Final Notes Mechatronics Back

Monday, November 23, 2015 10:24 PM

Strain Gages

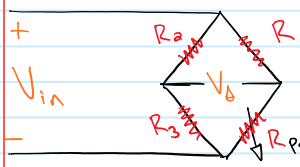
- Gage Factor F (Measured)

$$F = \frac{dR/R}{\varepsilon_{axial}} = 1 + 2\nu + \frac{d\rho/\rho}{\varepsilon_{axial}}$$

F is usually close to 2

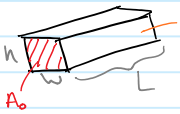
$$R = \frac{\rho \cdot L}{A_o}$$

& Gage R $\approx 120\Omega$



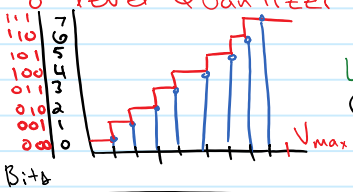
$$R_{SG} = \frac{R_2 \cdot R_{pot}}{R_3}$$

Balanced Brigde $(I_2R_2 = I_{sg}R_{sg})$



ρ (resistivity) $R_{SG} \approx 120\Omega + \Delta R$

8-level Quantizer



Bits

$$N = 2^n$$

Quantization Levels

Size

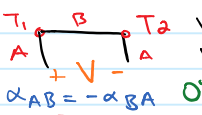
$$Q = \frac{\text{Range}}{N} = \frac{V_{max}}{8}$$ (Ex)

Temp Sensors

- Thermister (Semi-Conductor)

$$R = R_o e^{\beta\left(\frac{1}{T} - \frac{1}{T_o}\right)}$$

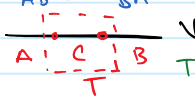
- Thermo couple



$$V = \alpha_{AB}T_1 + \alpha_{BA}T_2$$

$$V = \alpha_{AB}(T_1 - T_2)$$

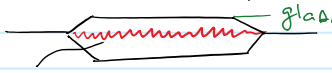
$\alpha_{AB} = -\alpha_{BA}$ 0°C Ref (ice Bath)



$$V = \alpha_{AC}T + \alpha_{CB}T = \alpha_{AB}T$$

$$T = \sum_{i=0} C_i V^i$$

- Resistive Temp Device



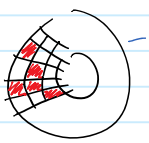
$$R = R_o(1 + \alpha(T - T_o))$$

Displacement Sensors

- Optical

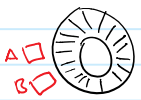
Absolute, x_1, x_2

Relative; $x_r = x_2 - x_1$



− Absolute

Incremental

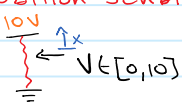


$\frac{1}{2}\Delta$ when High to Low

$\frac{1}{2}\Delta$ when high to Low or Low to high

Δ when H-L or L-H

Position Sensing

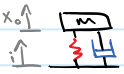


Potentiometer Angle + Dist.

Accelerometer $\omega \ll \omega_n$

Geophone $\omega \gg \omega_n$

Accelerometer



$$\omega_n = \sqrt{\frac{k}{m}}$$

$$\zeta = \frac{b}{2\sqrt{km}}$$

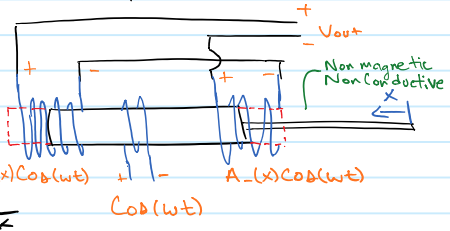
$x_r = x_o - x_i$

LVDT

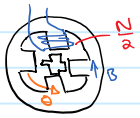
$$V_o = (A_+(x) - A_-(x))\cos(\omega t)$$

Ø when centered

$A_+(x) - A_-(x) \simeq kx$ linear



Variable Reluctance Motor (VR)



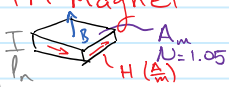
$$L_A(\theta) = \frac{N^2}{R_A(\theta)} \rightarrow \tau_A = -\frac{1}{2}I_A^2 \frac{d[L_A(\theta)]}{d\theta}$$

$$\frac{d}{d\theta}\left|L_A(\theta)\right| = -\frac{N^2}{R_A(\theta)^2} \cdot \frac{dR_A}{d\theta}$$

Battery

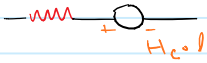
$V = V_o - RI$

PM Magnet

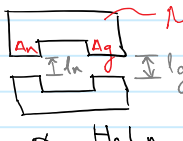


$\mu = 1.05\mu_o$

R = Reluctance $= \frac{l_m}{\mu A}$

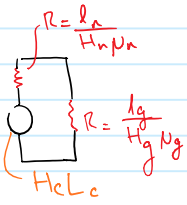


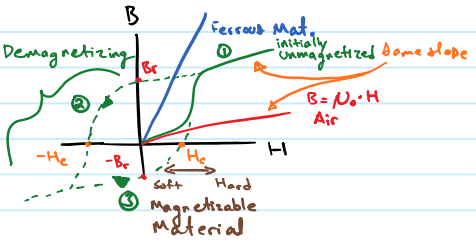
$H_c \cdot l_m$



$\mu = \infty$

$$\Phi = \frac{H_c L_m}{\frac{l_m}{1.05\mu_o A_m} + \frac{l_g}{1.05\mu_o A_g}}$$





$B \approx 1000\mu H$

B_r: Remnant Field

H_c: Coersivity

DC Motors

$$\bar{F} = I\bar{l} \times \bar{B}$$

$$\tau = 2rLB \cdot I = KI = J\omega_m$$

$K = 2rLB$ Torque Const.

$$V = \frac{d\Phi}{dt} + RI + L\frac{dI}{dt}$$

$K_T \left(\frac{N \cdot m}{A}\right)$ Torque Const.

$K_b \left(\frac{V}{rad/s}\right)$ Back EMF Const.

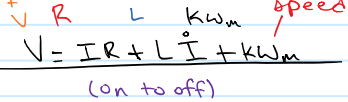
Mech time Const (Rotational Inertia J)

$$\tau_m = \frac{RJ}{k^2}$$

Max Speed $V_{rated} = k\omega_m$

$\tau_e = L/R$ E-time Const.

$$J\dot{\omega}_m = kI + \tau$$



$$V = IR + L\dot{I} + k\omega_m$$

(on to off)