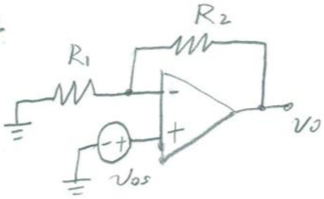
2.94



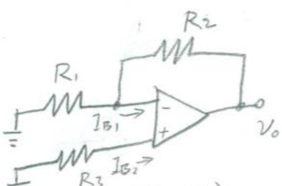
(Fig 1)

$$v_o = V_{os}\left(1 + \frac{R_2}{R_1}\right)$$

$$\Rightarrow V_{os} = \frac{v_o}{1 + \frac{R_2}{R_1}} = \frac{0.4V}{1 + \frac{100K\Omega}{1K\Omega}} \approx 4mV$$

2.95 $V_o = 0.01\sin\omega t \times 200 \pm 2mV \times 200 = 2\sin\omega t \pm 0.4V$

2.99



(Fig2a)

$$10V/V = 1 + \frac{R_2}{R_1} \Rightarrow R_1 = \frac{1}{9}R_2 = \frac{100}{9}K\Omega$$

$$\left.\begin{array}{l} I_{B1} + I_{B2} = 2uA \\ I_{B1} - I_{B2} = \pm 0.1uA \end{array}\right\} \Rightarrow \left\{\begin{array}{l} I_{B1} = 1 \pm 0.05uA \\ I_{B2} = 1 \pm 0.05uA \end{array}\right.$$

For $I_{B1} = 0.95uA$ & $I_{B2} = 0.95uA$, $v_o = -I_{B2}R_3 + R_2\left(I_{B1} - I_{B2}\frac{R_3}{R_1}\right) = 57.5mV$

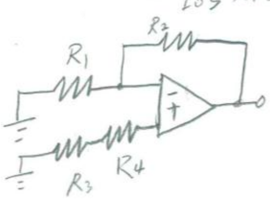
For $I_{B1} = 0.95uA$ & $I_{B2} = 1.05uA$, $v_o = -I_{B2}R_3 + R_2\left(I_{B1} - I_{B2}\frac{R_3}{R_1}\right) = 42.5mV$

$\Rightarrow 42.5mV \le v_o \le 57.5mV$

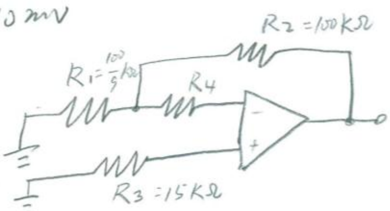
The negtive input terminal sees a resistance of $R_1 // R_2 = 10K\Omega$. To get the minimum dc output voltage, we need to make the resistance seen at the positive input terminal equal to that in the negative terminal. So we should add $5K\Omega$ series resistor R_4 in the positive input terminal (Fig2b),

$$v_o = -I_{B2}\times(5K\Omega + 5K\Omega) + 100K\Omega\times\left(I_{B1} - I_{B2}\times\frac{10K\Omega}{100/9\ K\Omega}\right) = (I_{B1} - I_{B2})\times 100$$

$$= I_{os}\times 100 = \pm 10mV$$



(Fig 2b)



(Fig 2c)

For the same reason, $(R_1 // R_2) + R_4 = R_3 \Rightarrow R_4 = 5K\Omega$

2.104. (a) $1+\frac{R_2}{R_1}=100 \Rightarrow R_1 = 10.1\,K\Omega$

$V_O = I_B \times R_2 = 100\,nA \times 1M\Omega = 0.1V$

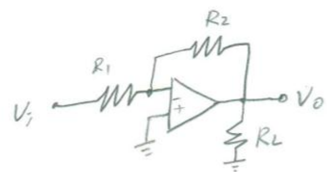
(b) $V_O = 1mV \times 100 + 0.1V = 0.2V$

(c) As shown in Fig 2a, $R_3 = R_1 // R_2 = 10.1K\Omega // 1M\Omega \approx 10k\Omega$

output offset voltage: $I_{OS} \cdot R_2 = 10nA \times 1M\Omega = 10mV$

(d) $V_o = 1mV \times 100 + 10mV = 110\,mV$

2.122



(a) $R_1 = 1k\Omega$, $R_2 = 100\,K\Omega$, $R_L = 1k\Omega$

$V_{P,max} = \frac{10V}{100V/V} = 0.1V$, here $i_o = \frac{10V}{R_L} + \frac{10V}{R_2} = 10.1mA < 20mA$

(b) $R_L = 100\,\Omega$

if $V_P = 0.1V$ $i_o = \frac{10V}{R_L} + \frac{10V}{R_2} > 20mA$

so let $i_o = 20mA$. $i_o = \frac{V_o}{R_L} + \frac{V_o}{R_2} \Rightarrow V_o = 2V \Rightarrow V_P = \frac{2V}{100V/V} = 20mV$

(c) $i_o = \frac{V_o}{R_L} + \frac{V_o}{R_2}$ $V_o = 10V$, $R_2 = 100K\Omega$

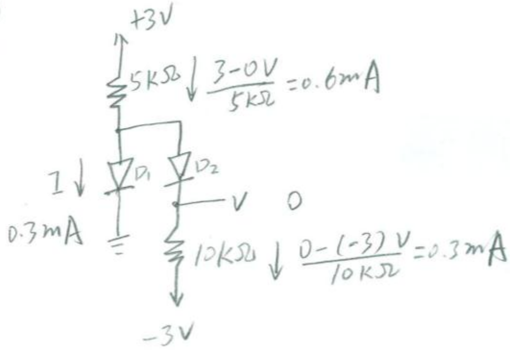
$R_{L,min} = \frac{V_o}{i_{o,max} - \frac{V_o}{R_2}} = \frac{10V}{20mA - \frac{10V}{100K\Omega}} = 502.5\Omega$

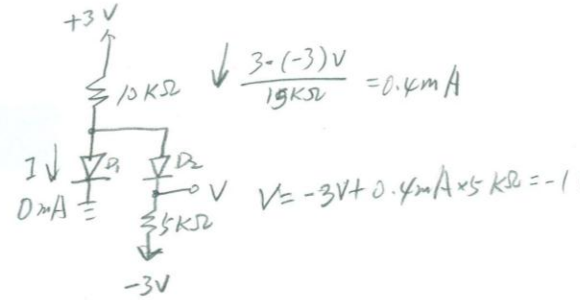
2.126 $v_o = 10\sin\omega t$ $\frac{dv_o}{dt} = 10\omega\cos\omega t$

slew rate $= \frac{dv_o}{dt}\Big|_{max} = 60\,V/\mu s = 10\,\omega_{max}$ $\omega_{max} = 6\times10^6\,rad/s$

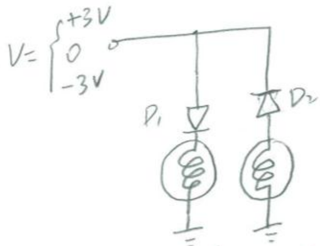
$f_{max} = \frac{\omega}{2\pi} = 0.956\,MHz$

4.9





4.16



	red	green
3V	on	off
0	off	off
-3V	off	on