SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
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DEPARTMENT OF MECHATRONICS

19MCB303 – SENSORS AND SIGNAL PROCESSING

UNIT 1 – SCIENCE OF MEASUREMENT

STATIC AND DYNAMIC CHARACTERISTICS

Mrs. P.KALAISELVI M.E.,(Ph.D.,)

ASSISTANT PROFESSOR,

DEPARTMENT OF MECHATRONICS,

SNSCT, Coimbatore.

Syllabus

UNIT-I	SCIENCE OF MEASUREMENT	9
Units and Standards– Calibration techniques –Errors in Measurements– Generalized Measurement System–Static and dynamic characteristics of transducers– Generalized Performance of Zero Order and First Order Systems - Response of transducers to different time varying inputs – Classification of transducers-Introduction to second order systems.		

Characteristics of Transducer

The various **static characteristics** are:

i) Accuracy
ii) Precision
iii) Sensitivity
iv) Linearity
v) Reproducibility
vi) Repeatability
vii) Resolution
viii) Threshold
ix) Drift
x) Stability
xi) Tolerance
xii) Range or span

The various **dynamic characteristics** are:

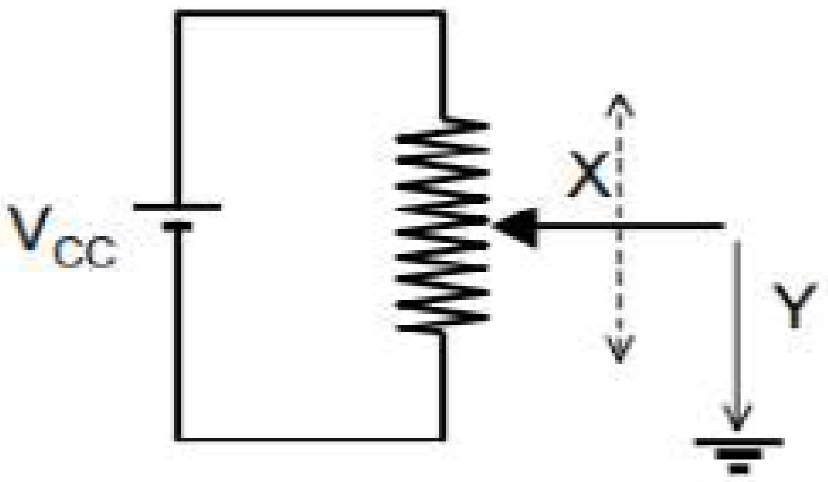
i) Speed of response
ii) Measuring lag
iii) Fidelity
iv) Dynamic error

Generalized Performance of Zero Order System

$$y(t) = k \cdot x(t) \Rightarrow \frac{Y(s)}{X(s)} = k$$

Example of a zero-order sensor

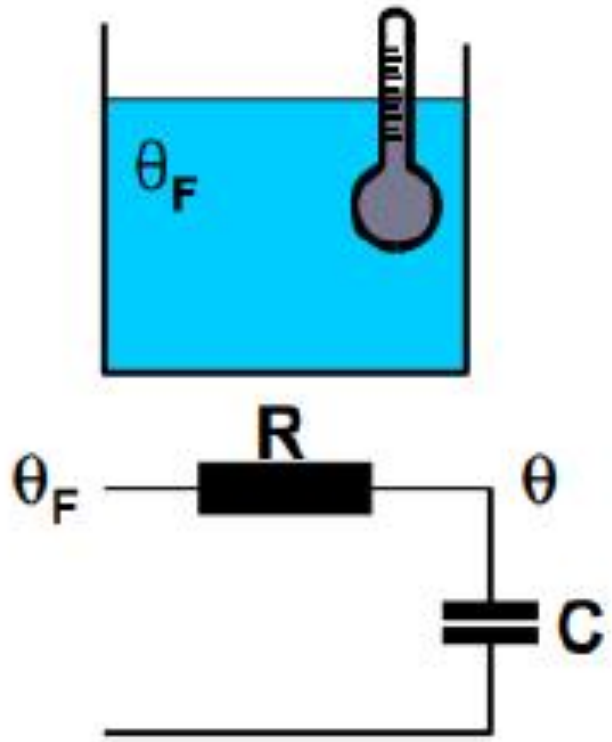
- A potentiometer used to measure linear and rotary displacements
  - This model would not work for fast-varying displacements



Generalized Performance of First Order System

$$a_1\frac{dy}{dt}+a_0y(t)=x(t)\Rightarrow\frac{Y(s)}{X(s)}=\frac{1}{a_1s+a_0}=\frac{k}{\tau s+1}$$

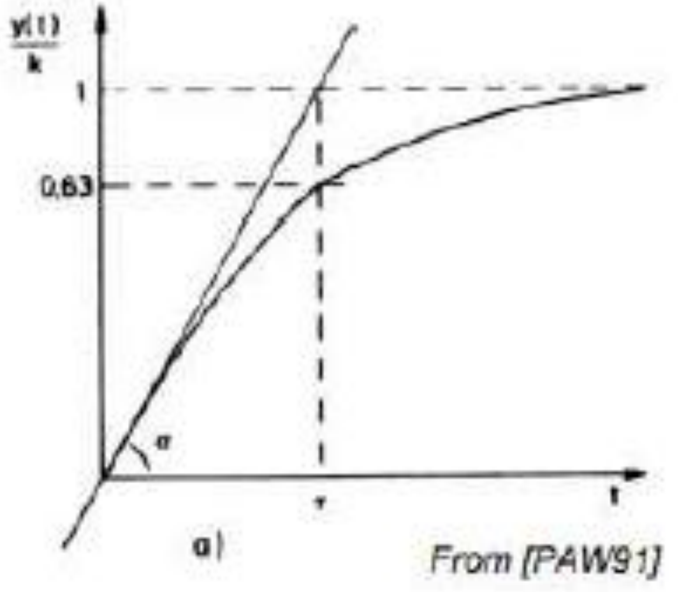
Example



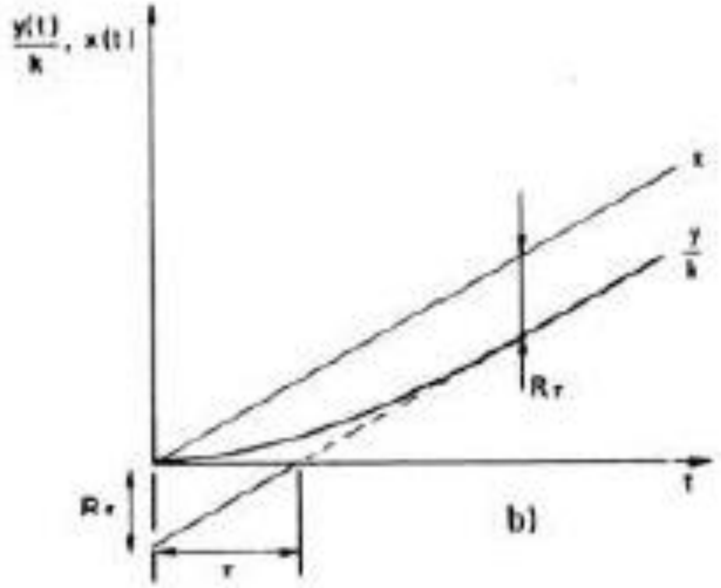
$$\theta(s)=\frac{\theta_F(s)}{(RCs+1)}\Rightarrow\theta(t)=\theta_F\left(1-e^{-t/RC}\right)$$

Response of Transducer with time varying input

Step response

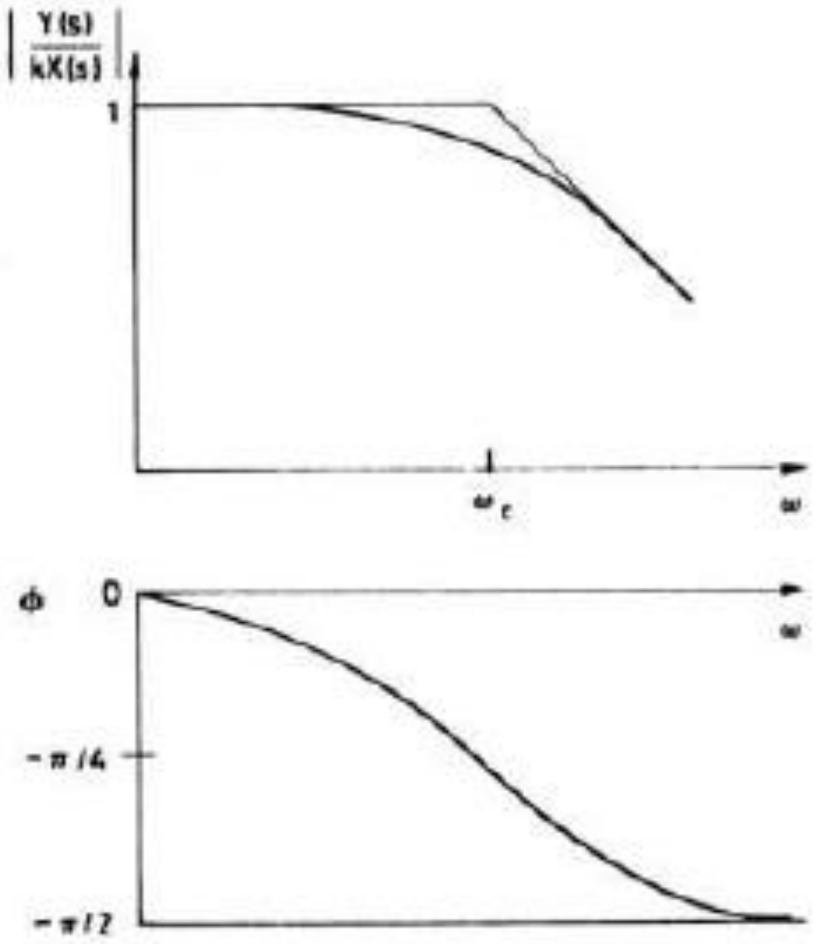


Ramp response



Frequency response

- Corner frequency $\omega_c = 1/\tau$
- Bandwidth



Introduction to Second Order System

$$a_2 \frac{d^2y}{dt^2} + a_1 \frac{dy}{dt} + a_0 y(t) = x(t) \Rightarrow \frac{Y(s)}{X(s)} = \frac{1}{a_2 s^2 + a_1 s + a_0}$$

We can express this second-order transfer function as

$$\frac{Y(s)}{X(s)} = \frac{k\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$$

$$\text{with } k = \frac{1}{a_0},\ \zeta = \frac{a_1}{2\sqrt{a_0 a_1}},\ \omega_n = \sqrt{\frac{a_0}{a_2}}$$

Thank You