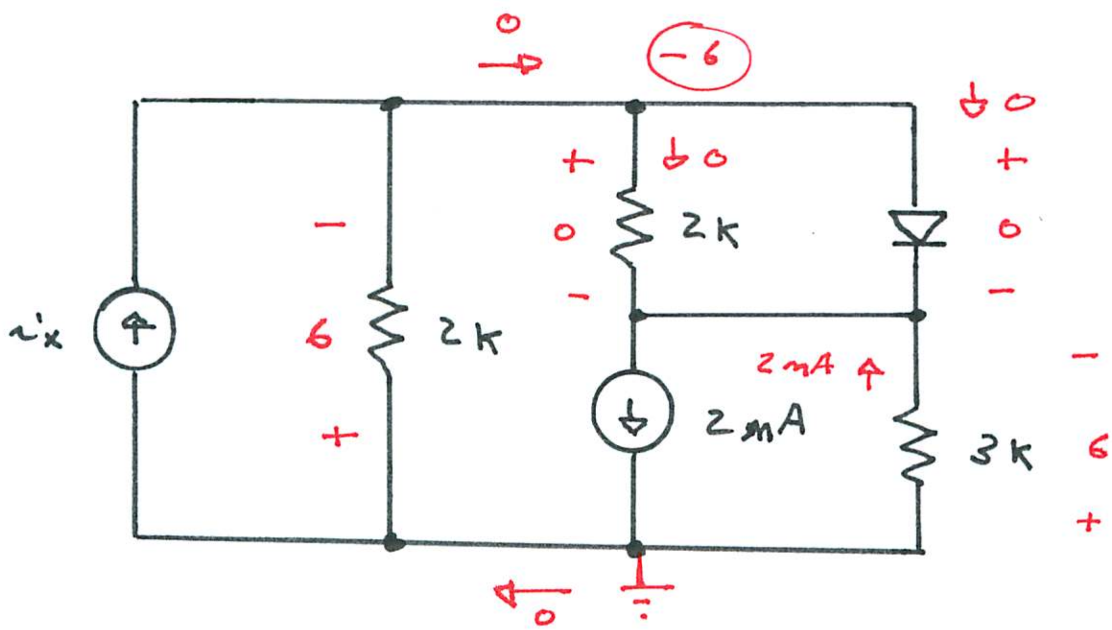
Problem 1

Determine the range of i_x that puts the diode in the "on" state.

The diode is ideal.

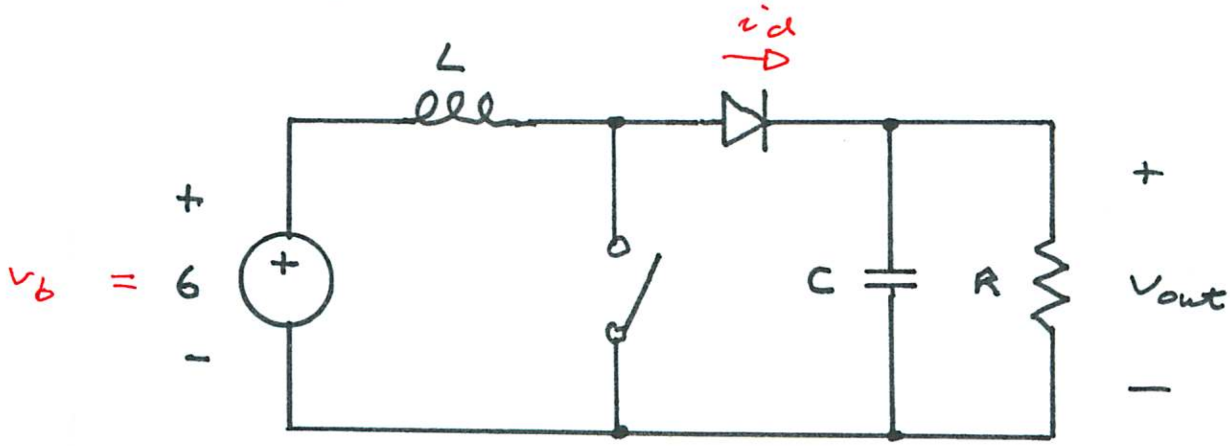


diode breakpoint when $i_x = \frac{-6}{2k} = -3mA$

diode "on" for $i_x > -3$ mA

Problem 2

The boost converter drawn below is intended to operate with $v_{out} = 10$ V subject to a 100-kHz switching frequency. An acceptable design will deliver a load current up to 500 mA.



A. Specify the duty cycle D.

$$10 = \frac{6}{1-D} \longrightarrow D = 0.4$$

B. Specify a reasonable design value for C. won't care $R = \frac{10}{0.5} = 20\Omega$

$$RC \sim 10T \quad \swarrow 1/f \longrightarrow C = \frac{10 \times 10^{-5}}{20} = 5\ \mu F$$

C. Specify L so that the minimum inductor current is just barely positive at all times (continuous mode).

$$L = \frac{v_b D(1-D)T}{2 \times \text{dc load current}} = \frac{6(0.4)(0.6)\times 10^{-5}}{1} = 14.4\ \mu H$$

D. Specify the maximum diode current subject to the conditions of part C.

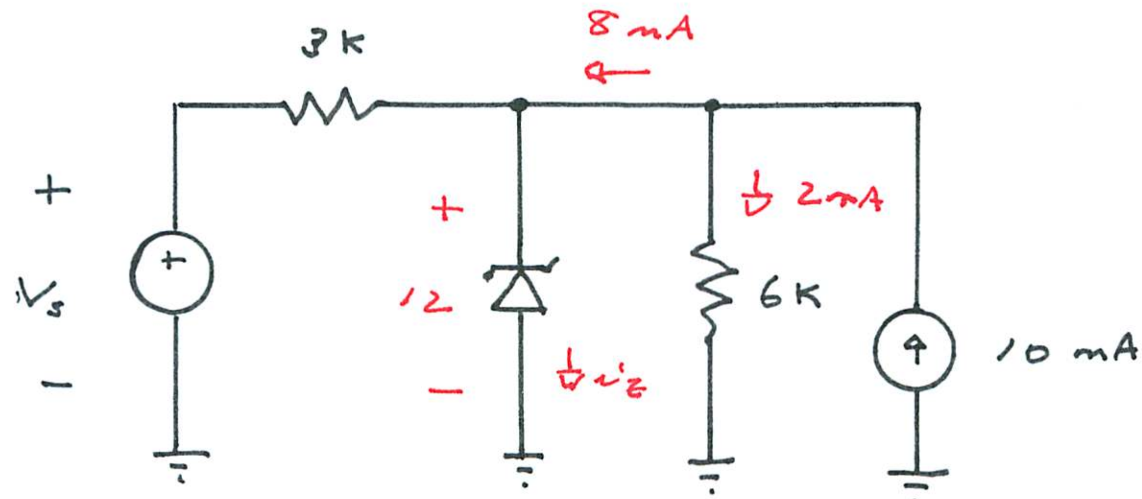
$$i_d\,(\max) = \frac{2v_b}{(1-D)^2 R} = \frac{2 \times 6}{(0.6)^6 \cdot 20} = 1.67\ A$$

Problem 3

The circuit drawn below features a Zener diode with $V_z = 12$ V. The voltage source V_s varies according to the relation

$$V_s(t) = 15\,[\,1 + \cos 100\,\omega t\,]\,. \qquad \left\{ \begin{array}{l} v_s\,(\max) = 30 \\ v_s\,(\min) = 0 \end{array} \right.$$

Determine the range of instantaneous power that the Zener diode absorbs.



$v_s = 30$ V $\longrightarrow$ $i_z = 8\text{ mA} + \dfrac{30-12}{3}$

$= 14$ mA

$P_Z = 12\text{ V} \times 14\text{ mA} = 168$ mW

$v_s = 0$ $\longrightarrow$ $i_z = 8\text{ mA} + \dfrac{0-12}{3}$

$= 4$ mA

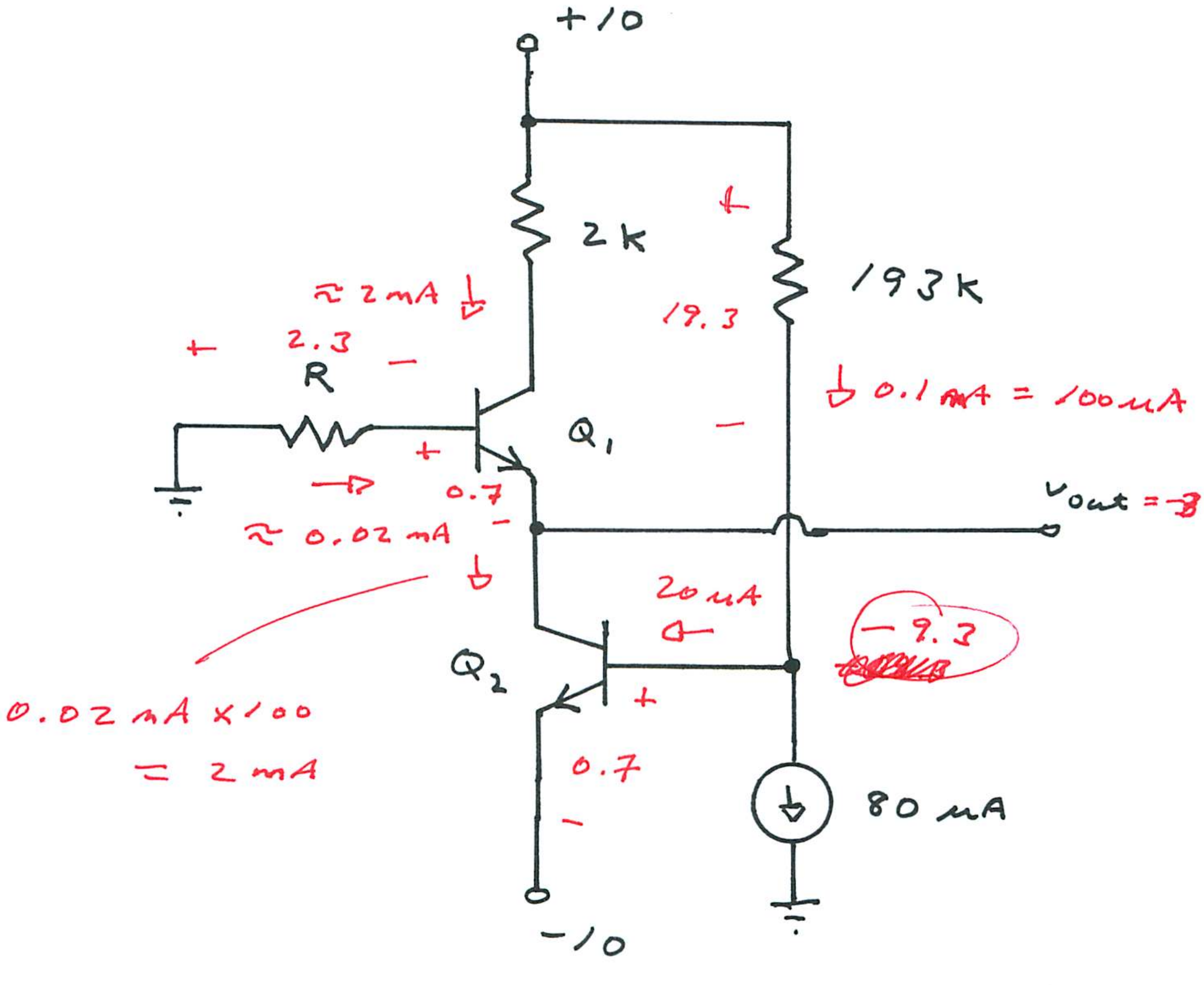
$P_Z = 12\text{ V} \times 4\text{ mA} = 48$ mW

$48\text{ mW} < P_Z < 168\text{ mW}$

Problem 4

The BJTs have $\beta_F = 100$.

Determine R such that $v_{out} = -3$ V.

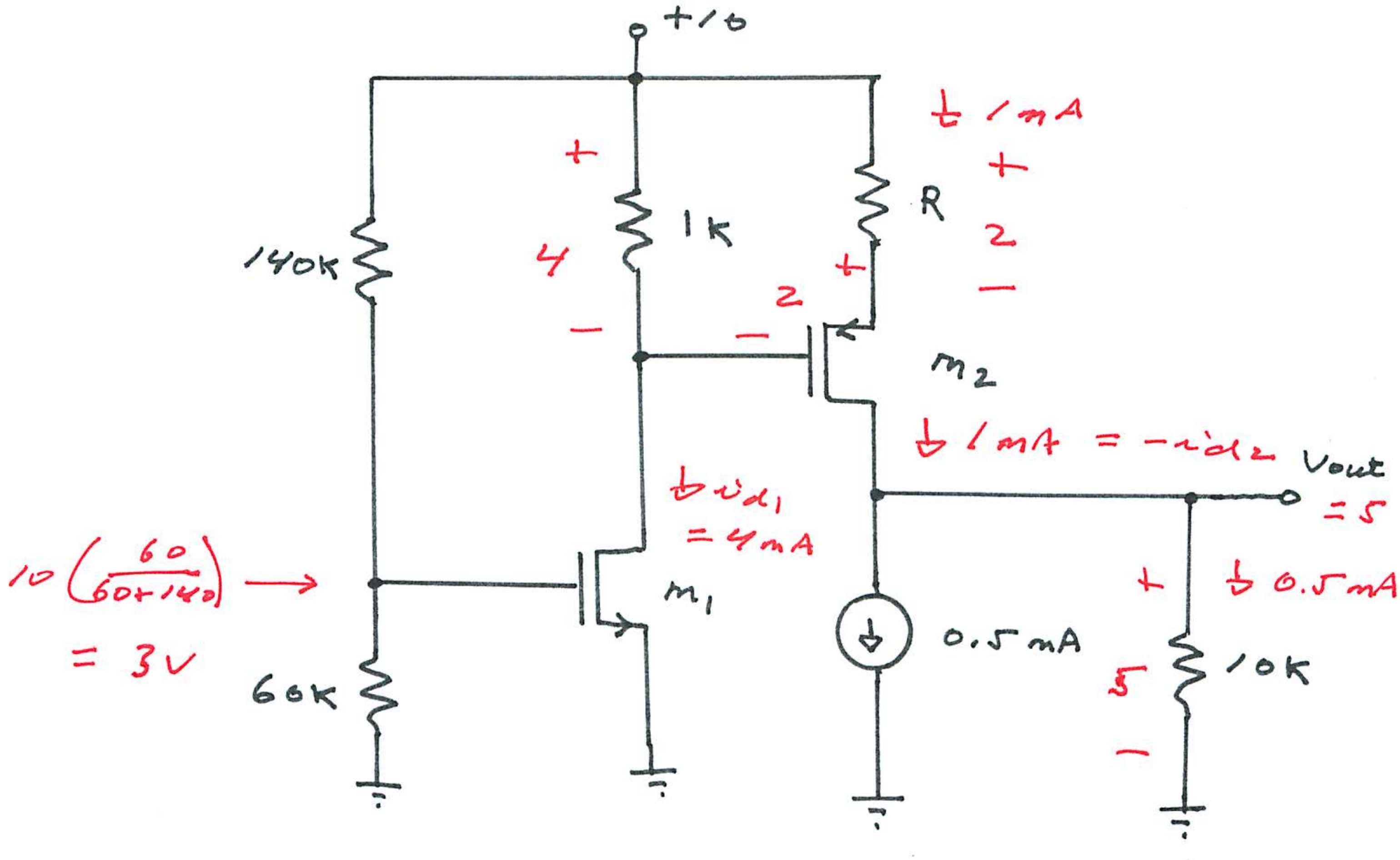


$$R = \frac{2.3}{0.02} = \underline{115\text{K}}$$

Problem 5

The MOSFETs have $K'W/L = 2\ \text{mA/V}^2$ and $|V_T| = 1$ V.

Find R such that $v_{out} = 5$ V.



$$i_{d1} = \tfrac{1}{2}(2)(3-1)^2 = 4\text{ mA}$$

$$-i_{d2} = 1\text{ mA} = \tfrac{1}{2}(2)(v_{gs2}+1)^2$$

$$v_{gs2} = \cancel{0},\ -2 \rightarrow v_{sg2} = +2$$

$$R = \frac{2}{1\text{ mA}} = \underline{2k}$$