EE303 - Problem Set

Problem 1

For the circuit shown in Figure P.4.3 using ideal diodes find the values of the labeled voltages and currents.

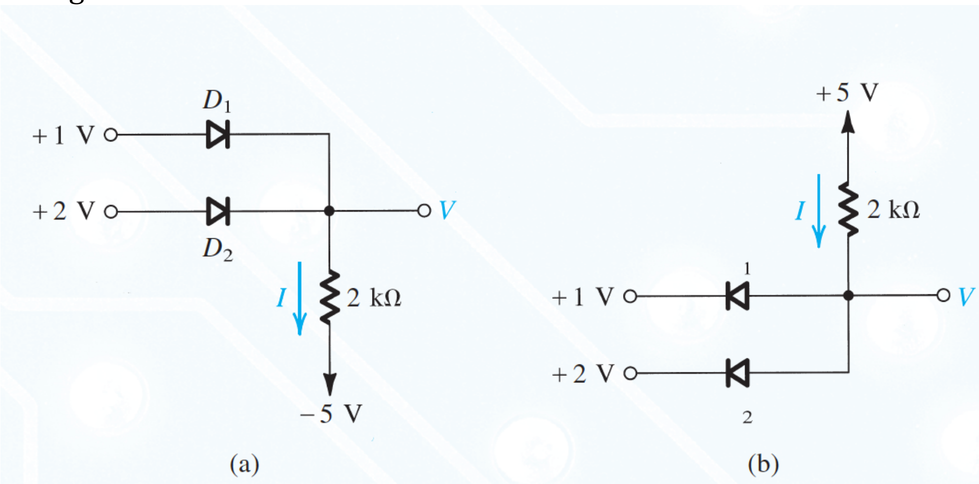


Figure P4.3

Problem 2

Consider the circuit shown in Fig. 4.15. A string of three diodes is used to provide a constant voltage of about 2.1 V. We want to calculate the percentage change in this regulated voltage caused by (a) a ±10% change in the power-supply voltage and (b) connection of a 1-kΩ load resistance.

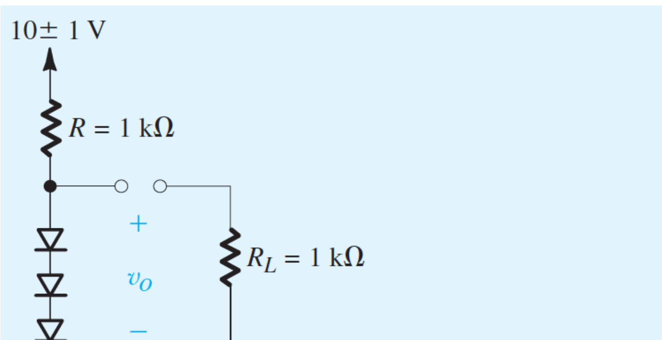


Figure 4.15

Problem 3

The 6.8-V zener diode in the circuit of Fig. 4.19(a) is specified to have V_Z=6.8 V at I_Z=5 mA, r_z=20 Ω , and I_{ZK}=0.2 mA. The supply voltage V^+ is nominally 10 V but can vary by ± 1V.

(a) Find V_O with no load and with V+ at its nominal value.

(b) Find the change in V_O resulting from the ± 1-V change in V+. Note that, $\Delta V_o/\Delta V^+$ is usually expressed in mV/V, is known as line regulation .

(c) Find the change in V_O resulting from connecting a load resistance R_L that draws a current I_L =1mA, and hence find the load regulation ($\Delta V_o/\Delta I_L$) in mV/ mA.

(d) Find the change in V_O when $R_L = 2\ k\Omega$.
(e) Find the value of V_O when $R_L = 0.5\ k\Omega$.
(f) What is the minimum value of R_L or which the diode still operates in the breakdown region?

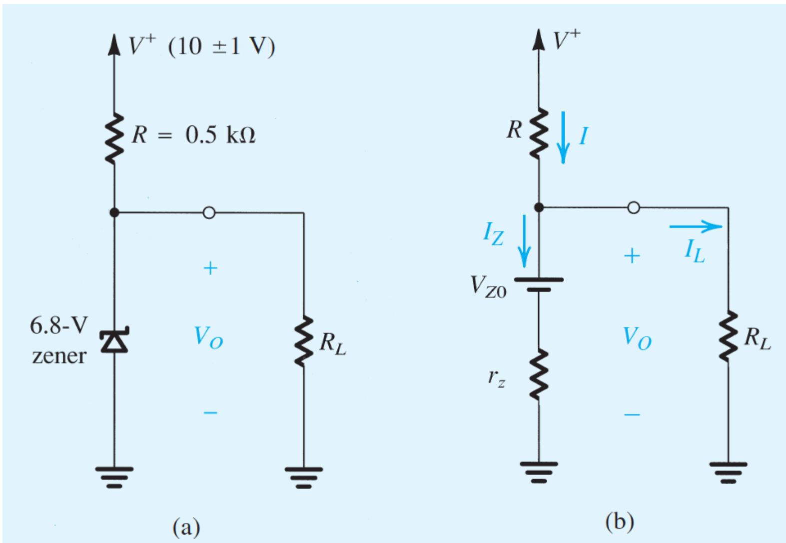
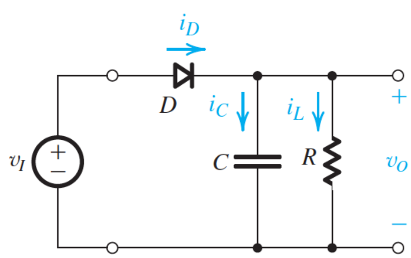


Figure 4.19 (a) Circuit for Problem. (b) Circuit with zener diode replaced with its equivalent circuit model.

Problem 4

Consider a peak rectifier fed by a 60-Hz sinusoid having a peak value Vp = 100 V. Let the load resistance R = 10 kΩ . Find the value of the capacitance C that will result in a peak-to-peak ripple of 2 V.
Also, calculate the fraction of the cycle during which the diode is conducting and the average and peak values of the diode current.



Problem 5

Assuming the diodes to be ideal, describe the transfer characteristic of the circuit shown in Fig. E4.26.

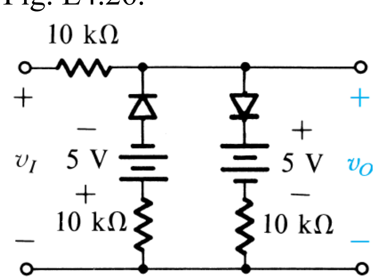


Figure E4.26

Problem 6

The circuit shown in Fig P4.5 is a model for a battery charger. Here v_I is a 10-V peak sine wave, D1 and D2 are ideal diodes, I is a 60-mA current source, and B is a 3-V battery. Sketch and label the waveform of the battery current i_B. What is its peak value? What is its average value? If the peak value of vI is reduced by 10%, what do the peak and average values of i_B become?

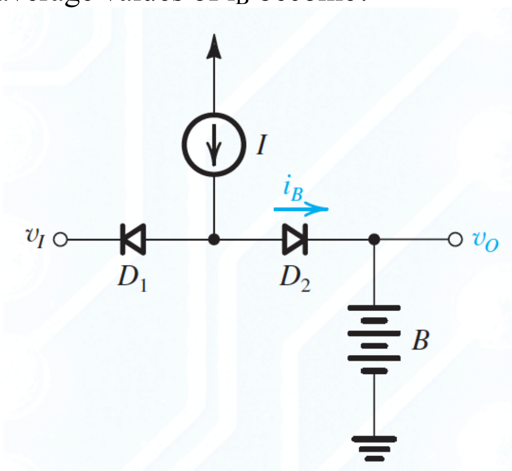


Figure P4.5

Problem 7

Consider the voltage-regulator circuit shown in Fig. P4.52. The value of R is selected to obtain an output voltage V_O (across the diode) of 0.7 V.

(a) Use the diode small-signal model to show that the change in output voltage corresponding to a change of 1 V in V+ is:

$$\frac{\Delta V_O}{\Delta V^+} = \frac{V_T}{V^+ + V_T - 0.7}$$

This quantity is known as the line regulation and is usually expressed in mV/V.

(b) Generalize the expression above for the case of m diodes connected in series and the value of R adjusted so that the voltage across each diode is 0.7 V (and V_O =0.7×m V).

(c) Calculate the value of line regulation for the case V + = 10 V (nominally) and (i) m = 1 and (ii) m = 3.

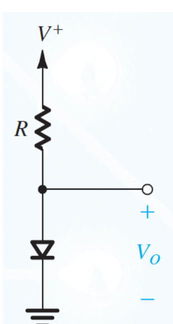


Figure P4.52

Problem 8

A shunt regulator utilizing a zener diode with an incremental resistance of 5 Ω is fed through an 82-Ω resistor.
If the raw supply changes by 1.0 V, what is the corresponding change in the regulated output voltage?

Problem 9

A half-wave rectifier circuit with a 1-kΩ load operates from a 120-V (rms) 60-Hz household supply through a 10-to-1 step-down transformer. It uses a silicon diode that can be modeled to have a 0.7-V drop for any current.
What is the peak voltage of the rectified output? For what fraction of the cycle does the diode conduct? What is the average output voltage? What is the average current in the load?

Problem 10

The op amp in the circuit of Fig. P4.84 is ideal with output saturation levels of ±12 V. The diodes exhibit a constant 0.7-V drop when conducting. Find v_-, v_A, and v_O for:

(a) $v_I = +1$ V
(b) $v_I = +2$ V
(c) $v_I = -1$ V
(d) $v_I = -2$ V

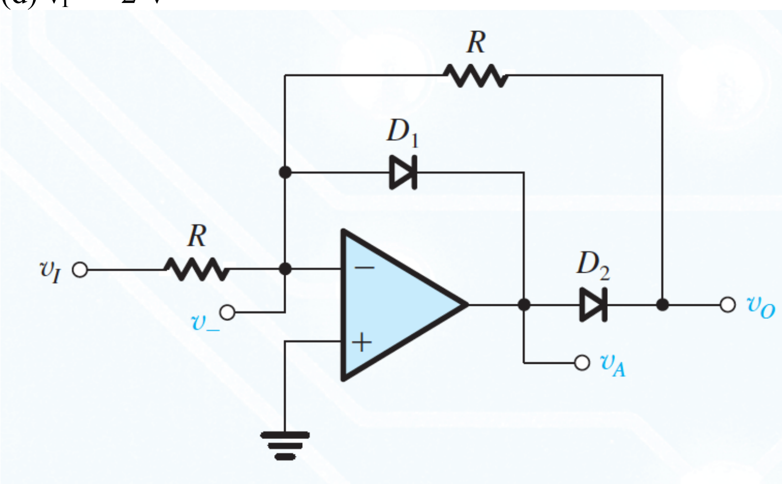


Figure P4.84

Problem 11

Sketch the transfer characteristic v_O versus v_I for the limiter circuits shown in Fig. P4.85. All diodes begin conducting at a forward voltage drop of 0.5 V and have voltage drops of 0.7 V when conducting a current $i_D \geq 1$ mA

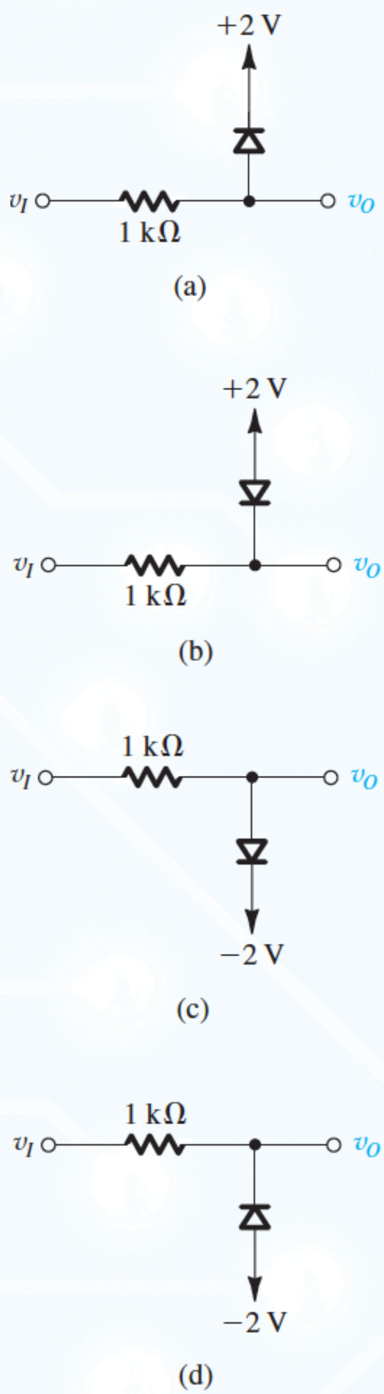


Figure P4.85