
(c) Reduces the effects of disturbance and noise signals in the forward path
(d)Increases the influence of variations of component parametres on the system performance

Question-03

A control system in which the control action is somehow dependent on the output is known as
(a) Closed loop system
(b) Semi closed loop system
(c) Open system
(d) None of the above

Question-04

Benefits of feedback
(a) Performance of system is greater
(b) Need for system much larger path gain and system instability
(c) Controlled variable accurately follows the desired value
(d) Affected by parameter variations.

Question-05

Feedback always increases the gain?
(a) True
(b) False

Question-06

Effect of feedback on sensitivity is minimum in:
(a) Open loop control system
(b) Closed loop control system
(c) None of the mentioned
(d) Both of the mentioned

Question-07

Systems in which the output has no effect on the control action arc called:
(a) Closed-loop control systems
(b) Open-loop control systems
(c) Linear control systems
(d) Feedback control systems

Question-08

A control system with excessive noise, is likely so saffer from
(a) Saturation in amplifying stages
(b) Loss of gain
(c) Vibrations
(d) oscillations

Question-09

A good control system has all the following features except
(a) Good stability
(b) Slow response
(c) Good accuracy
(d) Sufficient power handling capacity

Question-10

Human system is-
(a) An open-loop control system
(b) A closed –loop control system
(c) A multivariable feedback control system
(d) A complex control system

Question-11

In a non-linear control system, limit cycle is self-sustained oscillations of
(a) Variable amplitude
(b) Variable frequency
(c) Fixed frequency
(d) Fixed frequency and amplitude

Question-12

The following type of system has tendency to generate oscillations.
(a) Closed loop system
(b) Open loop system
(c) Open and closed loop system
(d) None of the above