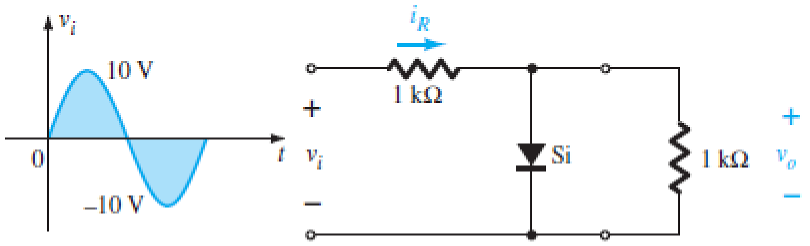
Remember to check your calculations using LTSpice

1. For the network below, sketch v_o and i_R



Answer:

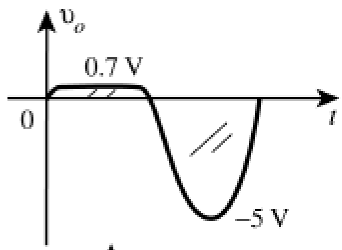
Diode will conduct when $v_o = 0.7$ V; that is,

$$v_o = 0.7\text{ V} = \frac{1\text{ k}\Omega(v_i)}{1\text{ k}\Omega + 1\text{ k}\Omega}$$

Solving: $v_i = \mathbf{1.4\ V}$

For $v_i \geq 1.4$ V Si diode is "on" and $v_o = \mathbf{0.7\ V}$.
For $v_i < 1.4$ V Si diode is open and level of v_o is determined by voltage divider rule:

$$v_o = \frac{1\text{ k}\Omega(v_i)}{1\text{ k}\Omega + 1\text{ k}\Omega} = 0.5\ v_i$$



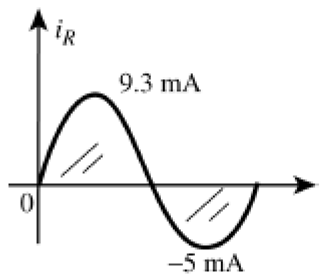
For $v_i = -10$ V:

$$v_o = 0.5(-10\text{ V}) = \mathbf{-5\ V}$$

When $v_o = 0.7$ V, $v_{R_{\max}} = v_{i_{\max}} - 0.7$ V

$$= 10\text{ V} - 0.7\text{ V} = 9.3\text{ V}$$

$$I_{R_{\max}} = \frac{9.3\text{ V}}{1\text{ k}\Omega} = 9.3\text{ mA}$$



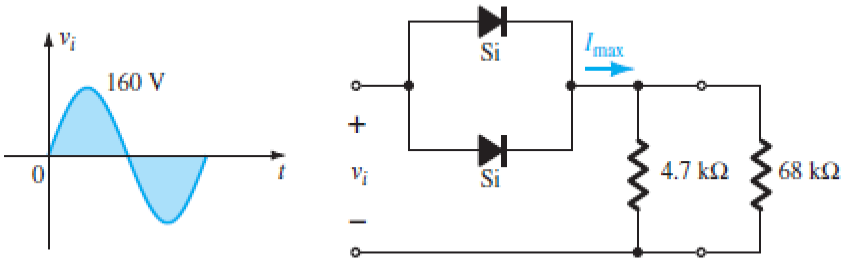
$$I_{\max}(\text{reverse}) = \frac{10\text{ V}}{1\text{ k}\Omega + 1\text{ k}\Omega} = \mathbf{0.5\ mA}$$

2. **a.** Given $P_{\max} = 14$ mW for each diode at Fig. 2.172 , determine the maximum current rating of each diode (using the approximate equivalent model).

b. Determine $I_{\max}$ for the parallel diodes.

c. Determine the current through each diode at $V_{i\max}$ using the results of part (b).

d. If only one diode were present, which would be the expected result?



Answer:

(a) $P_{max} = 14 \text{ mW} = (0.7 \text{ V})I_D$

$$I_D = \frac{14 \text{ mW}}{0.7 \text{ V}} = \mathbf{20\ mA}$$

(b) $I_{max} = 2 \times 20 \text{ mA} = \mathbf{40\ mA}$

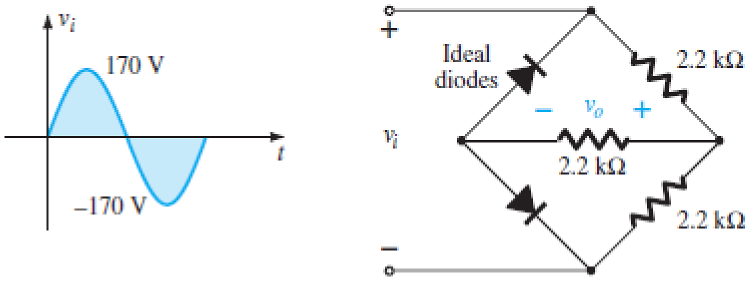
(c) $4.7 \text{ k}\Omega \,||\, 68 \text{ k}\Omega = 4.4 \text{ k}\Omega$

$V_R = 160 \text{ V} - 0.7 \text{ V} = 159.3 \text{ V}$

$$I_{max} = \frac{159.3 \text{ V}}{4.4 \text{ k}\Omega} = 36.2 \text{ mA}$$

$$I_d = \frac{I_{max}}{2} = \mathbf{18.1\ mA}$$

3. Sketch v_o for the network below and determine the dc voltage available.



Answer:

Positive pulse of v_i:

Top left diode "off", bottom left diode "on"

$2.2\text{ k}\Omega \parallel 2.2\text{ k}\Omega = 1.1\text{ k}\Omega$

$$V_{o_{\text{peak}}} = \frac{1.1\text{ k}\Omega(170\text{ V})}{1.1\text{ k}\Omega + 2.2\text{ k}\Omega} = 56.67\text{ V}$$

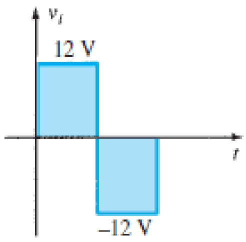
Negative pulse of v_i:

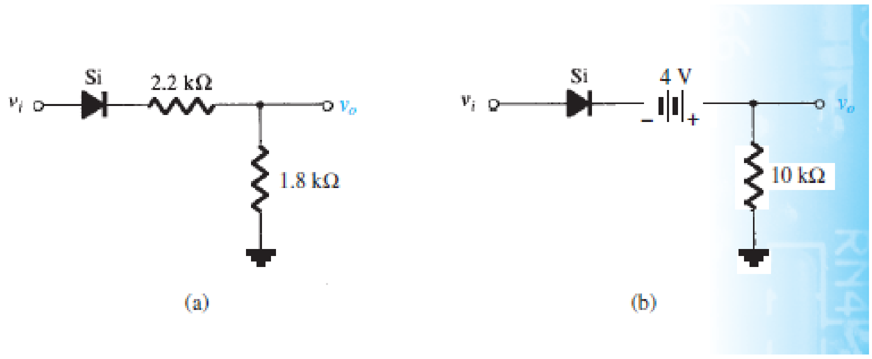
Top left diode "on", bottom left diode "off"

$$V_{o_{\text{peak}}} = \frac{1.1\text{ k}\Omega(170\text{ V})}{1.1\text{ k}\Omega + 2.2\text{ k}\Omega} = 56.67\text{ V}$$

$V_{dc} = 0.636(56.67\text{ V}) = \mathbf{36.04\text{ V}}$

4. Determine v_o for each network shown below, for the input shown.





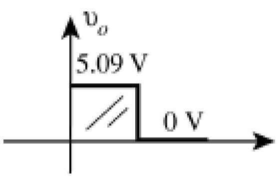
Answer:

(a) Positive pulse of v_i:

$$V_o = \frac{1.8\text{ k}\Omega(12\text{ V} - 0.7\text{ V})}{1.8\text{ k}\Omega + 2.2\text{ k}\Omega} = \mathbf{5.09\text{ V}}$$

Negative pulse of v_i:

diode "open", $v_o = \mathbf{0\text{ V}}$

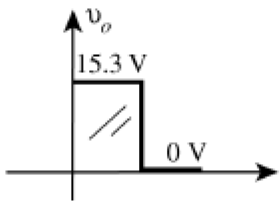


(b) Positive pulse of v_i:

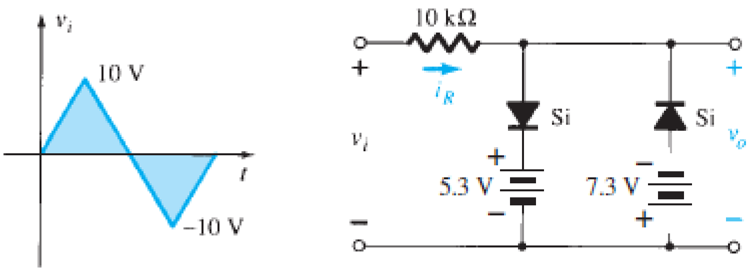
$V_o = 12\text{ V} - 0.7\text{ V} + 4\text{ V} = \mathbf{15.3\text{ V}}$

Negative pulse of v_i:

diode "open", $v_o = \mathbf{0\text{ V}}$



5. Sketch i_R and v_o for the network shown below for the input shown.



Answer:

For the positive region of v_i:

The right Si diode is reverse-biased.

The left Si diode is "on" for levels of v_i greater than 5.3 V + 0.7 V = 6 V. In fact, v_o = **6 V** for $v_i \geq 6$ V.

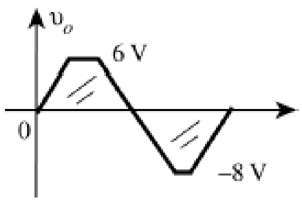
For $v_i < 6$ V both diodes are reverse-biased and $v_o = v_i$.

For the negative region of v_i:

The left Si diode is reverse-biased.

The right Si diode is "on" for levels of v_i more negative than 7.3 V + 0.7 V = 8 V. In fact, v_o = **−8 V** for $v_i \leq -8$ V.

For $v_i > -8$ V both diodes are reverse-biased and $v_o = v_i$.

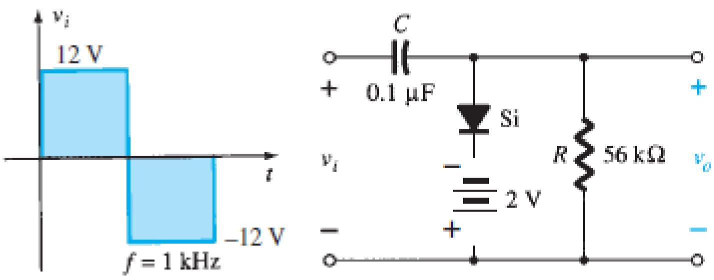


6. For the network shown below :

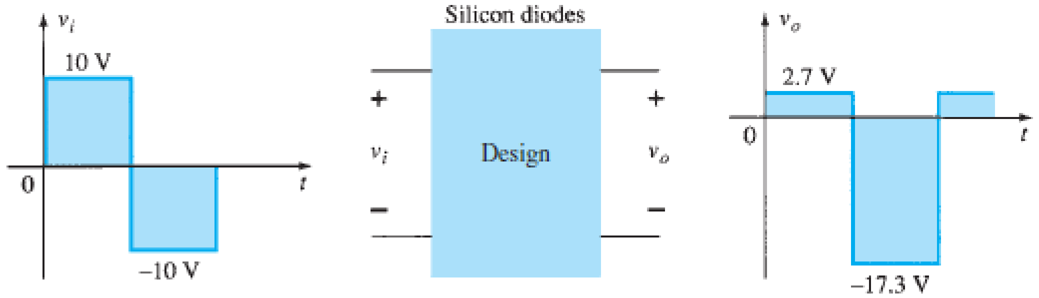
a. Calculate 5*t* .

b. Compare 5*t* to half the period of the applied signal.

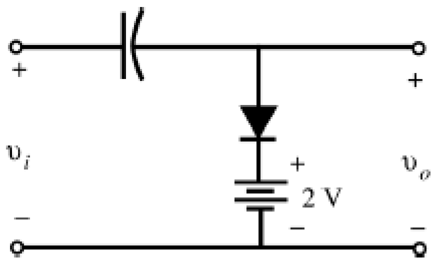
c. Sketch v_o .



7. Design a clamper to perform the function indicated

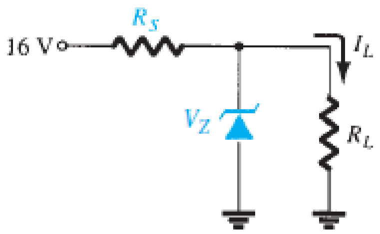


Answer:



8. **a.** Design the network shown below to maintain V_L at 12 V for a load variation (I_L) from 0 mA to 200 mA. That is, determine R_S and V_Z .

b. Determine $P_{Z\,max}$ for the Zener diode of part (a).



Answer:

(a) $V_Z = 12\text{ V},\ R_L = \dfrac{V_L}{I_L} = \dfrac{12\text{ V}}{200\text{ mA}} = \mathbf{60\ \Omega}$

$$V_L = V_Z = 12\text{ V} = \frac{R_L V_i}{R_L + R_S} = \frac{60\ \Omega(16\text{ V})}{60\ \Omega + R_s}$$

$$720 + 12R_s = 960$$
$$12R_s = 240$$
$$R_s = \mathbf{20\ \Omega}$$

(b) $P_{Z_{max}} = V_Z I_{Z_{max}}$

$= (12\text{ V})(200\text{ mA})$

$= \mathbf{2.4\ W}$