การบ้านครั้งที่ 3 (HW5)

นายโสรวณ สุขสมบูรณ์
6201011631188 sec 3
Elec Measurement (PSU)

5.3 Determine the resolution limit of this p
If the potentiometer of Exercise 5.2 has a resistance of 2000 Ω and can dissipate 2 W of power, determine the voltage required to maximize the sensitivity. What voltage change corresponds to the resolution limit?
...librated dial (100 divisions per turn) is ...

Solu

formula : $P = vi = \frac{v^2}{R}$

let $R = 2\ k\Omega$, $P = 2W$, Find $V_{max} = ?$

from $P = \frac{v^2}{R}$

$2 = \frac{v^2}{2k}$

$v^2 = 4 \times 10^3\ V^2$

$v = \sqrt{4 \times 10^3}\ V$

$\therefore v = 20\sqrt{10}\ V \approx 63.246\ V$

5.17 A strain gage with an initial resistance R_0 and a gage factor S_g is subjected to a strain ε. Determine ΔR and $\Delta R/R$ for the conditions listed below:

	$R_0(\Omega)$	S_g	$\varepsilon(\mu m/m)$
(a)	120	2.02	1600
(b)	350	3.47	650
(c)	350	2.07	650
(d)	1000	2.06	200

Solu

formula : $\frac{\Delta R}{R} = S_g \varepsilon$ (eq. 5.5)

(a) $R_0 = 120$, $S_g = 2.02$ and $\varepsilon = 1600$

$\frac{\Delta R}{R} = 2.02 \times 1600 = 3232 \Rightarrow \Delta R = 3232 \times 120 = 387{,}840\ \Omega$

$\therefore \Delta R = 387.840\ k\Omega$, $\Delta R/R = 3232$

(b) $R_0 = 350$, $S_g = 3.47$ and $\varepsilon = 650$

$\frac{\Delta R}{R} = 3.47 \times 650 = 2255.5 \Rightarrow \Delta R = 2255.5 \times 350 = 789{,}425\ \Omega$

$\therefore \Delta R = 789.425\ k\Omega$, $\Delta R/R = 2255.5$

(c) $R_o = 350$, $S_g = 2.07$ and $\varepsilon = 650$

$\frac{\Delta R}{R} = 2.07 \times 650 = 1345.5 \Rightarrow \Delta R = 1345.5 \times 350 = 470{,}925\ \Omega$

$\therefore \Delta R = 470.925\ k\Omega$, $\Delta R/R = 1345.5$

(d) $R_o = 1000$, $S_g = 2.06$ and $\varepsilon = 200$

$\frac{\Delta R}{R} = 2.06 \times 200 = 412 \Rightarrow \Delta R = 412 \times 1000 = 412{,}000\ \Omega$

$\therefore \Delta R = 412\ k\Omega$, $\Delta R/R = 412$

5.18 For the conditions described in Exercise 5.17, determine the output voltage v_o for an initially balanced bridge if the input voltage v_i is

(a) 2 V (c) 7 V

(b) 4 V (d) 10 V

Solution

formula : $v_o = \frac{v_s}{4}\left(\frac{\Delta R_g}{R_g}\right)$ (eq. 5.6)

let v_s denote input voltage ($v_s = v_i$)

$\Delta R_g / R_g$ from Ex. 5.17.

(a) $v_i = v_s = 2$ V

① $\Delta R_g/R_g = 3232$; $v_o = \frac{2}{4}(3232)$ $\therefore v_o = 1{,}616$ V

② $\Delta R_g/R_g = 2255.5$; $v_o = \frac{2}{4}(2255.5)$ $\therefore v_o = 1127.75$ V

③ $\Delta R_g/R_g = 1345.5$; $v_o = \frac{2}{4}(1345.5)$ $\therefore v_o = 672.75$ V

④ $\Delta R/R_g = 412$; $v_o = \frac{2}{4}(412)$ $\therefore v_o = 206$ V

(b) $v_i = v_s = 4$ V

① $\Delta R_g/R_g = 3232$; $v_o = \frac{4}{4}(3232)$ $\therefore v_o = 3232$ V

② $\Delta R_g/R_g = 2255.5$; $v_o = \frac{4}{4}(2255.5)$ $\therefore v_o = 2255.5$ V

③ $\Delta R_g/R_g = 1345.5$; $v_o = \frac{4}{4}(1345.5)$ $\therefore v_o = 1345.5$ V

④ $\Delta R_g/R_g = 412$; $v_o = \frac{4}{4}(412)$ $\therefore v_o = 412$ V

(c) $v_i = v_s = 7\ V$

① $\Delta R_g/R_g = 3232$; $v_o = \frac{7}{4}(3232)$ ∴ $v_o = 5656\ V$

② $\Delta R_g/R_g = 2255.5$; $v_o = \frac{7}{4}(2255.5)$ ∴ $v_o = 3947.125\ V$

③ $\Delta R_g/R_g = 1345.5$; $v_o = \frac{7}{4}(1345.5)$ ∴ $v_o = 2354.625\ V$

④ $\Delta R_g/R_g = 412$; $v_o = \frac{7}{4}(412)$ ∴ $v_o = 721\ V$

(d) $v_i = v_s = 10\ V$

① $\Delta R_g/R_g = 3232$; $v_o = \frac{10}{4}(3232)$ ∴ $v_o = 8080\ V$

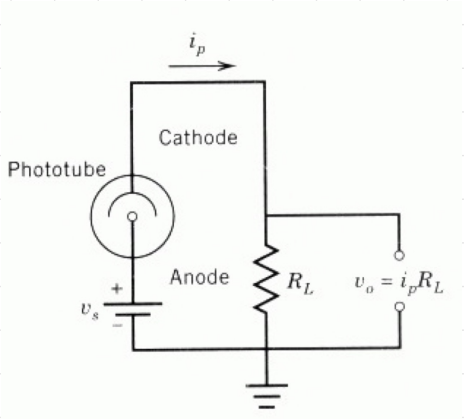
② $\Delta R_g/R_g = 2255.5$; $v_o = \frac{10}{4}(2255.5)$ ∴ $v_o = 5638.75\ V$

③ $\Delta R_g/R_g = 1345.5$; $v_o = \frac{10}{4}(1345.5)$ ∴ $v_o = 3363.75\ V$

④ $\Delta R_g/R_g = 412$; $v_o = \frac{10}{4}(412)$ ∴ $v_o = 1030$

10,000 Ω.

5.35 The sensitivity of a photoconducting tube employing Sb Cs as the photoemissive material is 50 mA/W. Determine the responsivity of the circuit defined in Fig. 5.20 if the area of the detector is 8 mm^2 and $R_l = 100{,}000\ \Omega$.



Solv. Formula: $S = R\left(\frac{A_D}{R_L}\right)$ (eq. 5.28)

where R_L is Load resister.

R is the responsivity (V/W)

let $S = 50\ mA/W$, $A_D = 8\ mm^2$, $R_L = 100\ k\Omega$

Find $R = ?$

From $S = R\left(\frac{A_D}{R_L}\right)$

; $R = \frac{SR_L}{A_D}$

$= \frac{(50\times10^{-3})(100\times10^{3})}{(8\times10^{-6})}$

∴ $R = 625\times10^{6}\ V/W$ ✱

5.45 Compute the voltage output (approximate) at the meter in Fig. 5.27 for the five thermocouples defined in Exercise 5.44 if

	T_1(°C)	T_2(°C)
(a)	300	0
(b)	200	0
(c)	250	10
(d)	−100	100

5.44 Determine the sensitivity of the following thermocouples:
(a) chromel–Alumel (b) copper–constantan (c) iron–constantan (d) iron–nickel (e) gold–silver

Table 5.4 Thermoelectric Sensitivities for Different Materials in Contact with Platinum

Material	Sensitivity (μV/°C)	Material	Sensitivity (μV/°C)
Constantan	−35	Copper	+ 6.5
Nickel	−15	Gold	+ 6.5
Alumel	−13.6	Tungsten	+ 7.5
Carbon	+ 3	Iron	+ 18.5
Aluminum	+ 3.5	Chromel	+ 25.8
Silver	+ 6.5	Silicon	+440

Solv formula : $V_o = S_{A/B}(T_1 - T_2)$ K

(เนื่องจาก K=273+C เมื่อหาผลต่าง จึงไม่มีผล)

$\Delta T = (273 + C_1) - (273 + C_2)$

$\Delta T = C_1 - C_2$

(green) แทนผลต่างของค่า S ของ2ตัว

(a) $T_1 = 300$ °C, $T_2 = 0$ °C

① chromel-Alumel (39.4 μ)

$V_o = (25.8 - (-13.6))(300 - 0)$

$\therefore V_o = 11{,}820\ \mu V = 11.820\ mV$

② copper-constantan (41.5 μ)

$V_o = (6.5 - (-35))(300 - 0)$

$\therefore V_o = 12{,}450\ \mu V = 12.450\ mV$

③ iron-constantan (53.5 μ)

$V_o = (18.5 - (-35))(300 - 0)$

$\therefore V_o = 16{,}050\ \mu V = 16.050\ mV$

④ iron-nickel (33.5 μ)

$V_o = (18.5 - (-15))(300 - 0)$

$\therefore V_o = 10050\ \mu V = 10.050\ mV$

⑤ gold-silver (0 μ)

$V_o = (6.5 - 6.5)(300 - 0)$

$\therefore V_o = 0\ \mu V = 0\ V$

(b) $T_1 = 200$ °C, $T_2 = 0$ °C

① chromel-Alumel

$V_o = (39.4\mu)(200 - 0)$

$\therefore V_o = 7{,}880\ \mu V = 7.880\ mV$

② copper-constantan

$V_o = (41.5\mu)(200 - 0)$

$\therefore V_o = 8300\ \mu V = 8.300\ mV$

③ iron-constantan

$V_o = (53.5\mu)(200 - 0)$

$\therefore V_o = 10{,}700\ \mu V = 10.700\ mV$

④ iron-nickel

$V_o = (33.5\mu)(200 - 0)$

$\therefore V_o = 6700\ \mu V = 6.700\ mV$

(5) gold-silver

$V_o = 0\ V$

(c) $T_1 = 250$ °C, $T_2 = 10$ °C

① chromel-Alumel

$V_o = (39.4\mu)(250 - 10) = 9456\ \mu V = 9.456\ mV$

② copper-constantan

$V_o = (41.5\mu)(250 - 10) = 9960\ \mu V = 9.960\ mV$

③ iron-constantan

$V_o = (53.5\mu)(250 - 10) = 12{,}840\ \mu V = 12.840\ mV$

④ iron-nickel

$V_o = (33.5\mu)(250 - 10) = 8040\ \mu V = 8.040\ mV$

⑤ gold-silver

$V_o = 0\ \mu V = 0 V$

(d) $T_1 = -100\,^\circ C$, $T_2 = 100\,^\circ C$

① Chromel-Alumel

$v_o = (25.8 - (-136))(-100 - 100)$

$\therefore v_o = -7880\ \mu V = -7.88\ mV$

② copper-constantan

$v_o = (6.5 - (-35))(-100 - 100)$

$\therefore v_o = -8,300\ \mu V = -8.300\ mV$

③ iron-constantan

$v_o = (18.5 - (-35))(-100 - 100)$

$\therefore v_o = -10,700\ \mu V = -10.700\ mV$

④ iron-nickel

$v_o = (18.5 - (-15))(-100 - 100)$

$\therefore v_o = -6,700\ \mu V = -6.700\ mV$

⑤ gold-silver

$v_o = (6.5 - 6.5)(-100 - 100)$

$\therefore v_o = 0\ \mu V = 0\ V$
