Tipe-tipe Instrumen Dan Karakteristik Kinerja

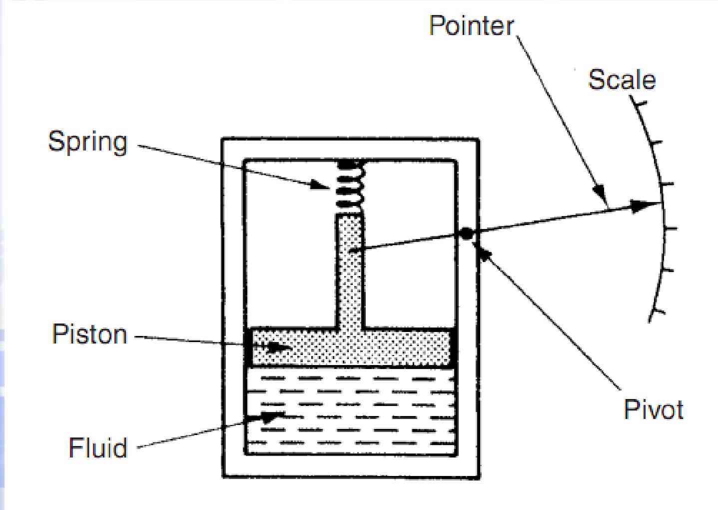
Out Line

- Jenis-jenis instrumen
- Karakteristik Statis
- Karakteristik Dinamis
- Pentingnya Kalibrasi
- Pengenalan alat-alat uji elektronik (praktikum)

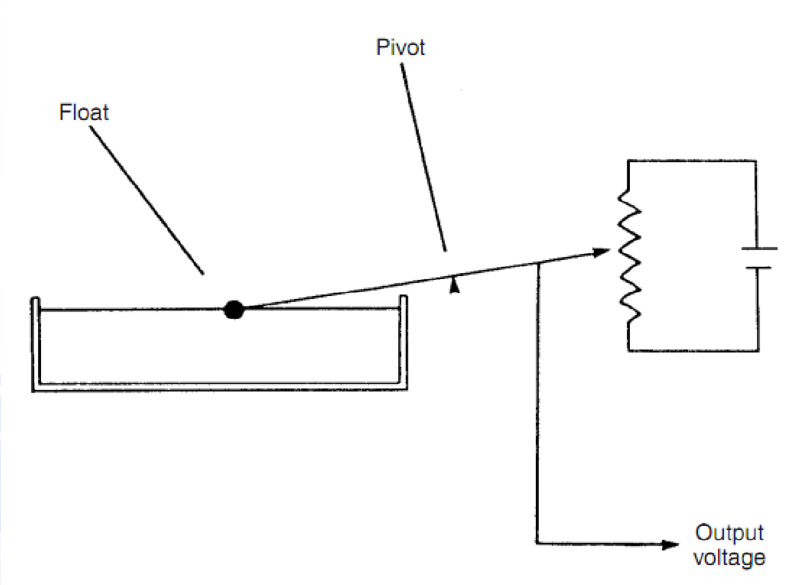
Tipe-tipe instrumen

- Instrumen aktif dan pasif.

Passive pressure gauge.

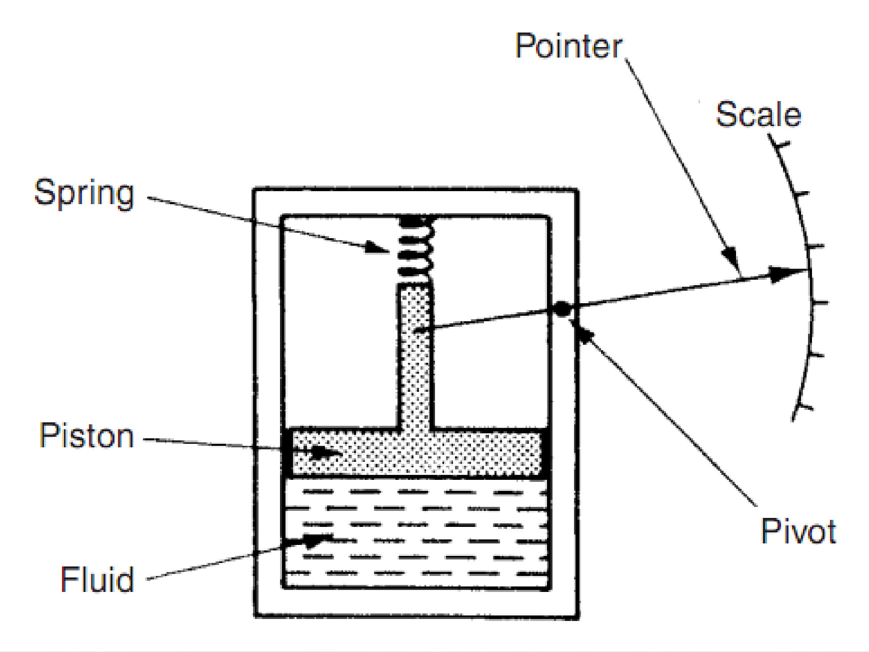


Level indicator

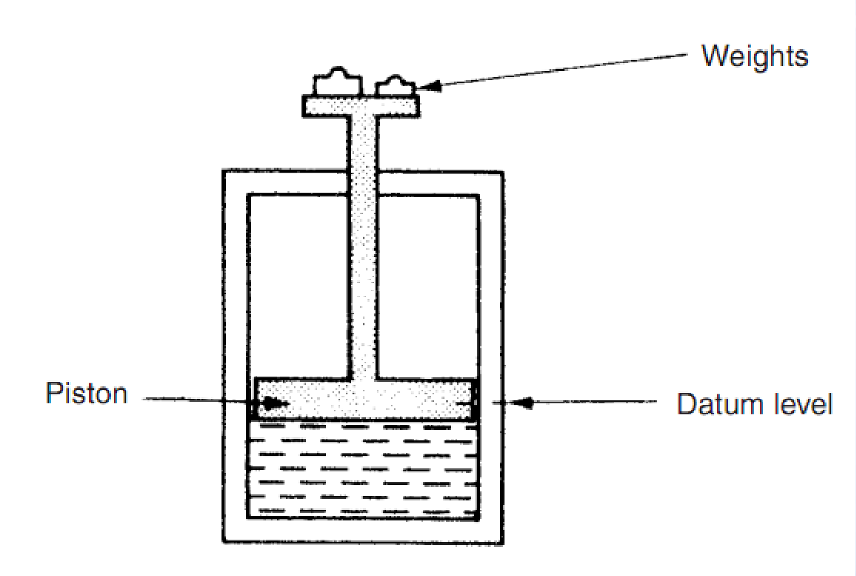


- Instrumen tipe null dan defleksi.
  - Definisi instrumen tipe defleksi.
  - Definisi instrumen tipe null.
  - Akurasi.

pressure gauge tipe defleksi



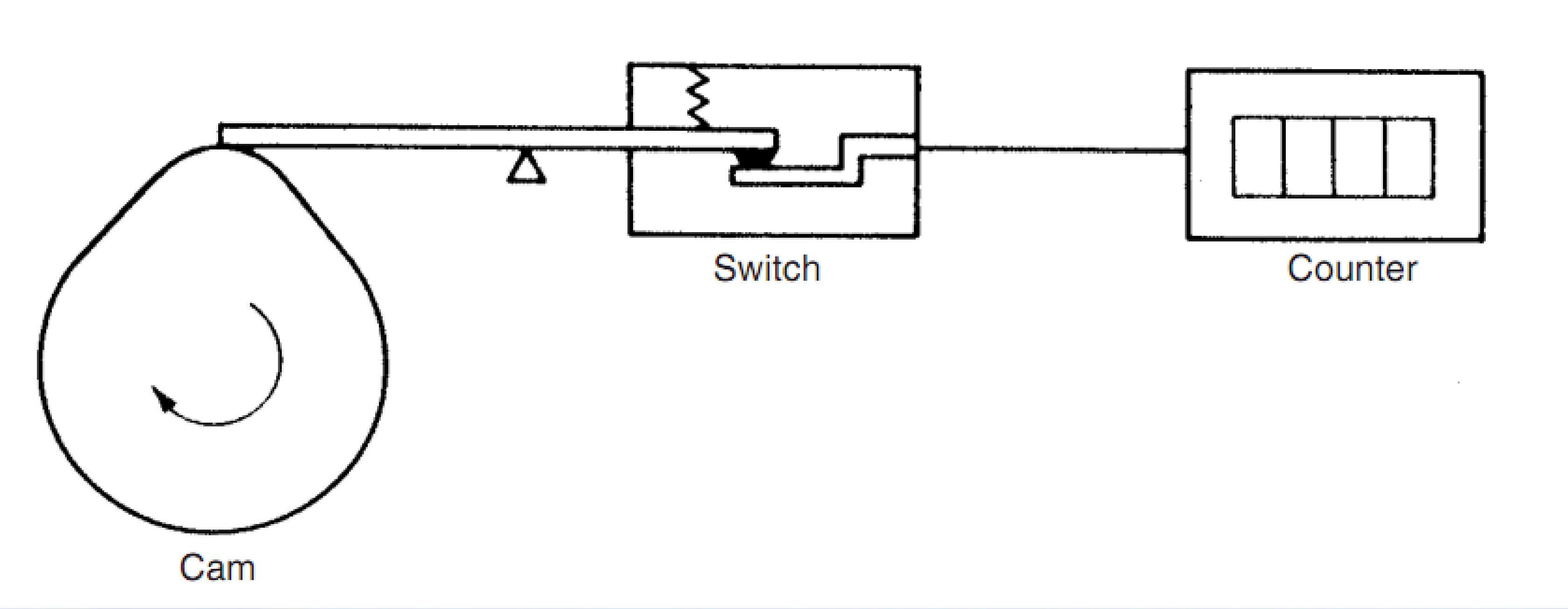
Dead weight gauge tipe null



- Instrumen Analog dan Digital.

  Definisi analog dan digital.

Rev counter digital instrument



Mikrokontroler dan otomasi sistem kendali.

Komputasi digital.

Interface instrumen analog ke microcomputer.

Kekurangan proses konversi:

- Biaya.
- Waktu proses konversi.

Output intrumen :

- Audio.
- Visual.

Indikator :

- Analog.
- Digital.

Gabungan analog dan digital.

Smart dan non smart instrumen.

Karakteristik Statis

Hasil pengukuran saat keadaan tunak (steady-state)

- Akurasi dan tidak akurasi.

  Seberapa dekat pembacaan output dari instrumen dengan nilai yang benar. inaccuracy of %1.0% full-scale. (%1% of full-scale reading)

Akurasi (ketelitian)

- Ketepatan alat ukur dalam memberikan hasil pengukuran

Ada beberapa cara menyatakan akurasi

1. Dalam variabel pengukuran

   contoh ; Termometer skala $0^{O}F$ – $100^{o}F$ dengan akurasi 1 ^{O}F

   Artinya jika pengukuran menunjukkan 60 ^{O}F, maka nilai sebenarnya adalah $59^{O}F$ – $61^{o}F$

2. Dalam presentase span

   contoh : pressure transmitter range 100 – 400 psi. akurasi 0,5 % span

   akurasi = 0,5 % x (400 – 100) = 1,5 psi

   Jika pengukuran menunjukkan 200 psi, maka sebenarnya adalah 198,5 – 201,5 psi

3. Dalam presentase skala maksimum

   contoh voltmeter skala maksimum 200 V dg akurasi 1% FS (full scale)

   akuras = 1 % x 200 = 2 V

4. Dalam presentase pembacaan

   contoh Level transmitter mempunyai akurasi 5 % output

   jika sinyal menunjukkan 40 %, maka akurasi adalah 40 x 5 % = 2 %, sehingga nilai sebenarnya 38 – 42 %

   jika sinyal menunjukkan 60 %, maka akurasi adalah 60 x 5 % = 3 %, sehingga nilai sebenarnya 57 – 63 %

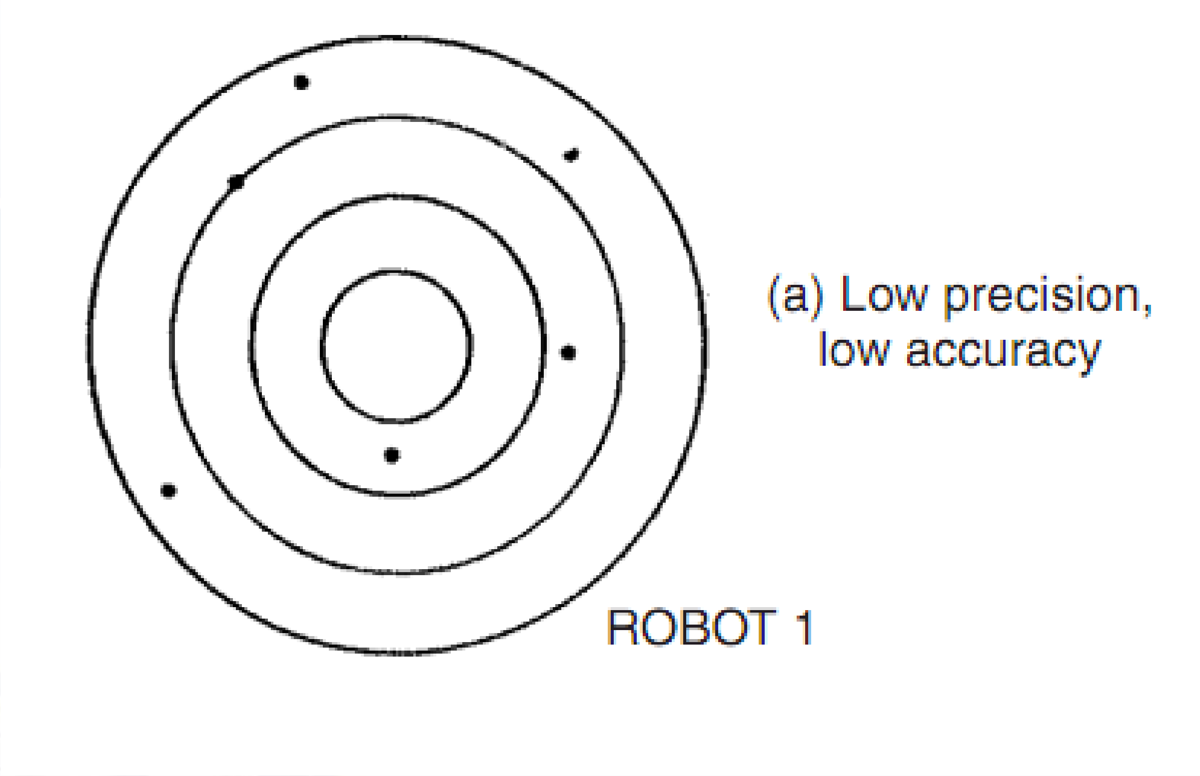
Presisi / repeatability

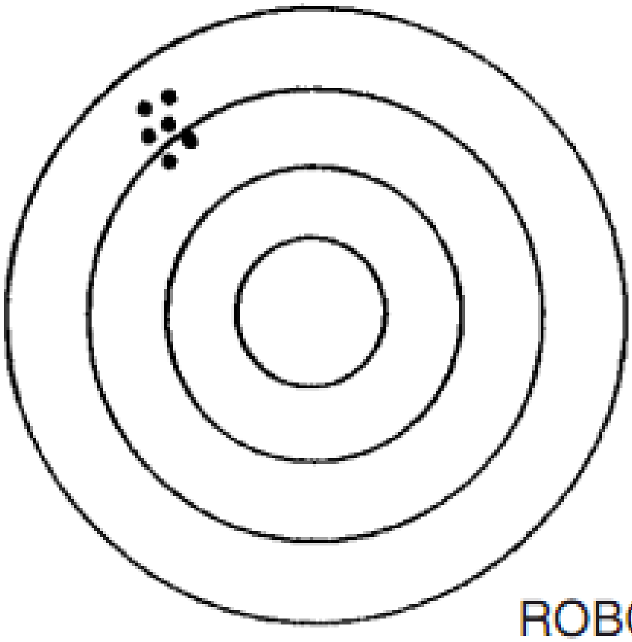
- Kemampuan sistem pengukuran untuk menampilkan ulang output yang sama pada pengukuran berulang singkat

Contoh

voltmeter mempunyai repeatability 0,2 %.

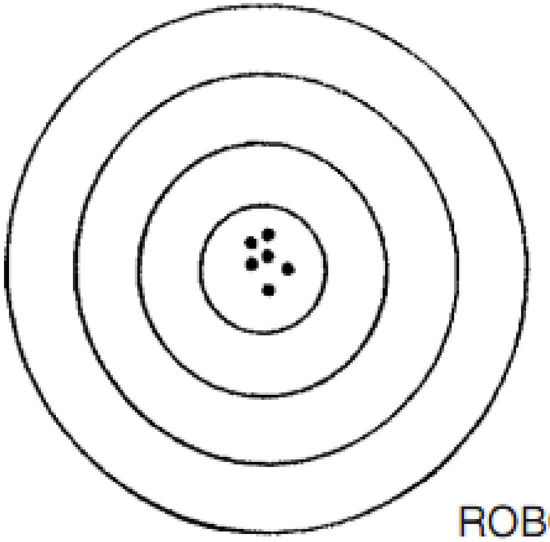
jika pengukuran sebenarnya 100 v, maka ketika pengukuran diulang – ulang (mis 20 kali) maka pembacaan akan berkisar 99,8 – 100,2 V


(a) Low precision,
low accuracy
ROBOT 1



(b) High precision,
low accuracy

ROBOT 2



(c) High precision,
high accuracy

ROBOT 3

Karakteristik Dinamis

Perilaku antara waktu kuantitas yang diukur berubah nilai dan waktu ketika instrumen output mencapai nilai yang stabil sebagai respons.

Time-invariant system pengukuran:

$$a_n \frac{d^n q_0}{dt^n} + a_{n-1} \frac{d^{n-1} q_0}{dt^{n-1}} + \cdots + a_1 \frac{dq_0}{dt} + a_0 q_0$$
$$= b_m \frac{d^m q_i}{dt^m} + b_{m-1} \frac{d^{m-1} q_i}{dt^{m-1}} + \cdots + b_1 \frac{dq_i}{dt} + b_0 q_i \qquad (2.1)$$

where q_i is the measured quantity, q_0 is the output reading and $a_0 \ldots a_n$, $b_0 \ldots b_m$ are constants.

$$a_n \frac{d^n q_0}{dt^n} + a_{n-1} \frac{d^{n-1} q_0}{dt^{n-1}} + \cdots + a_1 \frac{dq_0}{dt} + a_0 q_0 = b_0 q_i \qquad (2.2)$$

If all the coefficients $a_1 \dots a_n$ other than a_0 in equation (2.2) are assumed zero, then:

$$a_0 q_0 = b_0 q_i \quad \text{or} \quad q_0 = b_0 q_i / a_0 = K q_i \tag{2.3}$$

where K is a constant known as the instrument sensitivity as defined earlier.

Any instrument that behaves according to equation (2.3) is said to be of zero order

If all the coefficients $a_2 \dots a_n$ except for a_0 and a_1 are assumed zero in equation (2.2) then:

$$a_1 \frac{dq_0}{dt} + a_0 q_0 = b_0 q_i \tag{2.4}$$

Any instrument that behaves according to equation (2.4) is known as a first order instrument. If d/dt is replaced by the D operator in equation (2.4), we get:

$$a_1 D q_0 + a_0 q_0 = b_0 q_i \quad \text{and rearranging this then gives} \quad q_0 = \frac{(b_0/a_0)q_i}{[1 + (a_1/a_0)D]} \tag{2.5}$$

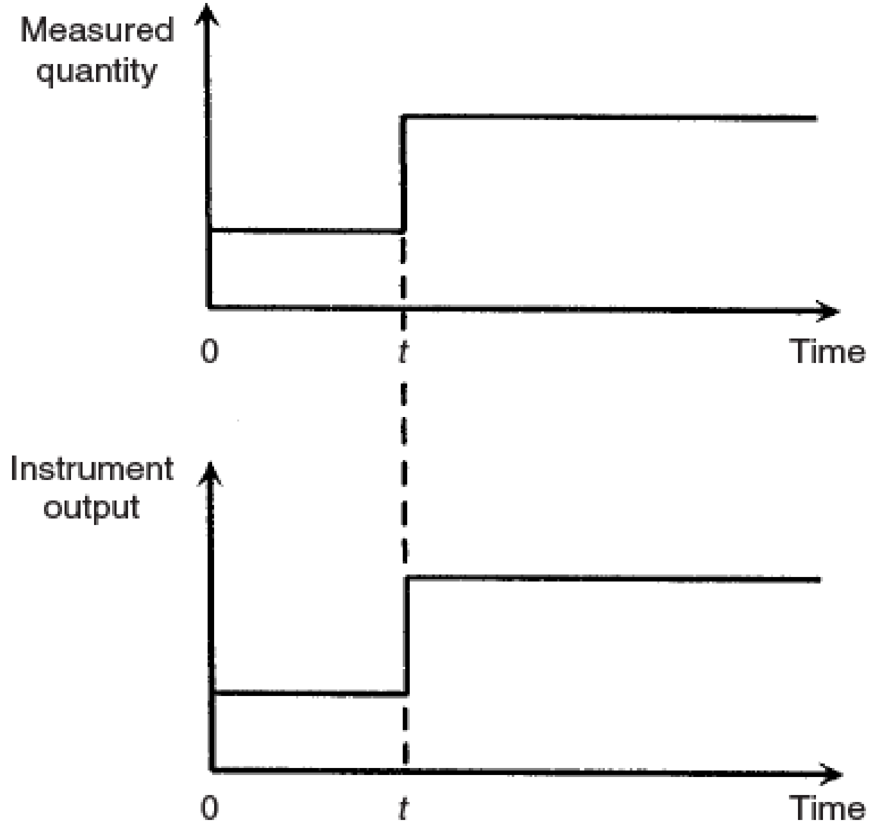


Fig. 2.10 Zero order instrument characteristic.

Defining $K = b_0/a_0$ as the static sensitivity and $\tau = a_1/a_0$ as the time constant of the system, equation (2.5) becomes:

$$q_0 = \frac{K q_i}{1 + \tau D} \tag{2.6}$$

If equation (2.6) is solved analytically, the output quantity q_0 in response to a step change in q_i at time t varies with time in the manner shown in Figure 2.11. The time constant τ of the step response is the time taken for the output quantity q_0 to reach 63% of its final value.

Example 2.3

A balloon is equipped with temperature and altitude measuring instruments and has radio equipment that can transmit the output readings of these instruments back to ground. The balloon is initially anchored to the ground with the instrument output readings in steady state. The altitude-measuring instrument is approximately zero order and the temperature transducer first order with a time constant of 15 seconds. The temperature on the ground, T_0, is 10°C and the temperature T_x at an altitude of x metres is given by the relation: $T_x = T_0 - 0.01x$

(a) If the balloon is released at time zero, and thereafter rises upwards at a velocity of 5 metres/second, draw a table showing the temperature and altitude measurements reported at intervals of 10 seconds over the first 50 seconds of travel. Show also in the table the error in each temperature reading.

(b) What temperature does the balloon report at an altitude of 5000 metres?