



## Sheet 2 Diodes

### Problem (1)

Draw the

- Charge density distribution,
- Electric field distribution
- Potential distribution ,

For each of the following cases for an abrupt p-n junction

- At zero bias (equilibrium)
- When forward biased
- When reverse biased

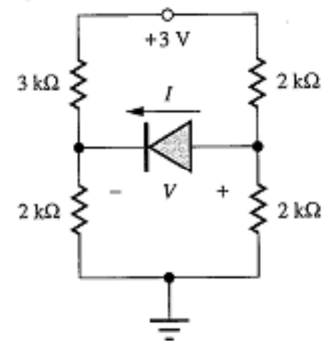
### Problem (2)

A silicon diode has  $V_D=0.68\text{V}$  at  $I_D=0.5\text{mA}$ . Find the voltage drop at  $I_D=1.5\text{mA}$  and  $I_D=5\text{mA}$ .

### Problem (3)

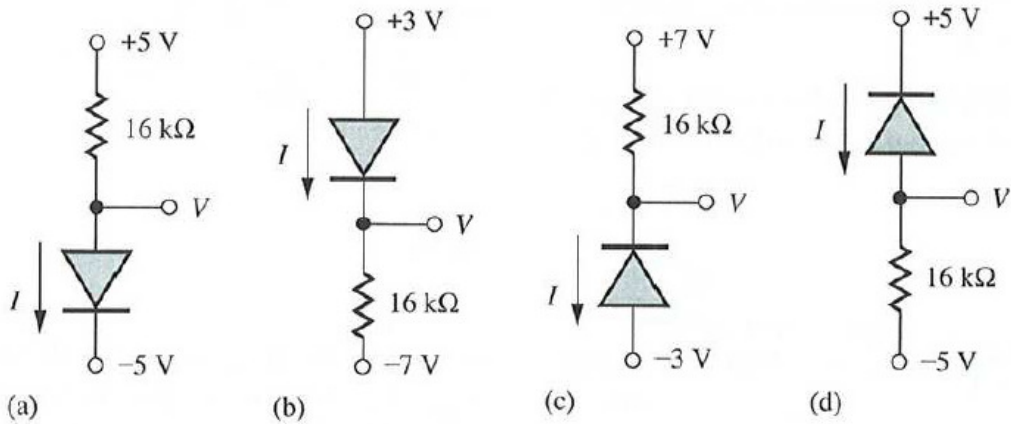
Find the operating point of the diode in the circuit shown aside

- Using An ideal diode model
- Using the constant voltage model with  $V_\gamma = 0.6\text{V}$
- using iterative analysis to find the actual Q-point if  $I_S = 1\text{fA}$ ,  $\eta=1$
- using a graphical solution by plotting both the load line and diode's I-V characteristic equation



**Problem (4)**

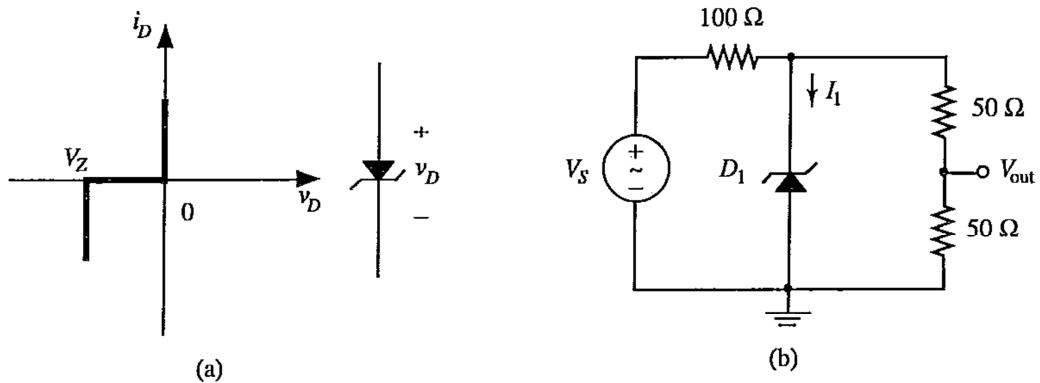
- i. Find  $I$  and  $V$  in the four circuits shown below using the ideal diode model
- ii. Repeat using the constant voltage model with  $V_\gamma = 0.7 \text{ V}$



**Problem (5)**

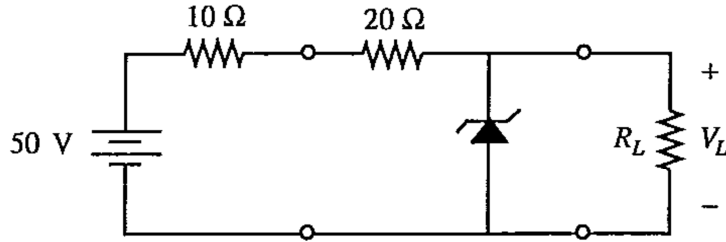
A Zener diode ideal I-V characteristic is shown below in figure (a). Given a Zener voltage of  $V_z = 7.7 \text{ V}$ , find the output voltage  $V_{\text{out}}$  for the circuit in figure (b) if  $V_s$  is

- a) 12V
- b) 20V



**Problem (6)**

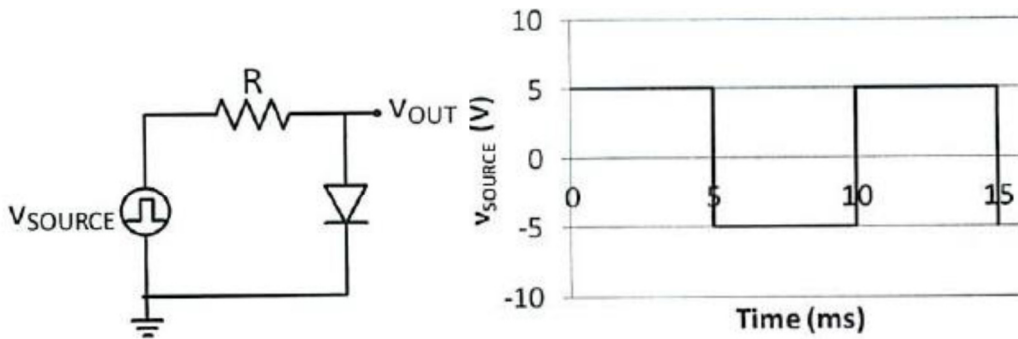
For the Zener regulator shown in the figure below, we desire to hold the load voltage to 14V. Find the range of the load resistances for which regulation can be obtained if the Zener diode is rated at 14V, 5W



**Problem (7)**

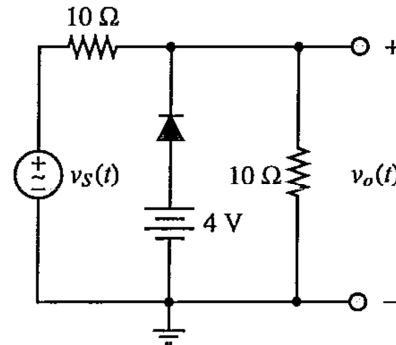
A circuit and its input signal  $v_{source}(t)$  are shown below. In your analysis, use the “constant voltage drop” model of the diode, with  $V_\gamma=0.7V$ .

- a) Sketch  $v_{out}(t)$ .
- b) Find the average (or “dc”) value of  $v_{out}$ .



**Problem (8)**

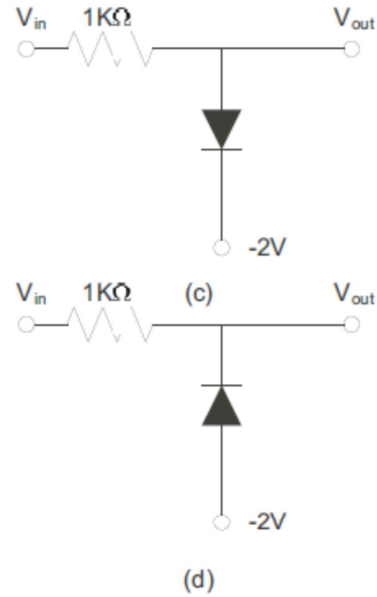
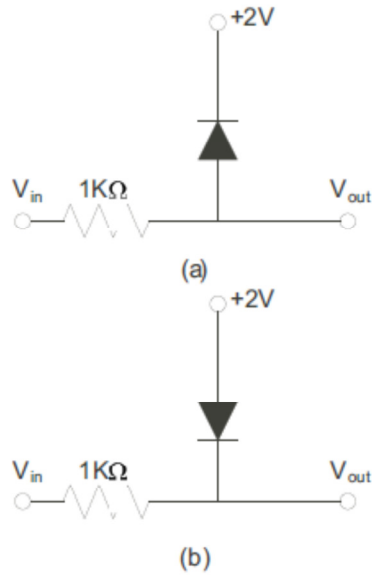
Sketch the output waveform for the circuit shown if the diode is considered ideal and  $v_s(t) = 10 \sin(2000\pi t)$



**Problem (9)**

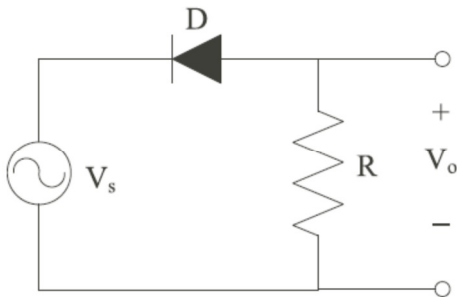
Sketch the output waveforms  $V_o$  for all of the limiter circuits shown in the figures below. The input voltage is a sinusoid with 5V amplitude

- i) First assume that the diodes are ideal.
- ii) Next, assume a constant voltage drop of 0.7V.



**Problem (10)**

Consider the rectifier in Fig. 2.  $V_s$  is a sinusoid with 15V peak amplitude, and  $R = 1.5k\Omega$ . Use the Constant Voltage Drop model with  $V_\gamma = 0.7V$



- a) What kind of rectifier is this circuit?
- c) Sketch the waveform  $V_o$ .
- d) Find the peak current in the diode.
- e) Find the peak inverse voltage PIV of the diode.

### **Problem (11)**

A full-wave rectifier circuit with a 1k load operates from a 120-V (rms) 60-Hz household supply through a 5-1 transformer having a center-tapped secondary winding (12Vrms at the secondary windings). It uses **two identical silicon diodes** that can be modeled to have a  $V_{\gamma}=0.7V$ . (Note: no capacitor)

- a) What is the peak voltage of the rectified output?
- b) For what fraction of a cycle does each diode conduct?
- c) What is the average current in the load?

Now add a smoothing capacitor in parallel with the load resistance.

- d) What capacitor value will give a ripple voltage of 10%?
- e) What is the average diode current?
- f) What is the peak diode current?

Now change the capacitor for one that gives a 1% ripple.

- f) What is the value of this capacitor?
- g) What is the average diode current?
- h) What is the peak diode current?

### **Problem (12)**

A full-wave bridge rectifier circuit with a 1k load operates from a 120-V (rms) 60-Hz household supply through a 10-1 step down transformer having a single secondary winding (12Vrms at the secondary winding). It **uses 4 diodes**, each which can be modeled to have a  $V_{\gamma}=0.7V$  (Note: no capacitor)

- a) What is the peak value of the rectified voltage across the load?
- b) What fraction of a cycle does each diode conduct?
- c) What is the average current in the load?

Now add a smoothing capacitor in parallel with the load resistance.

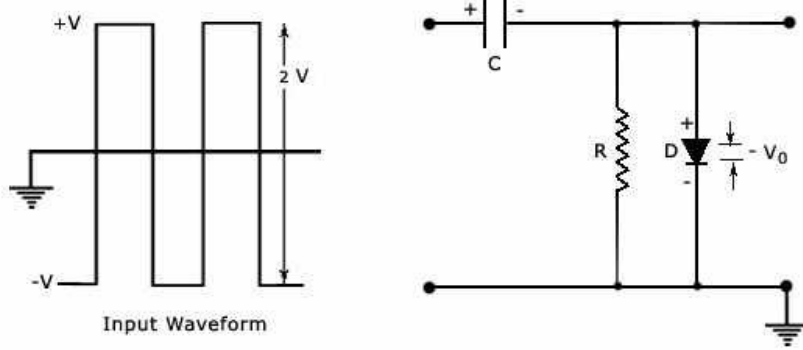
- d) What capacitor value will give a ripple voltage of 10%?
- e) What is the average diode current?
- f) What is the peak diode current?

Now change the capacitor for one that gives a 1% ripple.

- g) What is the value of this capacitor?
- h) What is the average diode current?
- i) What is the peak diode current?

**Problem (13)**

Find the output waveform of the following circuit with  $V=5$  assuming an ideal diode model.



**Problem (14)**

Find the output waveform of the following circuit with  $V=5$  assuming a constant voltage  $V_f=0.7$  diode model.

