SNS COLLEGE OF TECHNOLOGY

Coimbatore-26
An Autonomous Institution

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT212 – CONTROL SYSTEMS

II YEAR/ IV SEMESTER

UNIT II – TIME RESPONSE ANALYSIS

TOPIC 6-P Compensation.

OUTLINE

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PROPORTIONAL AND INTEGRAL CONTROLLER

PROPORTIONAL AND DERIVATIVE CONTROLLER

PROPORTIONAL PLUS INTEGRAL PLUS DERIVATIVE CONTROLLER (PID CONTROLLER)

WHAT IS A CONTROLLER? & USES

It is a mechanism that seeks to minimize the difference between the actual value of a system (i.e. the process variable) and the desired value of the system (i.e. the setpoint).

Controllers are a fundamental part of control engineering and used in all complex control systems.

The important uses of the controllers include:

Controllers can

- improve the steady-state accuracy by decreasing the steady state error.
- As the steady-state accuracy improves, the stability also improves.
- reducing the unwanted offsets produced by the system.
- control the maximum overshoot of the system.
- help in reducing the noise signals produced by the system.
- help to speed up the slow response of an over damped system.

TYPES OF CONTROLLERS

Two main types of controllers:

1. continuous controllers
2. discontinuous controllers.

Discontinuous controllers,

• The manipulated variable changes between discrete values. Depending on how many different states the manipulated variable can assume, a distinction is made between two position, three position, and multi-position controllers.

•Operate on very simple, switching final controlling elements.

Continuous controllers : controlled variable (also known as the manipulated variable) can have any value within the controller's output range. continuous controller theory→ three basic modes

1. **Proportional controllers**.
2. **Integral controllers**.
3. **Derivative controllers**.

THREE TYPES OF CONTROLLERS

The combination of these modes to control our system such that the process variable is equal to the set point (or as close as we can get it).

These three types of controllers can be combined into new controllers:

1. Proportional and integral controllers (PI Controller)
2. Proportional and derivative controllers (PD Controller)
3. Proportional integral derivative control (PID Controller)

PROPORTIONAL CONTROLLERS

We cannot just insert any type of controller at any system and expect a good result – there are certain conditions that must be fulfilled.

For a **proportional controller,** there are two conditions and these are written below:

The deviation should not be large; i.e. there should not be a large deviation between the input and output.

The deviation should not be sudden.

the output (also called the actuating signal) is directly proportional to the error signal.

MATHEMATICAL ANALYZE

As we know in proportional controller output is directly proportional to the error signal, writing this mathematically we have,

$$A(t) \propto e(t) \qquad A(t) = K_p \times e(t)$$

It is recommended that K_p should be kept greater than unity.

If the value of K_p is greater than unity (>1), then it will amplify the error signal

and thus the amplified error signal can be detected easily.

ADVANTAGES AND DISADVANTAGES OF PROPORTIONAL CONTROLLER

Advantages of Proportional Controller

- reducing the steady-state error, thus makes the system more stable.
- The slow response of the overdamped system can be made faster with the help of these controllers.

Disadvantages of Proportional Controller

- Due to the presence of these controllers, we get some offsets in the system.
- Proportional controllers also increase the maximum overshoot of the system.

ACTIVITY-PUZZLES

INTEGRAL CONTROLLERS

•The output (also called the actuating signal) is directly proportional to the integral of the error signal.

•To analyze integral controller mathematically.

• An integral controller output is directly proportional to the integration of the error signal, writing this mathematically we have,

$$A(t) \propto \int_0^t e(t)dt \qquad A(t) = K_i \times \int_0^t e(t)dt$$

•Where Ki is an integral constant also known as controller gain.

•The integral controller is also known as reset controller.

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1. Green with envy
2. For once in my life
3. What goes up must come down

ADVANTAGES AND DISADVANTAGES OF INTEGRAL CONTROLLER

Advantages of Integral Controller

•Due to their unique ability, Integral Controllers can return the controlled variable back to the exact set point following a disturbance that's why these are known as reset controllers.

Disadvantages of Integral Controller

•It tends to make the system unstable because it responds slowly towards the produced error.

Advantages of Derivative Controller

The major advantage of a derivative controller is that it improves the transient response of the system.

DERIVATIVE CONTROLLERS

We never use **derivative controllers** alone. It should be used in combinations with other modes of controllers because of its few disadvantages which are written below:

- It never improves the steady-state error.
- It produces saturation effects and also amplifies the noise signals produced in the system.

The output (also called the actuating signal) is directly proportional to the derivative of the error signal.

Now let us **analyze the derivative controller mathematically.**

As we know in a derivative controller output is directly proportional to the derivative of the error signal, writing this mathematically we have,

$$A(t) \propto \frac{de(t)}{dt}$$

Removing the sign of proportionality we have,

$$A(t) = K_d \times \frac{de(t)}{dt}$$

SUMMARY