HW6

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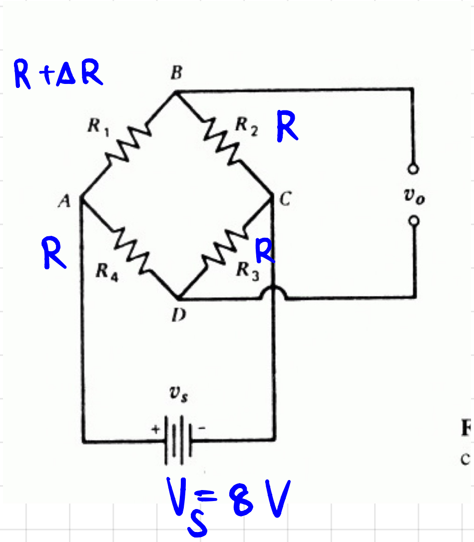
sec.3 PIV

6.18 Determine the output voltage v_o as a function of ΔR for the displacement transducer and Wheatstone bridge described in Exercise 6.17 if $v_s = 8$ V.



จาก ex. 6.18 กำหนด $R_1 = R_2 = R_3 = R_4 = 1\ k\Omega$

จาก $v_o = V_{AB} - V_{AD}$ —(1)

พิจารณา

จาก $V_{AB} = \dfrac{R_1}{R_1 + R_2} V_s$

จะได้ $V_{AB} = \left(\dfrac{R_1 + \Delta R_1}{R_1 + \Delta R + R_2}\right) V_s$ —(2)

และ $V_{AD} = \dfrac{R_4}{R_4 + R_3} V_s$ —(3)

แทน (2), (3) ใน (1) ;

$$v_o = \left(\frac{R_1 + \Delta R_1}{R_1 + \Delta R_1 + R_2} - \frac{R_4}{R_4 + R_3}\right) V_s$$

$$= \left(\frac{1000 + \Delta R_1}{2000 + \Delta R_1} - \frac{1000}{2000}\right) 8$$

$$\therefore\ v_o = \frac{8000 + 8\Delta R_1}{2000 + \Delta R_1} - 4$$ ##

linearity of the output voltage v_o?

6.20 A strain gage with $R_g = 350\ \Omega$, $p_T = 0.25$ W, and $S_g = 2.05$ is used in arm R_1 of a constant-voltage Wheatstone bridge. If the available power supply is limited to 28 V, determine:

(a) the values of R_2, R_3, and R_4 needed to maximize v_o

(b) the circuit sensitivity of the bridge

ⓐ

จาก eq. 6.23;
$$v_s = i_T(R_1 + R_2) = i_T R_T(1 + r) = (1 + r)\sqrt{p_T R_T}$$

โจทย์กำหนดให้ $V_s = 28V$, $P_T = 0.25$, $R_T = R_g = 350$

แทนค่าใน eq. 6.23 ;

$$28 = (1+r)\sqrt{(0.25)(350)}$$

$$r = \frac{28}{\sqrt{0.25 \times 350}} - 1$$

$$\therefore\ r = 1.993$$

จาก $r = \frac{R_2}{R_1}$ (เนื่องจาก $R_1 = R_g = R_T$)

และ $R_1 R_3 = R_2 R_4 \rightarrow \boxed{\frac{R_1}{R_4} = \frac{R_2}{R_3}}$

พิจารณา $r = \frac{R_2}{R_1}$

$$1.993 = \frac{R_2}{350}$$

$$\therefore R_2 = 697.55\ \Omega$$

สรุปได้ว่า $R_1 = R_4 = 350\ \Omega$, $R_2 = R_3 = 697.55\ \Omega$ เพื่อทำให้ eq. นี้เป็นจริง #

$$v_o = \frac{R_1R_3 - R_2R_4}{(R_1 + R_2)(R_3 + R_4)} v_s$$ จาก eq. 6.15

จะได้ $$V_o = \frac{(350)(697.55) - (697.55)(350)}{(350 + 697.55)(697.55 + 350)} \times 28$$

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

ⓑ
$$S_c = \frac{\Delta v_o}{\Delta R_1/R_1} = \frac{r}{(1 + r)^2} v_s$$ eq. 6.22

$$S_c = \frac{1.993}{(1+1.993)^2}(28)$$

$$\therefore\ S_c = 6.229$$

#

ential amplifiers.

6.29 If we have a common voltage of 0.1 V on the input to a differential amplifier with a gain $G_d = 500$ and we measure a voltage difference $\Delta v = 10$ mV, find the output voltage v_o if the common-mode rejection ratio is as follows:

(a) 1000
(b) 5000
(c) 10,000
(d) 20,000

$$v_o = \underbrace{G_d \Delta v}_{\text{Diff}} + \underbrace{G_c v}_{\text{Common}}$$ eq. 6.38. , $CMMR = \frac{G_d}{G_c}$

จากโจทย์ กำหนด $G_d = 500$, $\Delta V = 10$ mV และ $V = 0.1$ V

ⓐ $G_c = 1000$

; $V_o = 500(10\times10^{-3}) + \left(\frac{500}{1000}\right)(0.1)$

$\therefore V_o = 5.05$ V

ⓑ $G_c = 5000$

; $V_o = 500(10\times10^{-3}) + \left(\frac{500}{5000}\right)(0.1)$

$\therefore V_o = 5.01$ V

ⓒ $G_c = 10{,}000$

; $V_o = 500(10\times10^{-3}) + \left(\frac{500}{10{,}000}\right)(0.1)$

$\therefore V_o = 5.005$ V

ⓓ $G_c = 20{,}000$

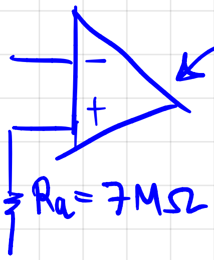
; $V_c = 500(10\times10^{-3}) + \left(\frac{500}{20{,}000}\right)(0.1)$

$\therefore V_o = 5.0025$ V

6.33 Use an op-amp with a gain of 100 dB and $R_a = 7$ MΩ to design a differential amplifier with a gain of

(a) 10
(b) 20
(c) 50
(d) 100

จาก



$G = 100$ dB

Ideal

กำหนดให้ $\frac{R_F}{R_1} = \frac{R_3}{R_2}$

$\boxed{\therefore R_3 = G_c R_2}$

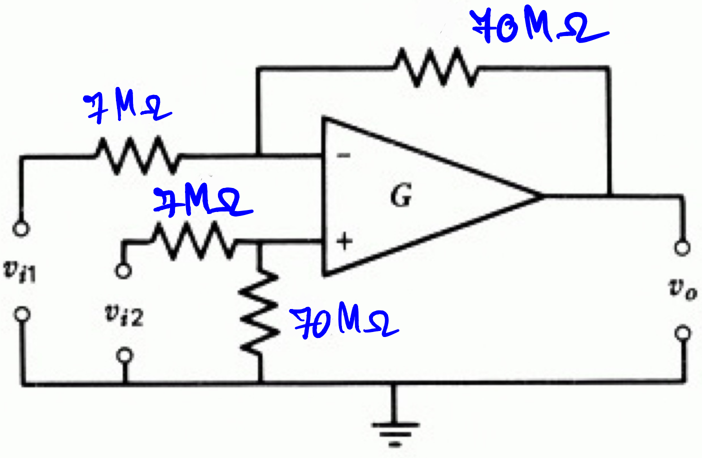
สมมติให้ $R_2 = 7$ MΩ

ⓐ $G_c = 10$

จากสมการ $G_c \approx \frac{R_F}{R_1}$

let $R_1 = R_a = 7\times10^6\,\Omega$

; $R_F = 7\times10^7\,\Omega$



(b)

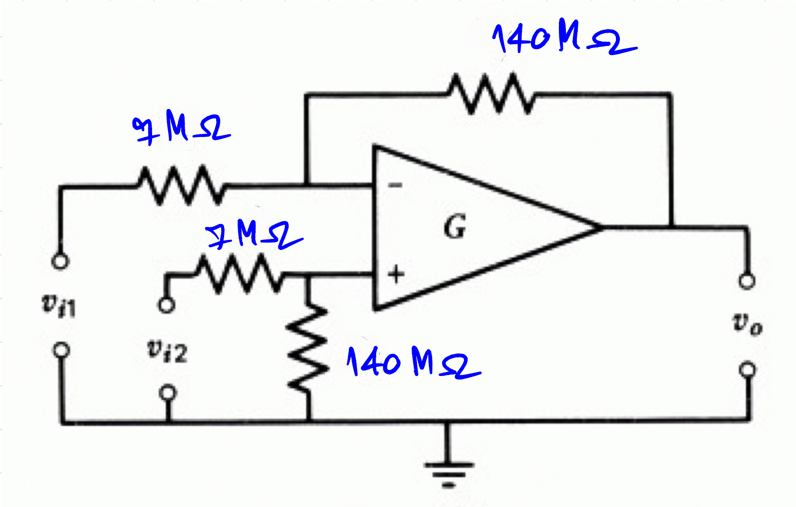
(b) $G_c = 20$

จากสมการ

$$G_c \approx \frac{R_f}{R_a}$$

; $R_f = 20 \times 7 \times 10^6$

$\therefore R_f = 140\ M\Omega$



(b)

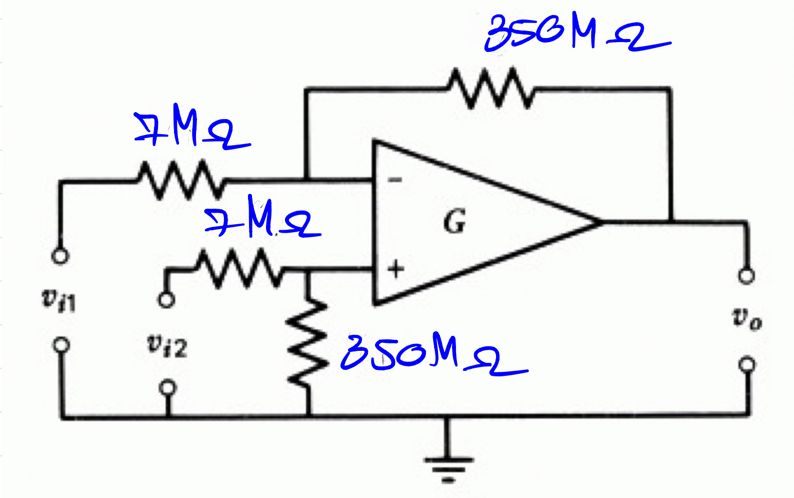
(c) $G_c = 50$

จากสมการ

$$G_d = \frac{R_f}{R_a}$$

; $R_f = 50 \times 7 \times 10^6$

$\therefore R_f = 350\ M\Omega$



(b)

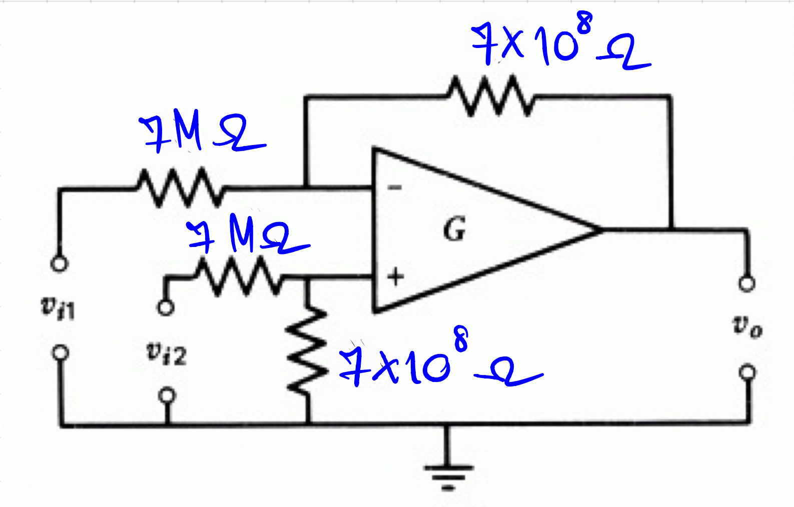
(d) $G_c = 100$

จากสมการ

$$G_c = \frac{R_f}{R_a}$$

; $R_f = 10^2 \times 7 \times 10^6$

$\therefore R_f = 7 \times 10^8\ \Omega$



(b)

(b) 20 Hz

6.47 Select R and C for a low-pass filter that will block 60-Hz noise but transmit the following low-frequency signals with less than 1 percent loss:

(a) 5 Hz

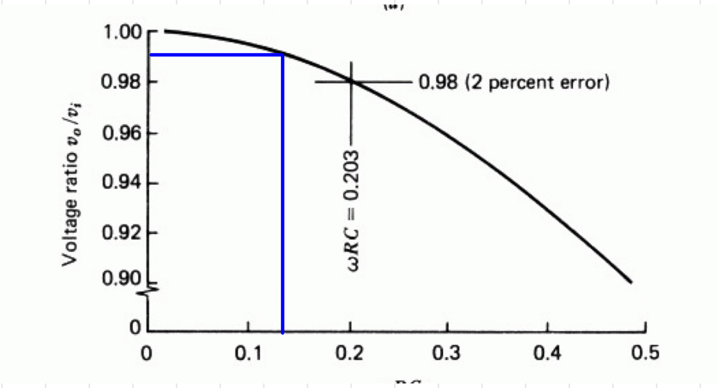
(b) 10 Hz

(c) 20 Hz

let $f = 60\ Hz$

from $\omega = 2\pi f \Rightarrow \omega = 2\pi \times 60$

$\therefore \omega = 120\pi$



สมมติว่า 2% error ค่า ratio อยู่ที่ 0.98 จะได้ว่า 1% error ค่า ratio อยู่ที่ 0.99 ค่า $\omega RC \approx 0.1015$

กำหนด $C = 1\mu C$

(a) 5 Hz

$$2\pi \times 5 \times R \times 1\times 10^{-6} = 0.1015$$

$$R = 3230.85\ \Omega$$ #

(b) 10 Hz

$$2\pi \times 10 \times R \times 1 \times 10^{-6} = 0.1015$$

$$R = 1615.423\ \Omega$$ #

(c) 20 Hz

$$2\pi \times 20 \times R \times 1 \times 10^{-6} = 0.1015$$

$$R = 807.711\ \Omega$$ #