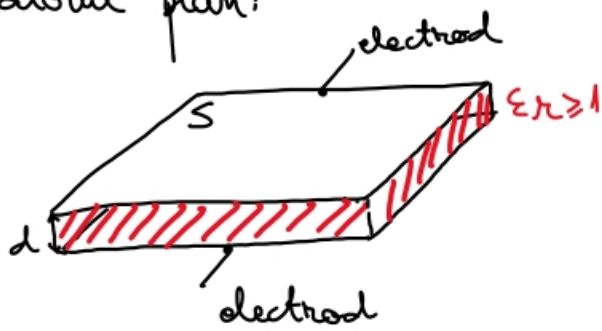
Curs 9 SIS:

Senzori capacitivi.

.) condensatorul plan:

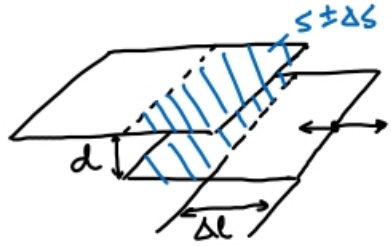


$$C = \frac{\varepsilon \cdot S}{d} = \frac{\varepsilon_0 \varepsilon_r S}{d}$$

$$\varepsilon_0 = 8.85 \times 10^{-12}\ F/m$$

Exemple:

1.) Variația suprafeței S determinată de deplasarea unei armături (senzor de deplasare)

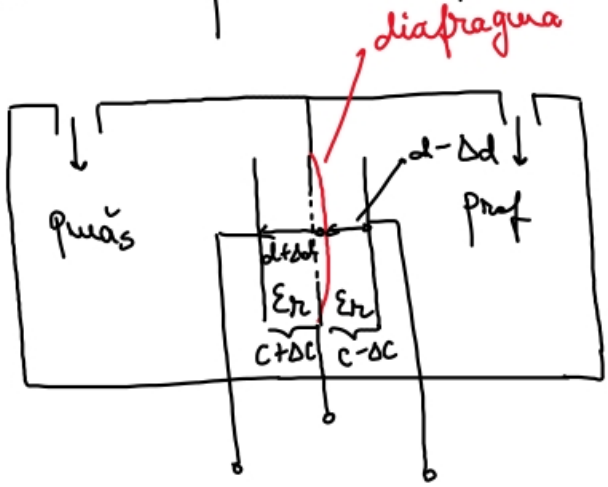


$$\Delta C = \frac{\varepsilon_0 \varepsilon_r \Delta S}{d}$$

2.) Variația distanței dintre armături

$$\Delta C = \frac{\varepsilon_0 \varepsilon_r S}{\Delta d}$$ (deplasări mici)

3.) senzor de presiune capacitiv:



4.) Variația lui ε_r

ε_r depinde → temperatură, presiune, umiditate

↳ material adecvat

Ex. pt. aer: $\varepsilon_r = 1.0006$ $p = 1$ atm, $19^\circ C$

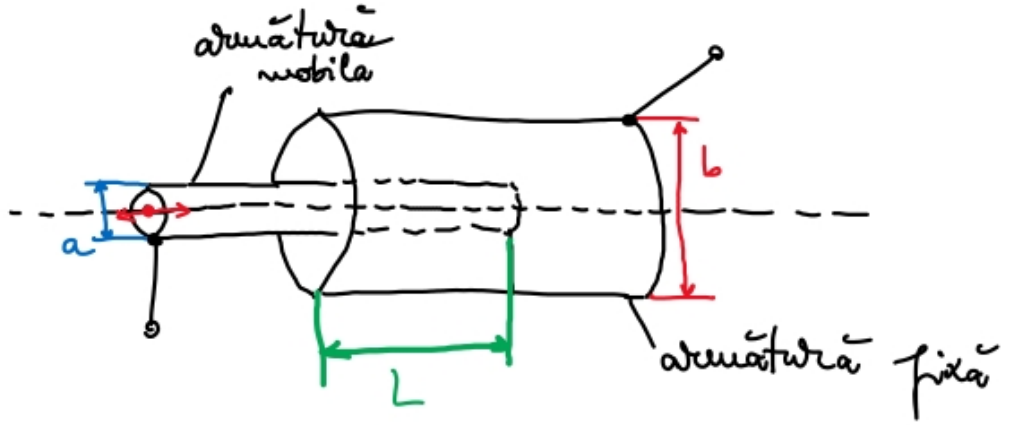
$\varepsilon_r = 1.0548$ $p = 100$ atm, $19^\circ C$

Măsurarea capacității → punți AC

→ circuite rezonante

$V_{rez} = f(C)$

Condensatorul cilindric cu arie variabilă:



$$C = \frac{2\pi \varepsilon_0 \varepsilon_r}{\ln \frac{b}{a}} \cdot L$$ → variația lui L duce la variația lui C

$$\Delta C = \frac{2\pi \varepsilon_0 \varepsilon_r}{\ln \frac{b}{a}} \Delta L$$

Senzori piezoelectrici:

Piezoelectricitatea: acumularea de sarcină în solide ca urmare a deformării acestora.

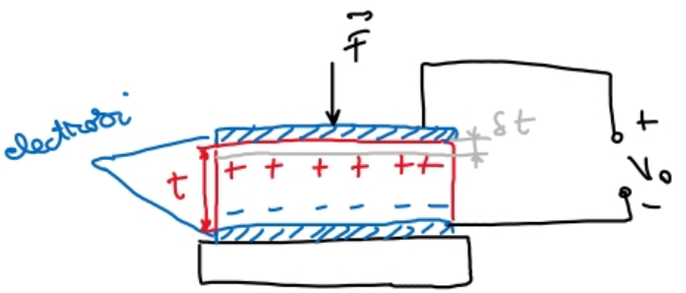
IN → OUT

Deformare $\frac{\Delta l}{l}$ → Q sau V

IDEAL: material piezoelectric < izolator, ε_r mare

exemple: PZT, BTO, cuarț, sare Rochelle

$T > T_c$ → piezoelectricitatea dispare



capacitatea senzorului $C = \frac{\varepsilon_0 \varepsilon_r S}{t}$

Modulul lui Young: $Y = \frac{\frac{F}{S}}{\frac{\delta t}{t}} = [Pa]$

Sarcina generată de forța F:

$$Q = d \cdot F$$

d - sensibilitatea în sarcină (catalogată „charge sensitivity")

$$[d] = \frac{C}{N}$$

În regim de mers în gol:

$$V_0 = \frac{Q}{C} = \frac{dF}{\frac{\varepsilon_0 \varepsilon_r S}{t}} = \frac{d F t}{\varepsilon_0 \varepsilon_r S} = \frac{d t}{\varepsilon_0 \varepsilon_r} \cdot \frac{F}{S} = g \cdot \frac{F}{S} \cdot t$$

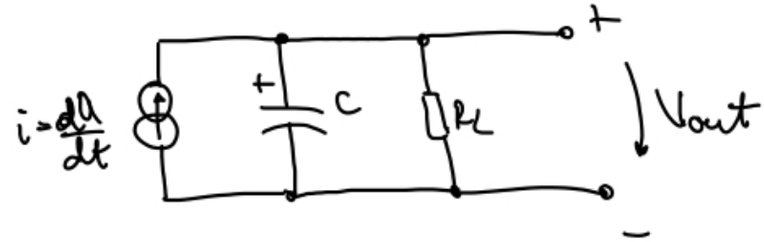
g - sensibilitatea în tensiune
(„voltage sensitivity")

$$[g] = \frac{V}{N} \cdot m$$

Forță aplicată => variație de sarcină $\frac{dQ}{dt}$ => curent echivalent

$$i_{eq} = \frac{dQ}{dt} = d \cdot \left(\frac{dF}{dt}\right)$$

Schema echivalentă a unui senzor piezoelectric



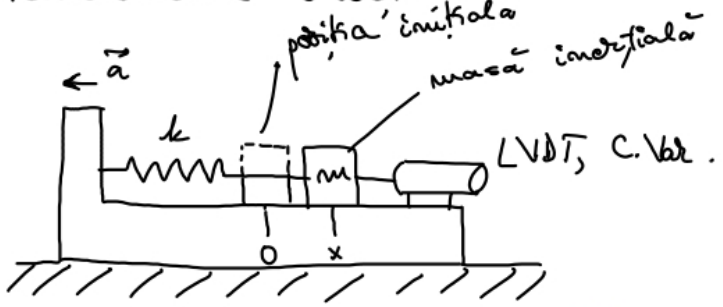
Traductor piezo:

senzor piezo + amplificator de sarcină

„charge (mode) amplifier"

Accelerometre:

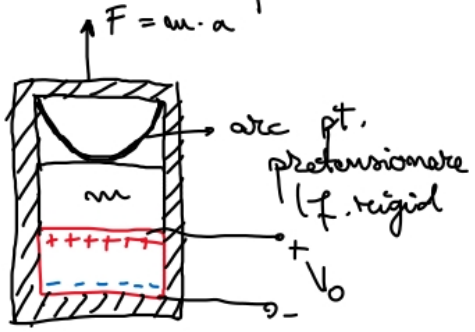
·) Accelerometru inertial:



$$F = m \cdot a = kx \Rightarrow a = \frac{kx}{m}$$

știm m, k
x - se măsoară

·) Accelerometru piezoelectric



$Q = d \cdot F = d \cdot m \cdot a$

d, m se cunosc $\Rightarrow$ putem măsura a

Generatoare tahometrice:

·) Generatorul tahometric DC

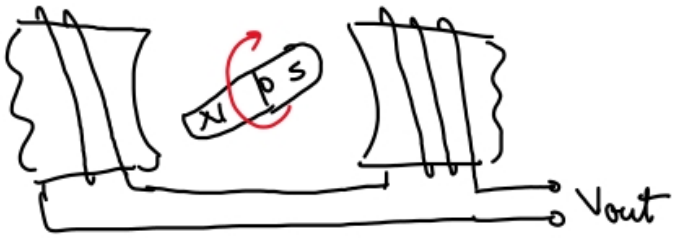
curentul indus în rotor este proporțional cu v_{rot}.

$v_{rot} = 0 - 6000$ rpm

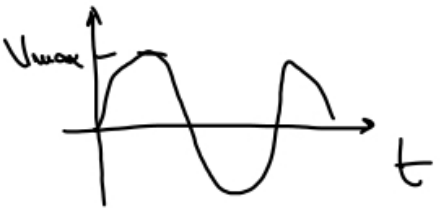
$V_{out} = k \cdot v_{rot}$.

-semnul lui V_{out} indică sensul de rotație

•) Generatorul tahometric AC:



$V_{out}^{max} = k \cdot n_{rot}$



•) Tahometru AC:

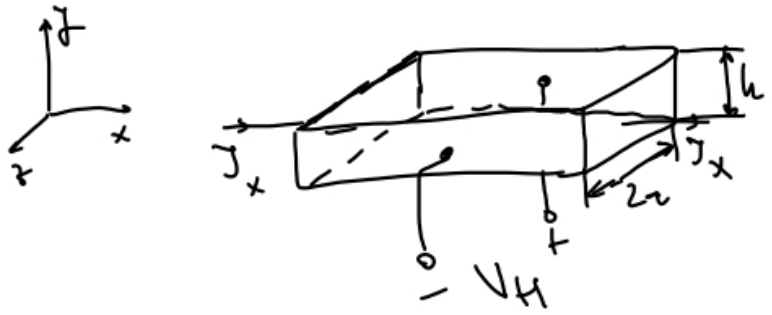
$V_{out} = k \cdot n_{rot}$

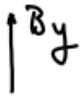
$\Delta\varphi = 0 \rightarrow$ sens +

$\Delta\varphi = 180° \rightarrow$ sens −

$n_{rot} \simeq 0 - 4000$ rpm

Senzori cu efect Hall:

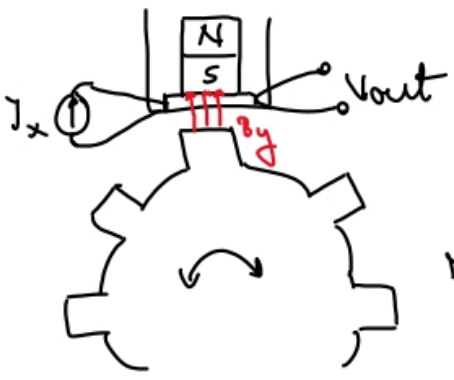


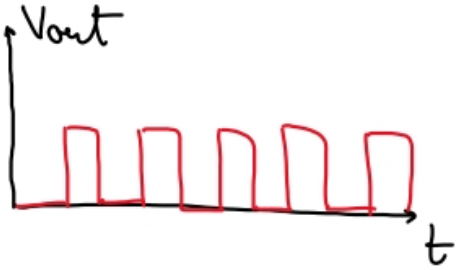


$$V_H = \frac{R_H \cdot I_x \cdot B_y}{h}$$

R_H – constanta Hall (coef.)

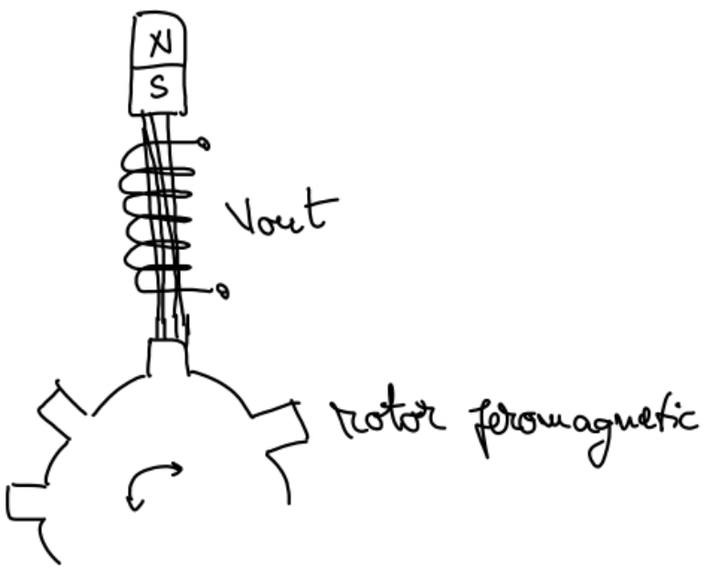
•) Senzor de rotație cu efect Hall

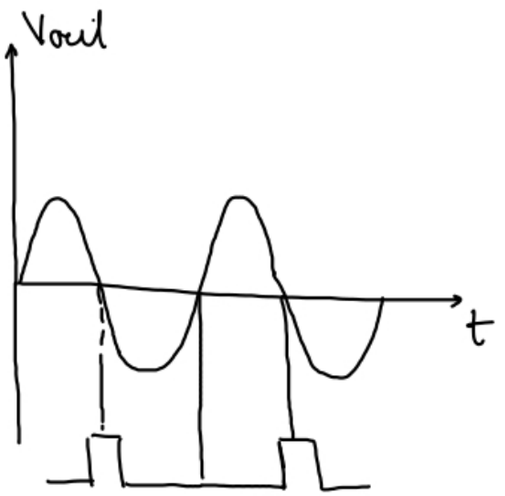




.) Senzor cu reluctanță variabilă

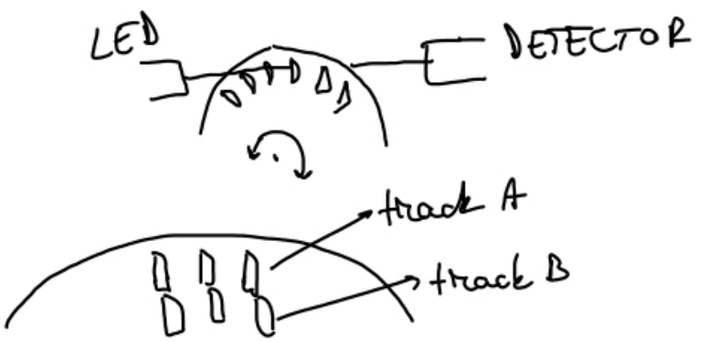
$R = \frac{\mathcal{F}}{\Phi}$ — forță magnetică $\left[\frac{1}{H}\right]$



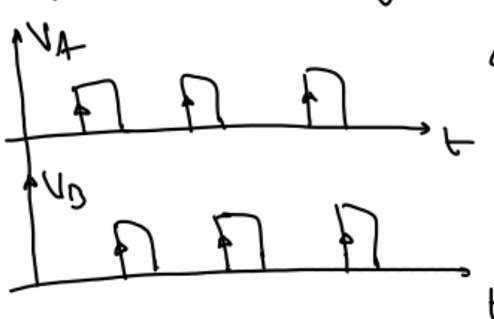


Senzori optici:

.) Encoder optic cu rotație:



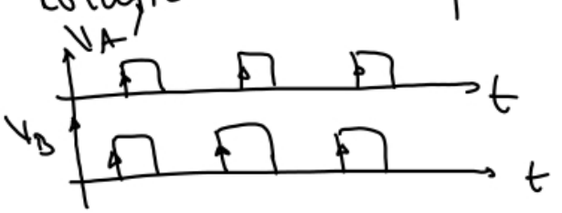
Rotație către stânga



$\Delta\varphi > 0$

$\Delta\varphi = \varphi_B - \varphi_A$

Rotație către dreapta



$\Delta\varphi < 0$