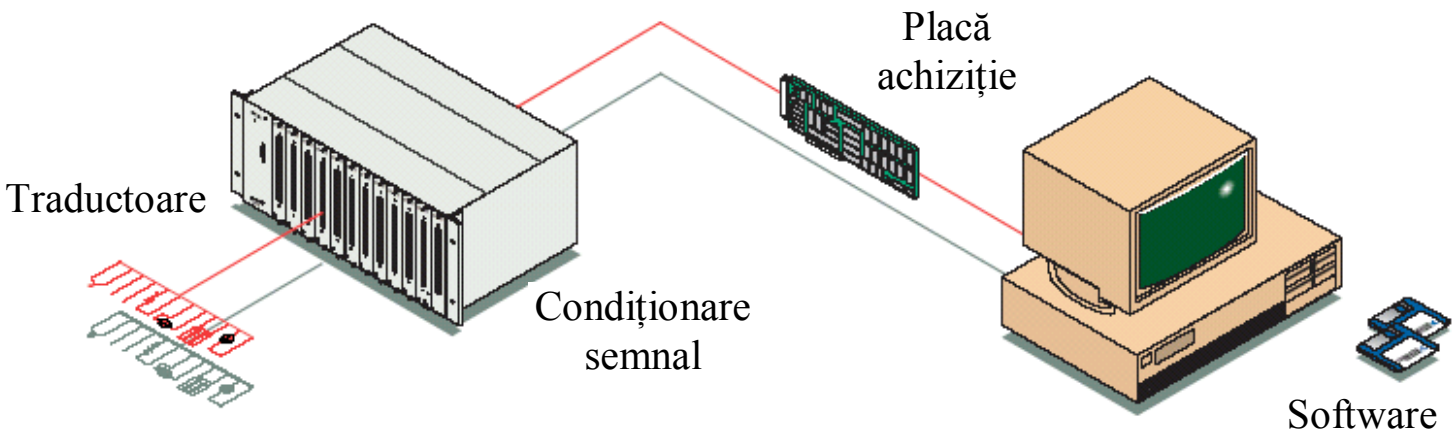
Departamentul de MECATRONICĂ
Facultatea de MECANICĂ
UNIVERSITATEA POLITHENICA TIMIŞOARA

Senzori si sisteme senzoriale

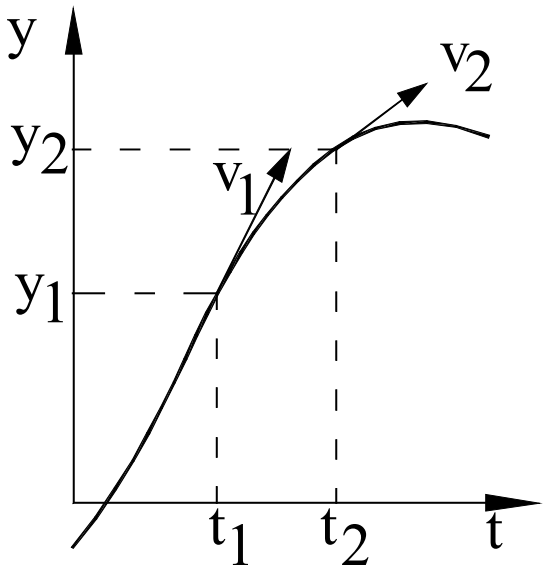


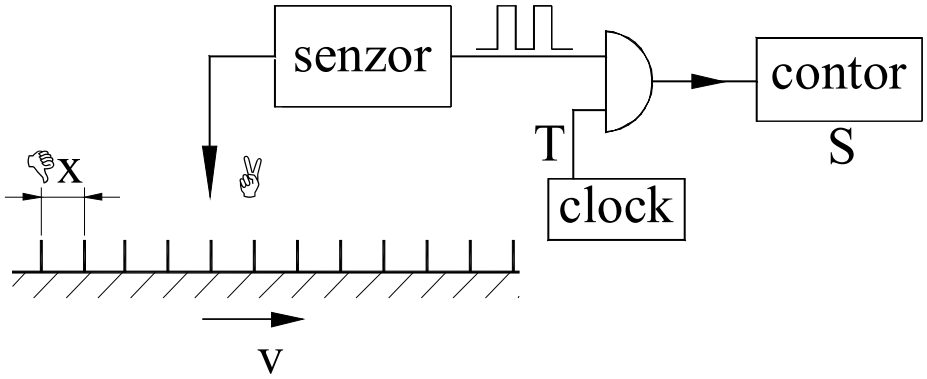
Prof. dr. ing. Valer DOLGA,

Cuprins_7

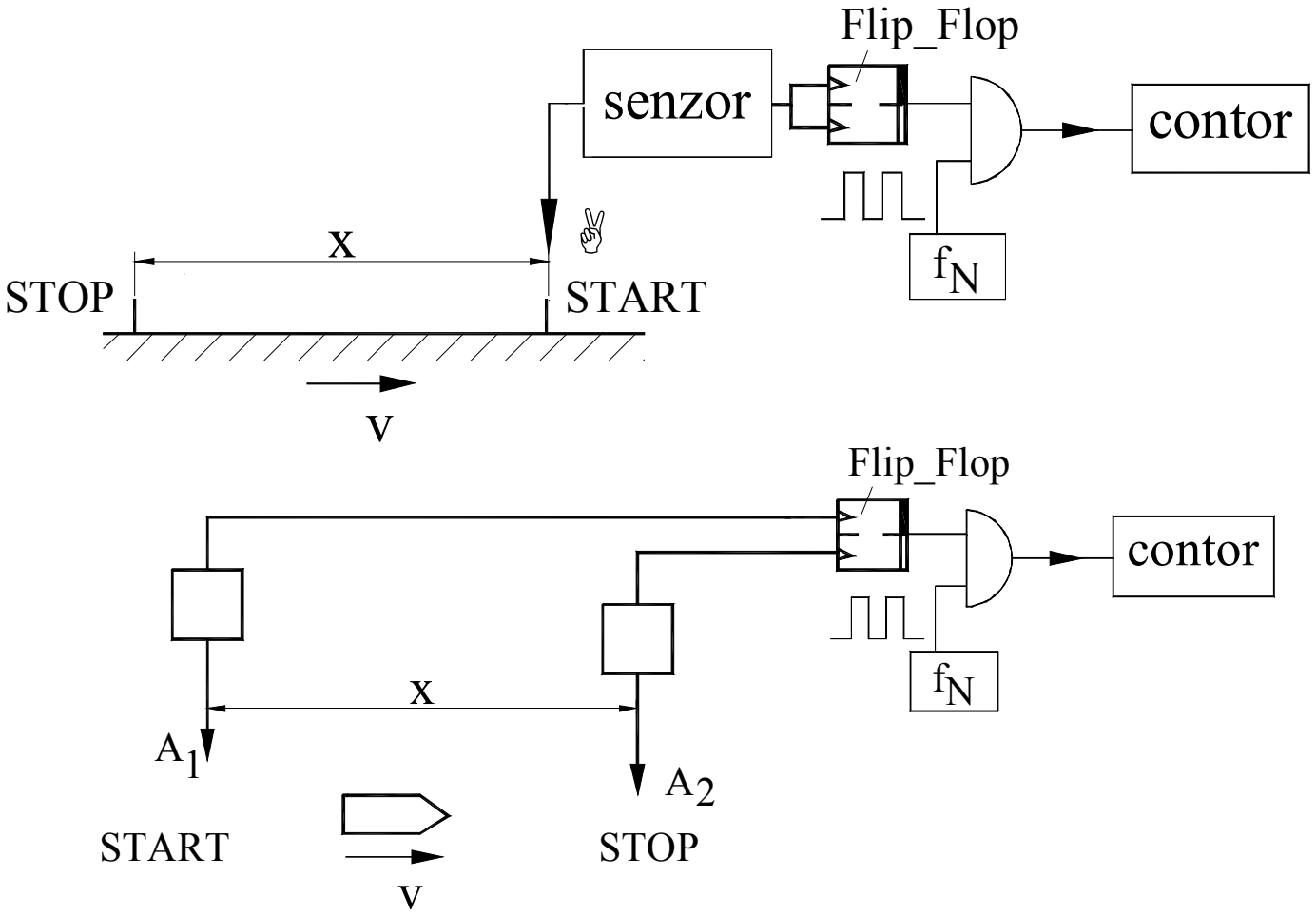
- Masurarea vitezei. Principii, traductoare de viteza
- Masurarea acceleratiei. Principii, traductoare de acceleratie, exemple de calcul

Viteza si mod de estimare





Viteza liniara si metode de masurare



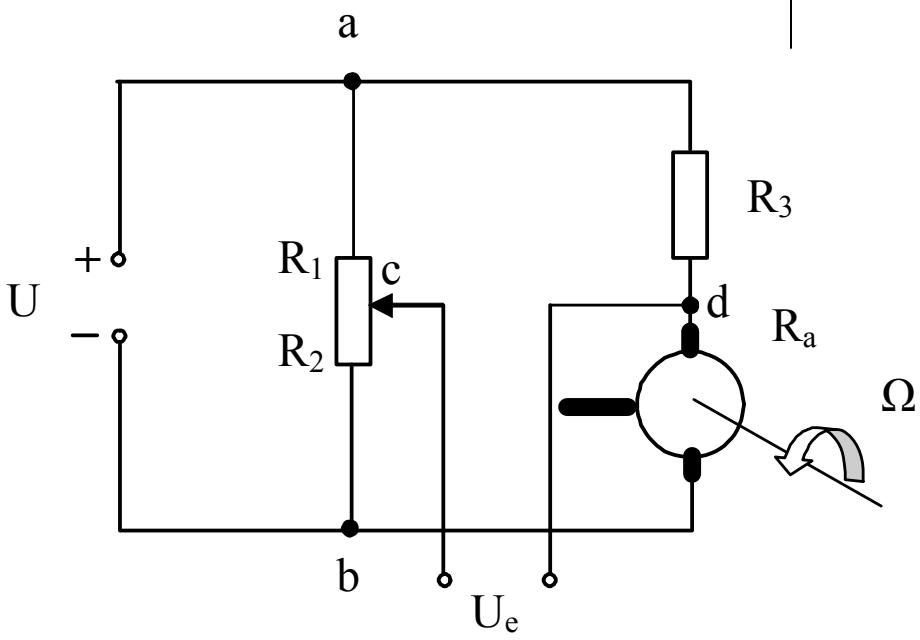
Punte pentru masurarea vitezei unghiulare

$$U_e = U_{ac} - U_{ad}$$

$$U_{ad} = I_a \cdot R_3$$

$$U_{ac} = \frac{R_1}{R_1 + R_2} \cdot U$$

$$I_a = \frac{U - E}{R_a + R_3} = \frac{U - K \cdot \Omega}{R_a + R_3}$$



$$U_e = \left(\frac{R_1}{R_1 + R_2} - \frac{R_3}{R_a + R_3} \right) \cdot U + \frac{K \cdot R_3}{R_a + R_3} \cdot \Omega$$

$$R_1 R_a = R_2 \cdot R_3$$

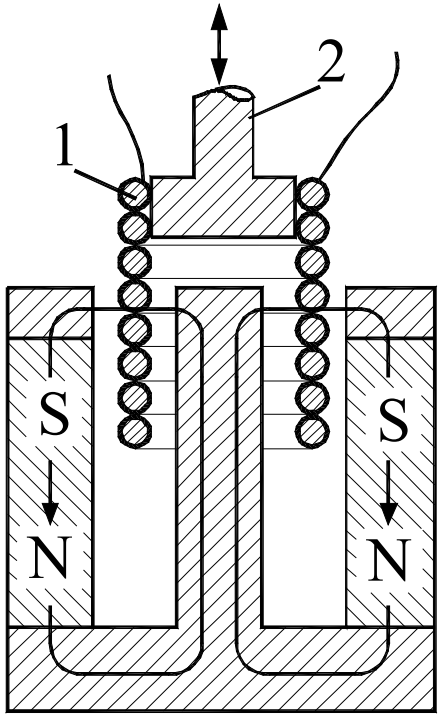
$$U_e = \frac{K \cdot R_3}{R_a + R_3} \cdot \Omega = C \cdot \Omega$$

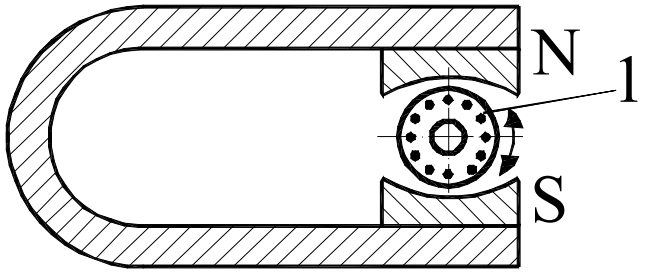
Ecuatia caracteristicii statice

Eroarea de măsurare - în intervalul - (2 - 5) %

Masurarea electrodinamica a vitezei

$$E = BLv$$

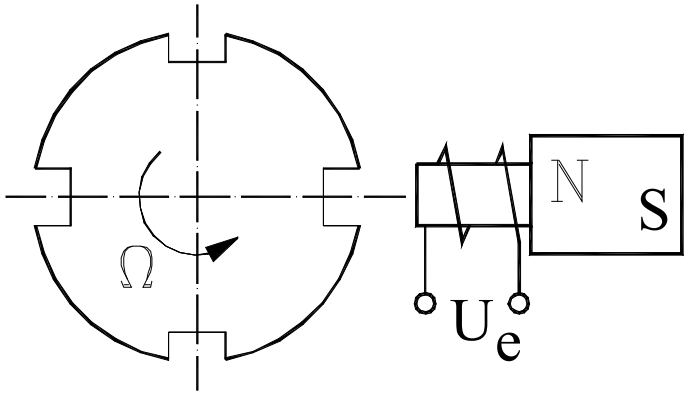


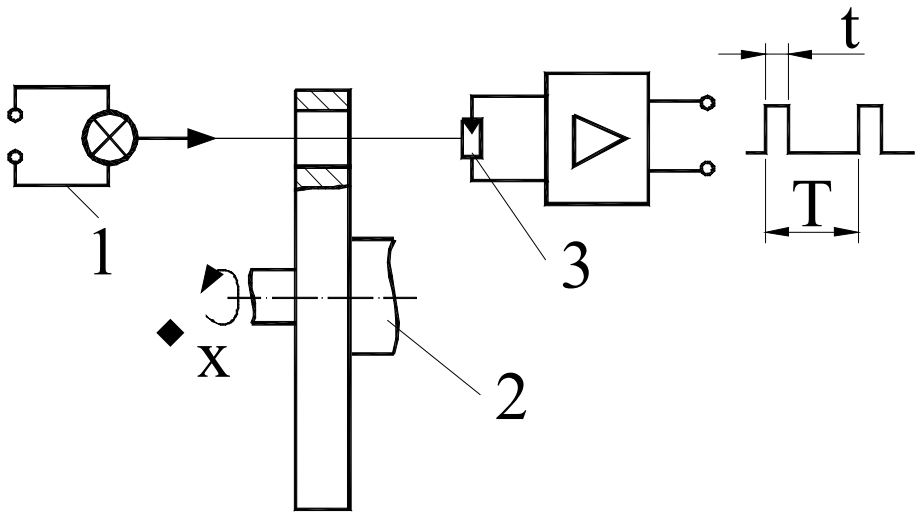


1- bobina

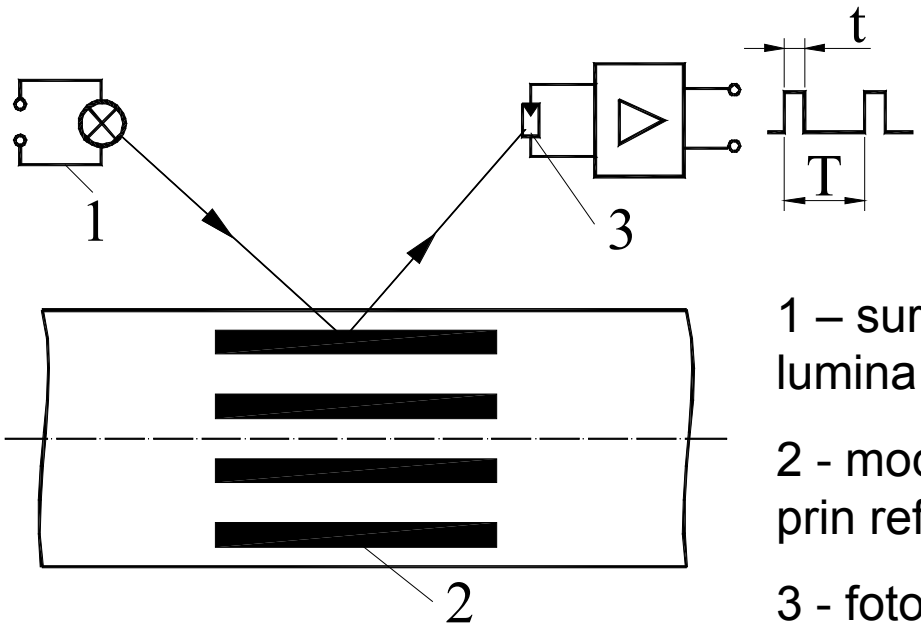
2 – element mobil

Masurarea vitezei pe baza de impulsuri





Masurarea optoelectronica a vitezei unghiulare



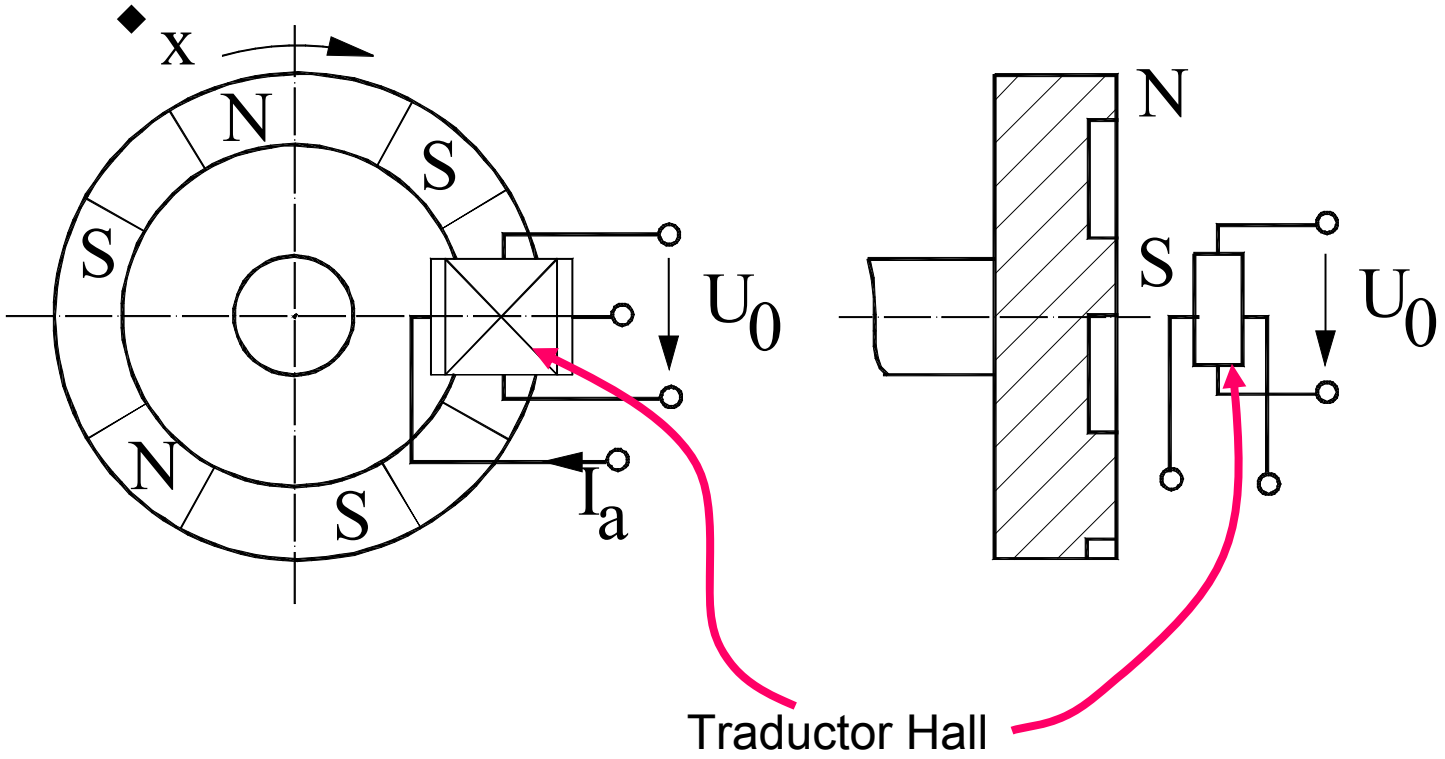
1 – sursa de lumina

2 - modulator prin reflexie

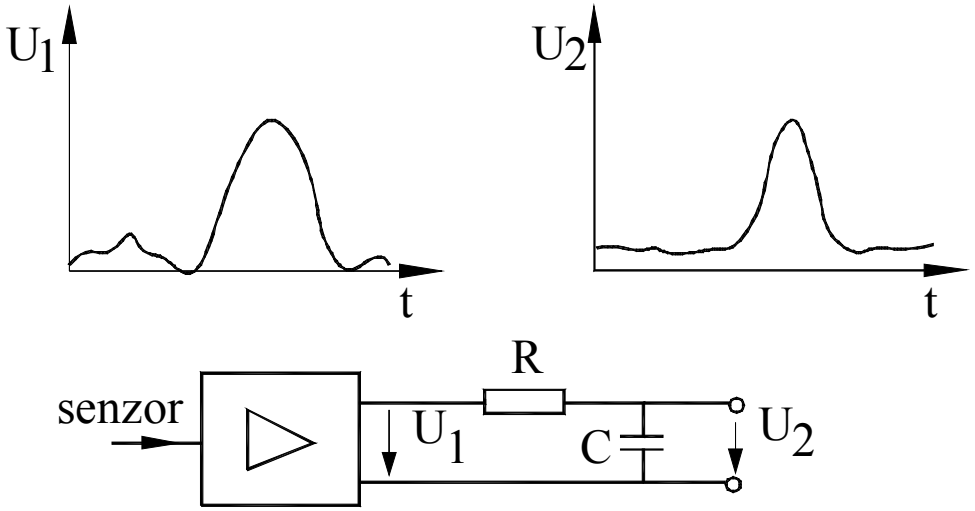
3 - fotoelement receptor

Domeniul de utilizare al traductoarelor cu elemente fotoelectrice este foarte larg: de la 1 [rot/min] la 10^7 [rot / min]

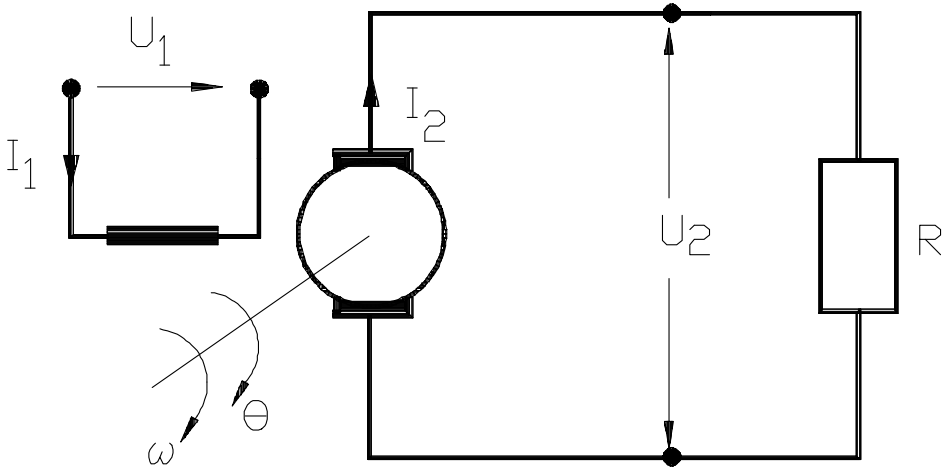
Masurarea vitezei unghiulare pe baza efectului Hall



Prelucrarea semnalului primar



Tahogeneratorul de c.c.



$$e = i_2 \cdot (R_i + R) + L_i \cdot \frac{di_2}{dt}$$

$$e = k_e \cdot \omega = k_e \cdot \frac{d\theta}{dt}$$

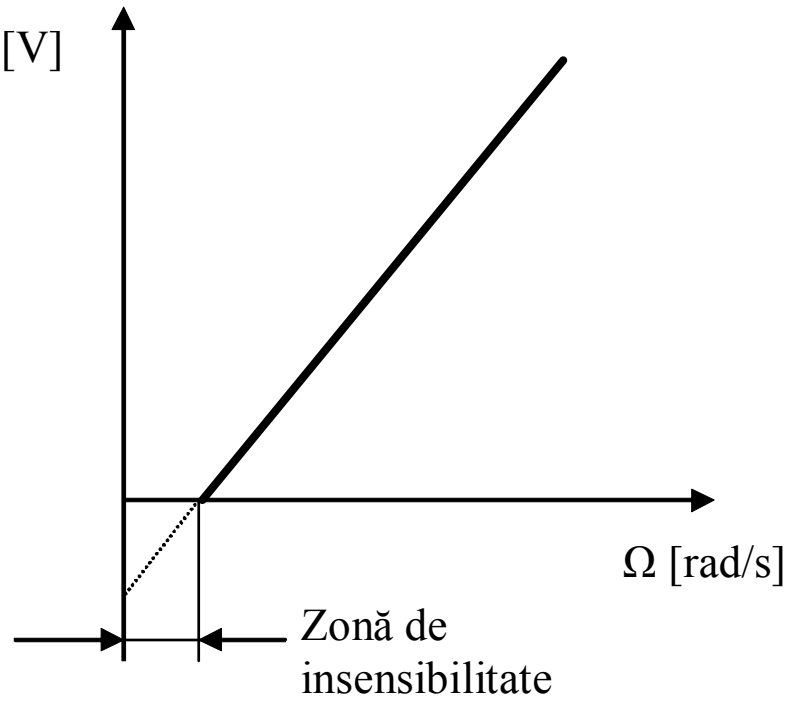
$$u_2 = i_2 \cdot R$$

Tahogeneratorul de c.c.

$$\frac{L_i}{R_i + R} \cdot \frac{du_2}{dt} + u_2 = \frac{R \cdot k_e}{R_i + R} \cdot \omega$$

$$U_2 = \frac{S}{\tau s + 1} \cdot \omega$$

$$U_e = K_e \cdot \omega$$



Tahogenerator de c.a.

•Asincron:

❖Rotor - realizat în formă de pahar din material nemagnetic(aluminiu).

❖ Stator - două înfăşurări, în cuadratură, plasate în interiorul şi exteriorul rotorului pahar.

➢ înfăsurarea de excitaţie - alimentată de la sursă de c.a.

➢ a doua înfăsurare - o tensiune proporţională cu viteza unghiulară a rotorului.

•Sincron:

❖ rotor pe bază de magneţi permanenţi

❖ stator cu circuit feromagnetic în care sunt practicate înfăşurări.

❖ caracteristica instabila ω – U la modificarea vitezei

❖ utilizat cu precădere ca element indicator - mai puţin în sistemele automate.

Acceleratie

$$x(t) = X_0 \sin(\omega t) \qquad \omega = 2\pi f$$

$$v(t) = \frac{dx}{dt} = \omega X_0 \cos(\omega t) = V_0 \sin\left(\omega t + \frac{\pi}{2}\right)$$

$$V_0 = \omega X_0$$

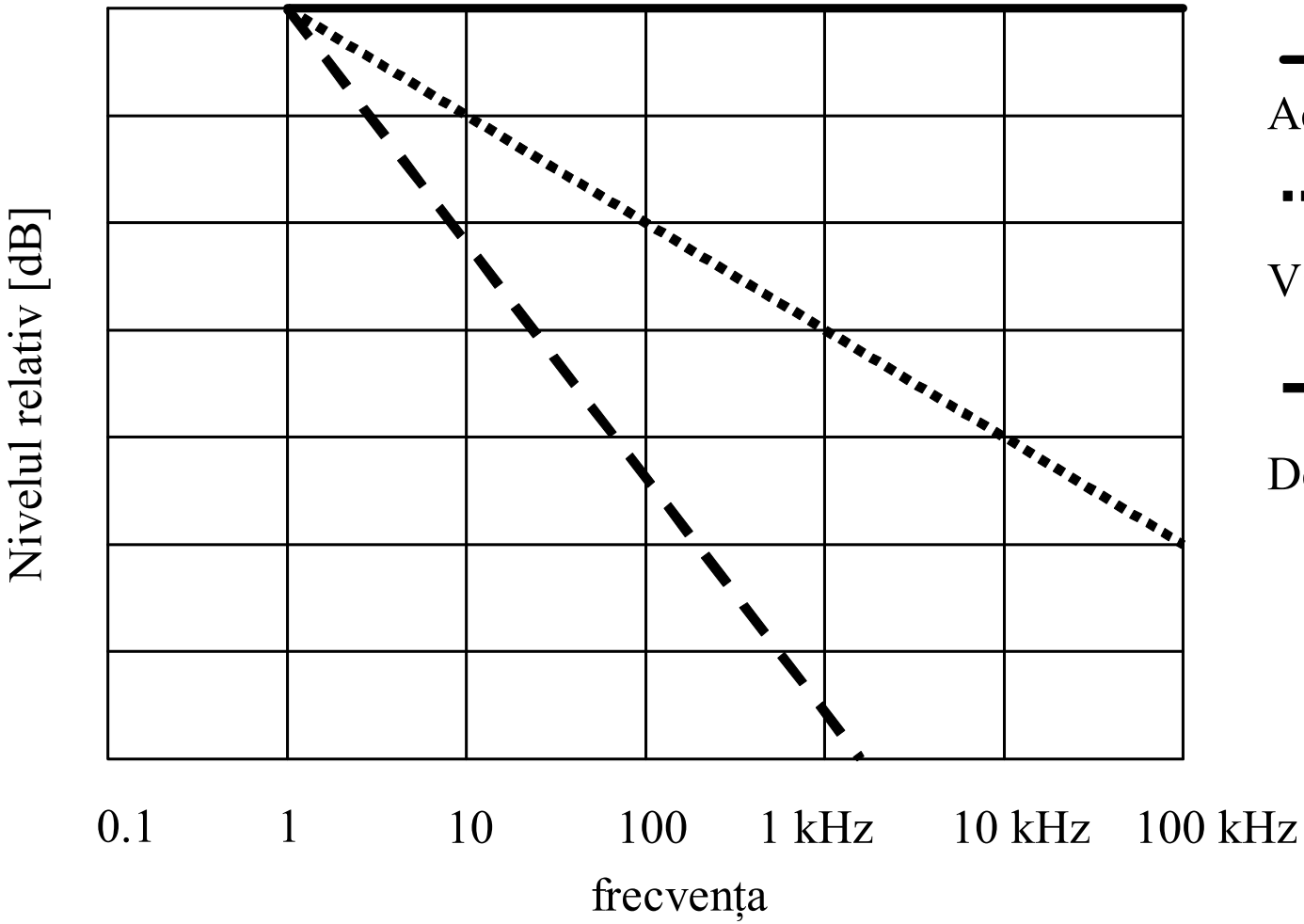
$$a(t) = \frac{dv}{dt} = \frac{d^2x}{dt^2} = -\omega^2 X_0 \sin(\omega t) = A_0 \sin(\omega t + \pi)$$

$$A_0 = \omega^2 X_0 = \omega V_0$$

Accelerația – parametru cinematic [m/s^2]

- Senzori pasivi (de ex. capacitiv);
- Senzori activi (de ex. piezoelectric);

Parametrii cinematici si dinamici



Accelerația “a”

Viteza $\frac{a}{\omega}$

Deplasarea $\frac{a}{\omega^2}$

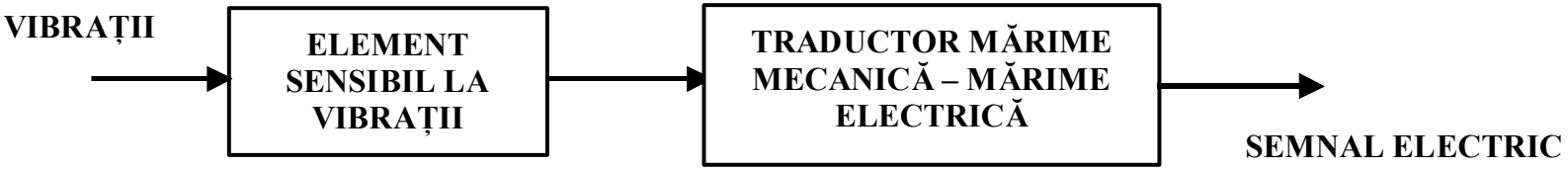
$$x(t) = X_0 + X_{10}\sin(\omega_1 t + \varphi_1) + ... + X_{n0}\sin(\omega_n t + \varphi_n)$$

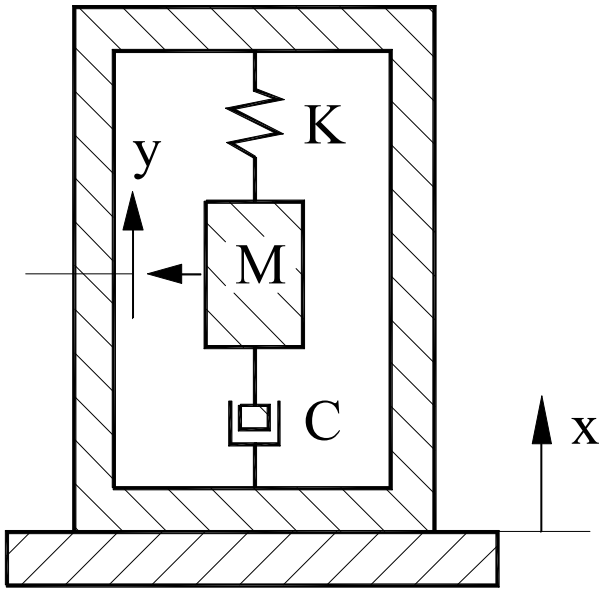
$\omega_1, \omega_2, ..., \omega_n$ pulsațiile spectrului oscilant [rad.s^{-1}];

$\varphi_1, \varphi_2, ..., \varphi_n$ fazele mişcărilor oscilante pentru spectrul de frecvențe

- Accelerometru mecanic (inerțial) ;
- Accelerometru electromecanic ;
- Accelerometru piezoelectric ;
- Accelerometru piezorezistiv ;
- Accelerometru tensorezistiv ;
- Accelerometru capacitiv, electrostatic ;
- Micro-accelerometru, nanoaccelerometru ;

Senzorul de acceleratie – principiul de realizare si functionare





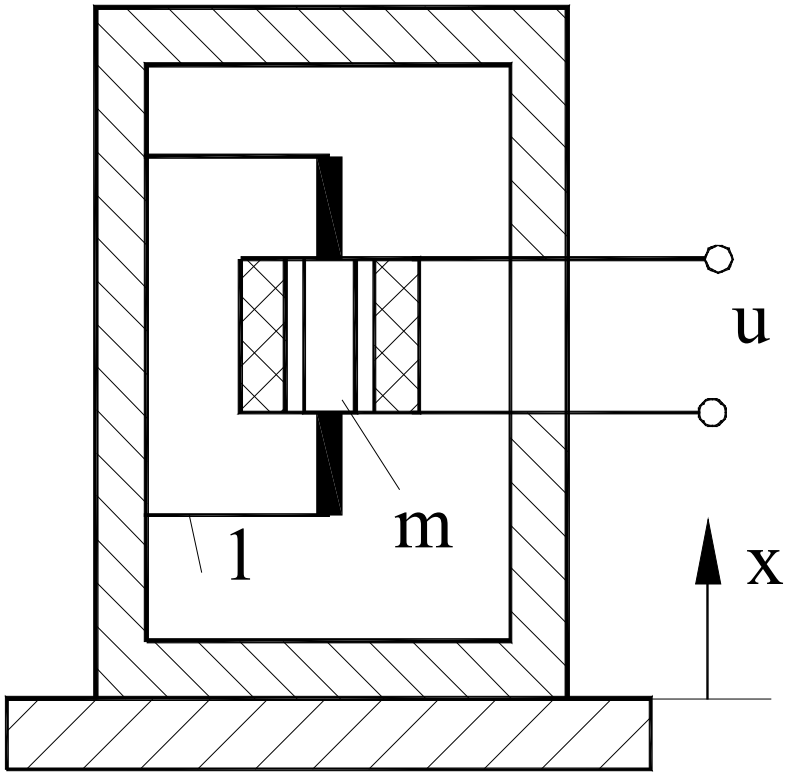
Pulsatia de rezonanta

$$\omega_0 = \sqrt{K/M}$$

$\omega >> \omega_0$ - sistemul lucrează în regim de vibrometru;

$\omega << \omega_0$ - regim de accelerometru,

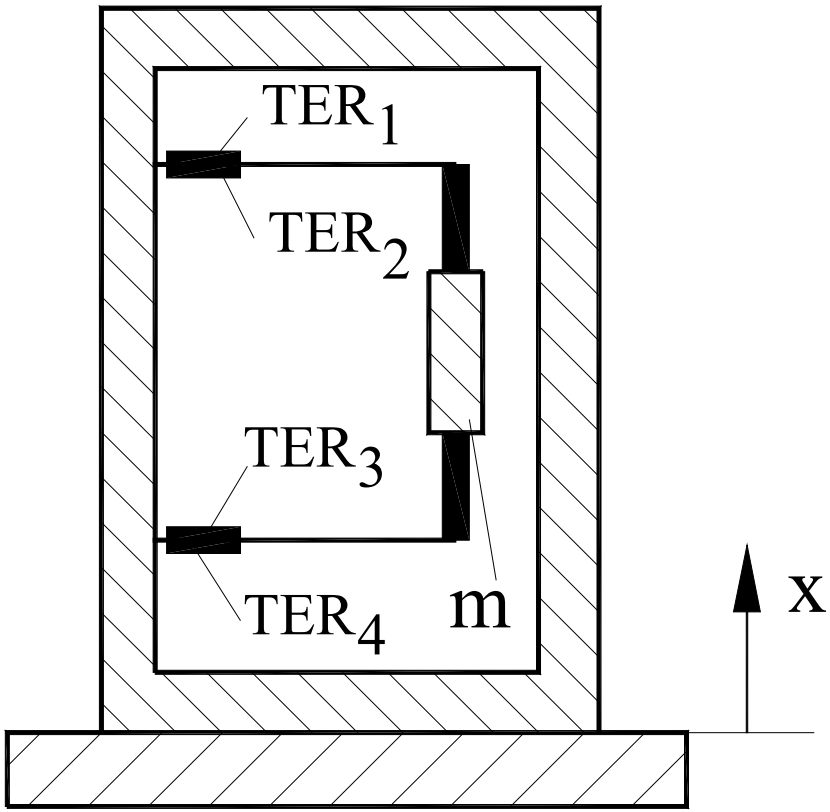
Senzor de acceleratie electrodinamic

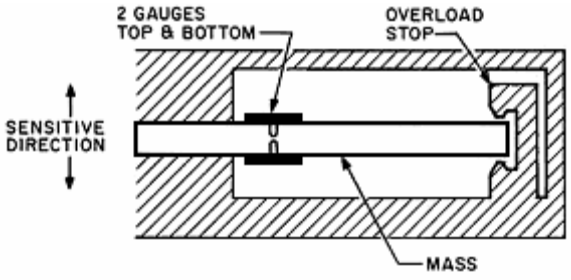


1 - Sistem elastic

m- masa inertiala

Senzor tensometric pentru acceleratie



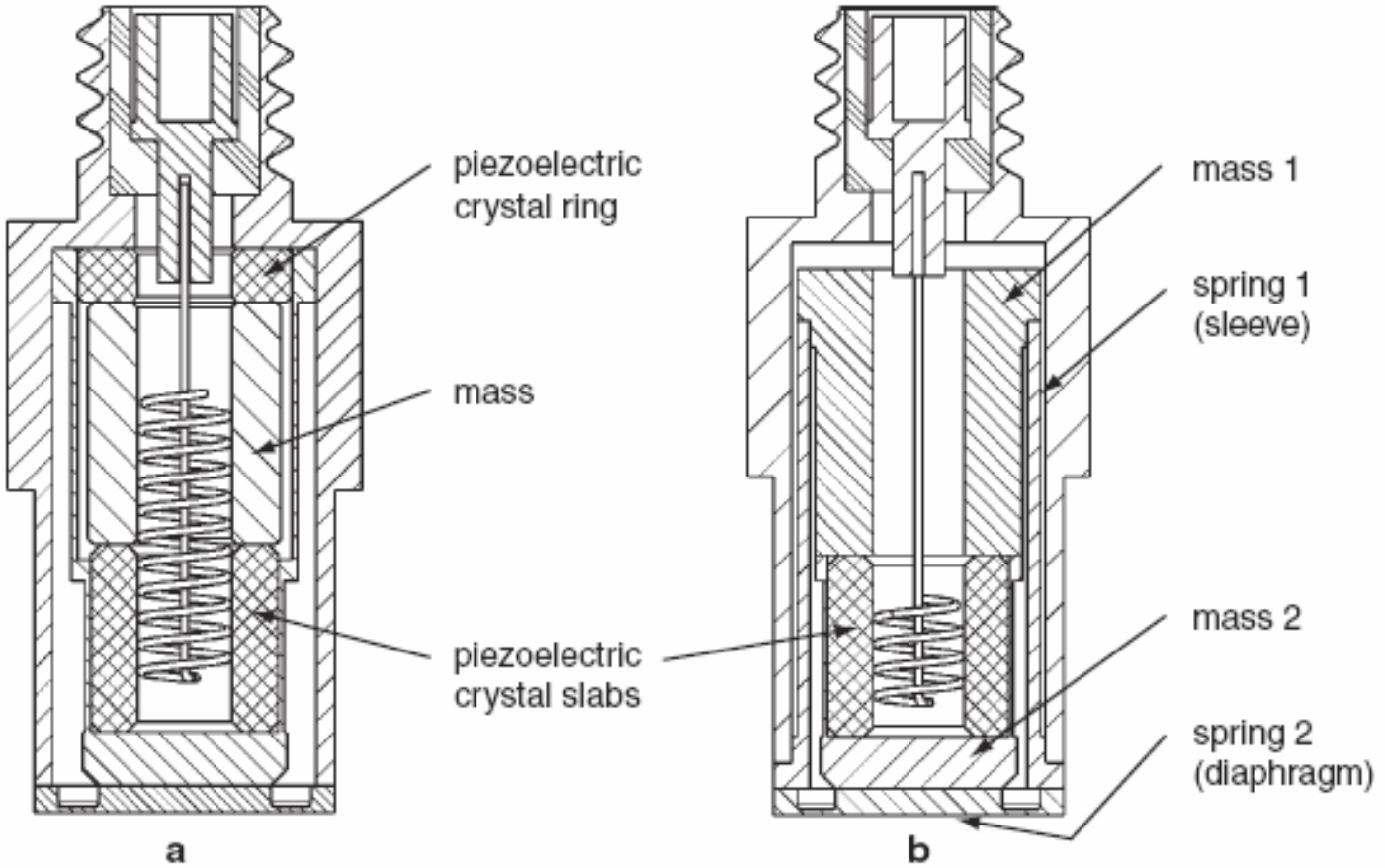


Exemplu de calcul

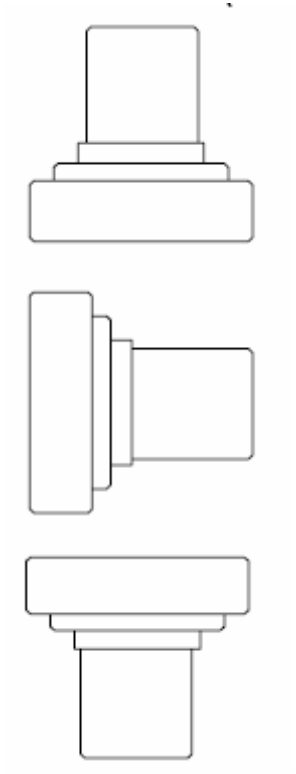
$$a_0 = 8\ m/s^2$$

$$a = \frac{8\ m/s^2}{9.8\ m/s^2/\mathbf{g}} = 0.81\ \mathbf{g}$$

Senzor piezoelectric



Montajul senzorului de acceleratie



+1g

0 g

- 1g

$$Linearity = V_{out,0g} - \frac{1}{2}\left(V_{out,+1g} + V_{out,-1g}\right)$$

$$Sensitivity = \frac{\Delta V_{out}}{\Delta g} = \frac{V_{out,+1g} - V_{out,-1g}}{2g}$$