


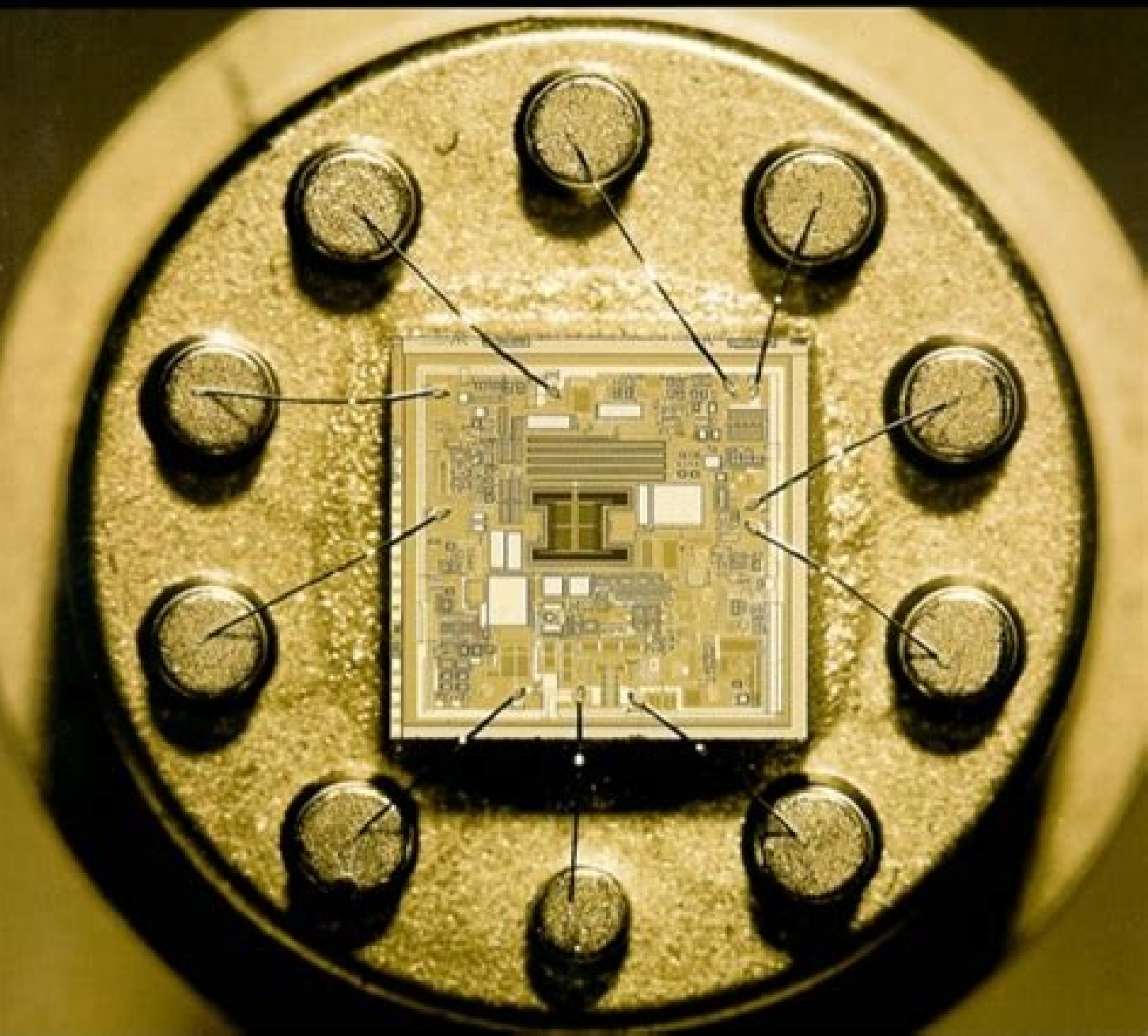
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# KC's Problems and Solutions

for *Microelectronic Circuits* FOURTH EDITION

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Chapter 2-1

2.1

The minimum number of pins required by dual-op-amp is 8. Each op-amp has 2 input terminals (4 pins) and one output terminal (2 pins). Another 2 pins are required for power. Similarly the minimum number of pins required by quad-op-amp is 14:  $4 \times 2 + 4 \times 1 + 2 = 14$

2.2

Refer to fig P 2.2

$$v_o = v_i \times \frac{1 \text{ K}}{1 \text{ K} + 1 \text{ M}} = v_i \frac{1}{1001}$$

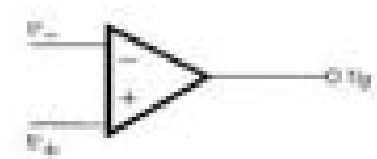
$$v_o = A v_i = A v_i \frac{1}{1001}$$

$$A = 1001 \frac{v_o}{v_i}$$

$$= 1001 \times \frac{4}{2}$$

$$A = 2002 \text{ V/V}$$

2.3



$$v_1 = -2.000 \text{ V}$$

$$v_2 = -1.000 \text{ V}$$

For ideal op-amp

$$v_1 = v_2 = -1.000 \text{ V}$$

Measured voltage at positive input = -1.010 V

$$\text{Amplifier gain } A = \frac{v_o}{v_1 - v_2} = \frac{-2.000}{-1.010 - (-1.000)} = 200 \text{ V/V}$$

2.4

#	$v_1$	$v_2$	$v_o = v_2 - v_1$	$v_o$	$v_o/v_o$
1	0.00	0.00	0.00	0.00	-
2	1.00	1.00	0.00	0.00	-
3	(a)	1.00	(b)	1.00	
4	1.00	1.10	0.10	10.1	101
5	2.01	2.00	-0.01	-0.99	99
6	1.99	2.00	0.01	1.00	100
7	5.10	(c)	(d)	-5.10	

experiments 4.5.6 show that the gain is approximately 100 V/V. The missing entry for experiment #3) can be predicted as follows:

$$(b) v_o = \frac{v_i}{A} = \frac{1.00}{100} = 0.01 \text{ V}$$

$$(a) v_1 = v_2 - v_o = 1.00 - 0.01 = 0.99 \text{ V}$$

The missing entries for experiment #7:

$$(d) v_o = \frac{-5.10}{100} = -0.051 \text{ V}$$

$$(c) v_1 = v_2 + v_o = 5.10 - 0.051 = 5.049 \text{ V}$$

All the results seem to be reasonable.

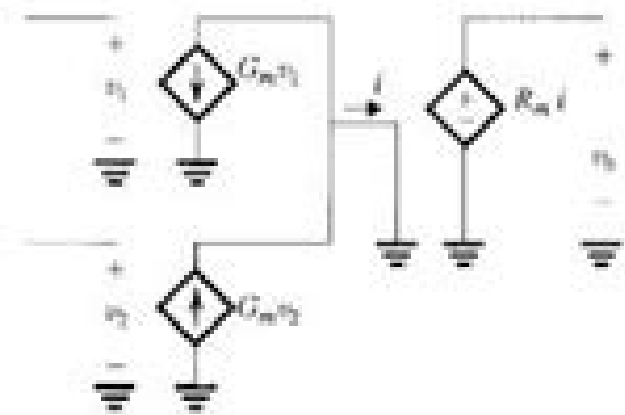
2.5

$$i = G_m (v_1 - v_2)$$

$$v_o = R_o i$$

$$= R_o G_m (v_1 - v_2)$$

$$\text{Gain } A = \frac{v_o}{v_1 - v_2} = R_o G_m = 2 \times 10^4 \times 10 \times 10^{-3} = 20,000 \text{ V/V}$$



2.6

$$v_{1av} = 1 \text{ V Sin } (2\pi 60t) = \frac{1}{2}(v_1 + v_2)$$

$$v_{2av} = 0.01 \text{ Sin } (2\pi 1000t) = v_1 - v_2$$

$$v_1 = v_{1av} - v_{2av} / 2 = \text{Sin } 120\pi t - 0.005 \text{ Sin } 2000\pi t$$

$$v_2 = v_{1av} + v_{2av} / 2 = \text{Sin } 120\pi t + 0.005 \text{ Sin } 2000\pi t$$

2.7

$$v_o = R(G_m v_1 - G_m v_2) \text{ Refer to Fig. 2.4}$$

$$v_o = v_1 = \mu v_o = \mu R(G_m v_1 - G_m v_2)$$

$$v_o = \mu R \left( G_m v_1 + \frac{1}{2} G_m v_2 - G_m v_1 + \frac{1}{2} G_m v_2 \right)$$

$$v_o = \mu R G_m \frac{(v_2 - v_1)}{v_o}$$

$$+ \frac{1}{2} \mu R \Delta G_m \frac{(v_1 + v_2)}{2 v_{1av}}$$

we have  $v_1 = A_1 v_o + A_{1av} v_{1av}$

$$\Rightarrow A_1 = \mu R G_m, A_{1av} = \mu R \Delta G_m$$







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