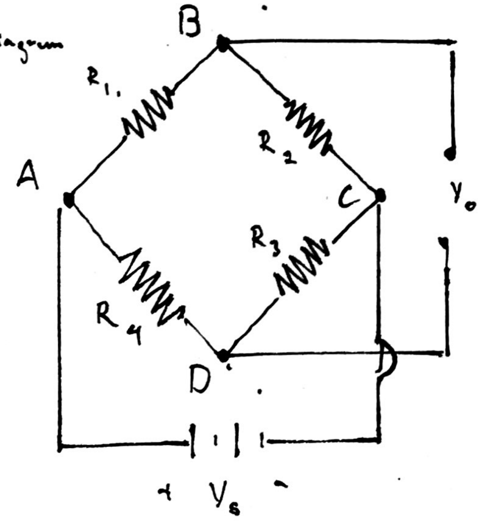
Experimental Mechanics : 20 Sept 2018

Notes on

{ Guest Speaker 18 Oct }

- Midterm Presentation and Report
  - Use Dr. KZ's research as more familiar
  - 5 pages use Terrall format
- Electrical Resistance Strain Gage Analysis
  - $\frac{\Delta R}{R} = S_g \varepsilon_a$ ← Unknown strain, to be found

    S_g ← Gage property (see 17 Sept)
  - Convert $\Delta R/R$ into ΔV, read by instrument called Wheatstone Bridge
- Wheatstone Bridge Equations
  - Equations for circuit sensitivity & effective range
  - Can go down to low resistance $\in [3, 5]\ \mu\varepsilon$
  - Diagram



- $V_{AB} = \frac{R_1}{R_1 + R_2} V_s$
- $V_{AD} = \frac{R_4}{R_3 + R_4} V_s$

$V_o = V_{BD} = V_{AB} - V_{AD}$

- $V_o = \frac{R_1(R_3 + R_4) - R_4(R_1 + R_2)}{(R_1 + R_2)(R_3 + R_4)} V_s$
- for $V_o = 0$: $R_1 R_3 + \cancel{R_1 R_4} - \cancel{R_1 R_4} - R_2 R_4 = 0$

$$\underline{R_1 R_3 = R_2 R_4}$$

- Place Strain Gage on any resistor, we convert $\varepsilon \to \Delta V$

$$V_o(R_i) \to \Delta V_o = f(R_i + \Delta R_i) \to \Delta V_o = \frac{R_1 R_2}{(R_1 + R_2)^2}\left(\frac{\Delta R_1}{R_1} - \frac{\Delta R_2}{R_2} - \frac{\Delta R_3}{R_3} - \frac{\Delta R_4}{R_4}\right) V_s$$

Neglect H.O.T.

→ Generally only one "R" is replaced so is "active"

→ Linear function of ΔR because we neglect Higher order terms

- Bridge Sensitivity

→ "S_c" or sensitivity of bridge one by constant V_s & single active arm

→ $S_c = \dfrac{\Delta V_o}{\Delta R_1 / R_1} = \dfrac{r}{(1+r)^2} V_s$

+ ΔV_o for only ΔR_1

+ $r = \cancel{R_1 R_2}\ R_2 / R_1$

$$V_s = I_T (R_1 + R_2) = I_T R_T (1+r)$$

$$V_s = \underbrace{(1+r)}_{\text{circuit efficiency}} \underbrace{\sqrt{P_T R_T}}_{\text{physical characteristics}}$$

→ $S_c = \dfrac{r}{1+r} \sqrt{P_T R_T}$

circuit efficiency

generally less than 70%

P_T : power dissapated as heat

R_T : total resistance

$$P_T R_T : \in [1, 1000]\ W \cdot \Omega \text{ , commercially}$$

- Strain Analysis

→ What is known affects gage placement

→ Stress State

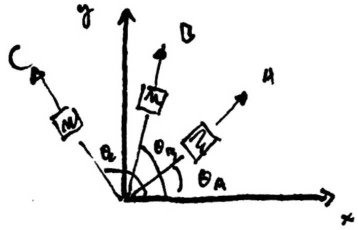
(i) Uniaxial Stress : 1 gage in stress axis

if E is known : $\sigma_{xx} = \sigma_1 = E \epsilon_{xx}$

(ii) Principal direction known but unknown magnitude : rectangular rosette in principal direction

(iii) Stress field unknown : 3 element rosettes needed

→ 3 Element Rosettes in general



· measuring $\varepsilon_A, \varepsilon_B, \varepsilon_C$

$\downarrow$

ε_{xx} + ε_{yy} ! by Mohr's Circle