Fall 2009

EE40 Homework #9

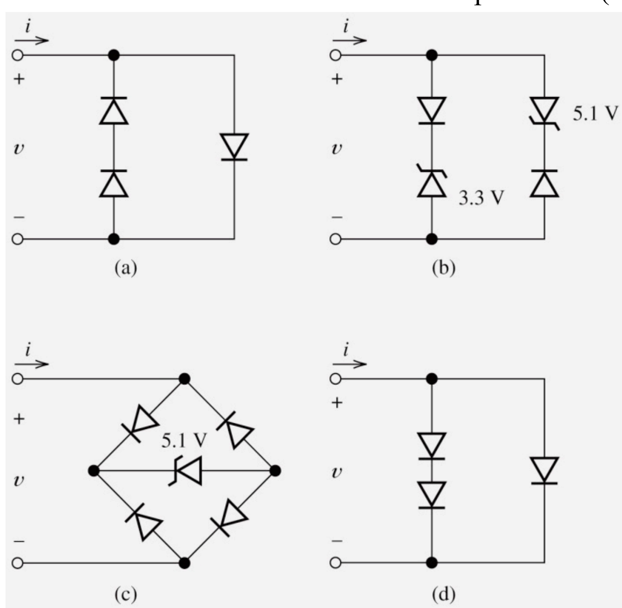
Due Nov 12 (Thursday), 12:00 noon in Cory 240

Reading Assignments

Chapter 10 of Hambley

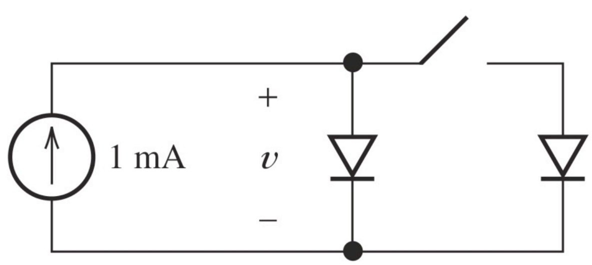
Problem 1: I-V of Diodes (Hambley P10.7)

Sketch i vs. v to scale for the circuits shown. The reverse-breakdown voltages of the Zener diodes are shown. Assume voltages of 0.6 V for all diodes, including the Zener diodes, when current flows in the forward direction.
Suggestion: Do the simpler exercises in Problem 10.6 as a warm-up exercise (but that will not be graded).



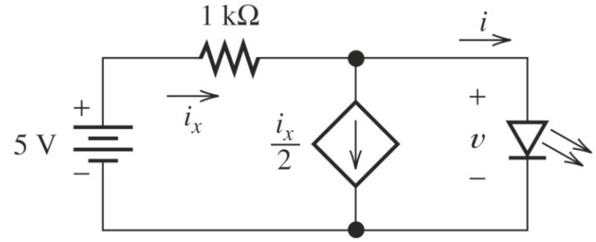
Problem 2: Ideality Factor of Diodes (Hambley P10.13)

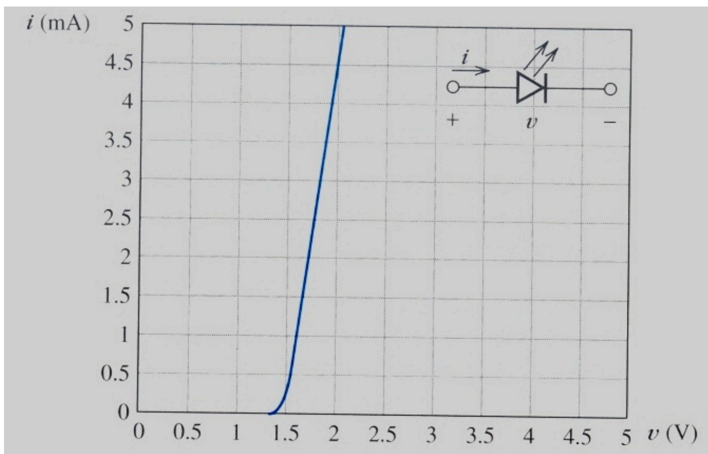
The diodes shown in the figure are identical and have $n = 1$. The temperature of the diodes is constant at 300 K. Before the switch is closed, the voltage v is 600 mV. Find v after the switch is closed.
Repeat for $n = 2$.



Problem 3: Load-line Analysis of LED (Hambley P10.23)

Determine the values of i and v for the circuit shown. The diode (LED) has the characteristic shown in the figure.
Hint: Find the Thévenin equivalent of the supply circuit first.





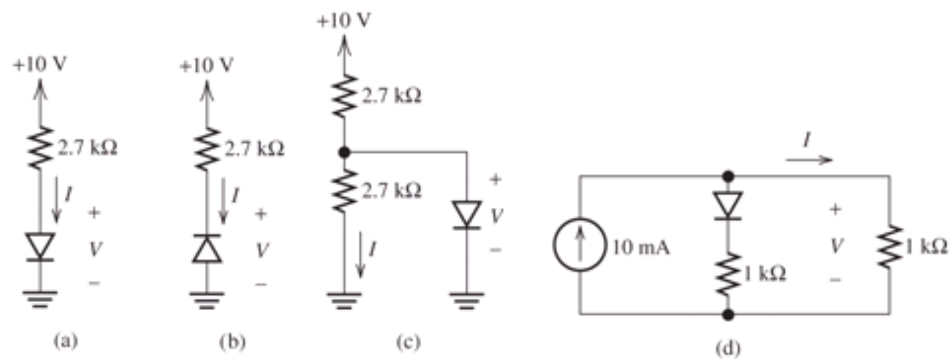
(b) Volt – ampere characteristic of a light-emitting diode (LED).

Problem 4: Voltage Regulator Design with Zener Diode (Hambley P10.29)

Design a voltage-regulator circuit to provide a constant voltage of 5 V to a load from a variable supply voltage. The load current varies from 0 to 100 mA, and the source voltage varies from 8 to 10 V. Draw the circuit diagram of your regulator, and specify the value of each component. Also, find the worst-case (maximum) power dissipated in each component in your regulator.
You may assume that ideal Zener diodes are available. Resistors of any value may be specified. Try to use good judgment in your design.

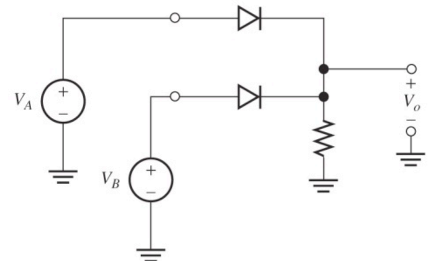
Problem 5: Ideal Diode Model – Simple exercise (Hambley P10.36)

Find the values of I and V for the circuits shown. Assume that the diodes are ideal.

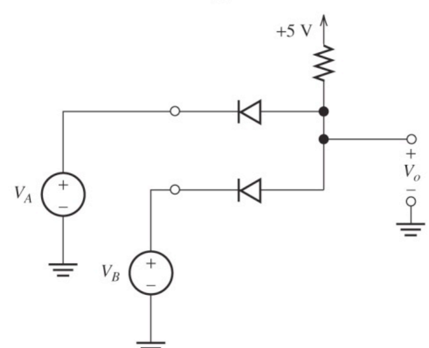


Problem 6: Ideal Diode Model – Logic Gates (Hambley P10.40)

Each of the circuits in the figure is a type of logic gate. Assume that the diodes are ideal. The voltages V_A and V_B independently have values of either logic 0 (0 V) or logic 1 (5 V). For which of the four combinations of input voltages is the output high (logic 1)? What type of logic gate is this?



(a)



(b)

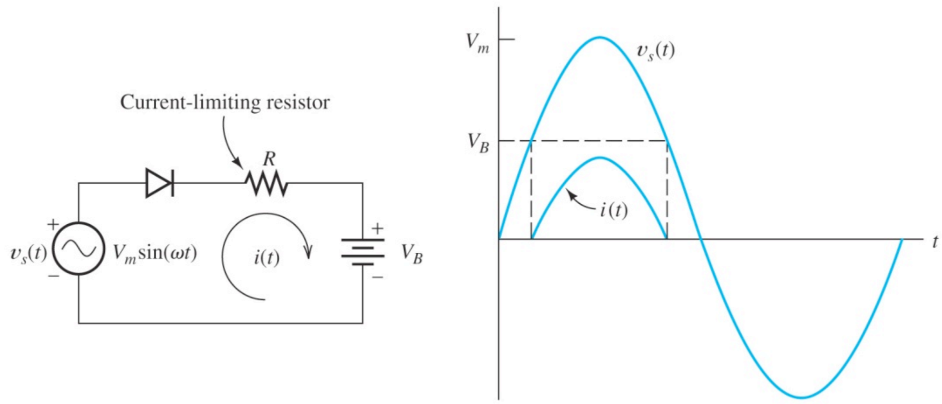
Problem 7: Battery Charging Circuit (Hambley P10.59)

Consider the battery-charging circuit shown in the figure. The diode is ideal.

a) Sketch the current $i(t)$ to scale versus time. Label significant points on the horizontal and vertical axes.

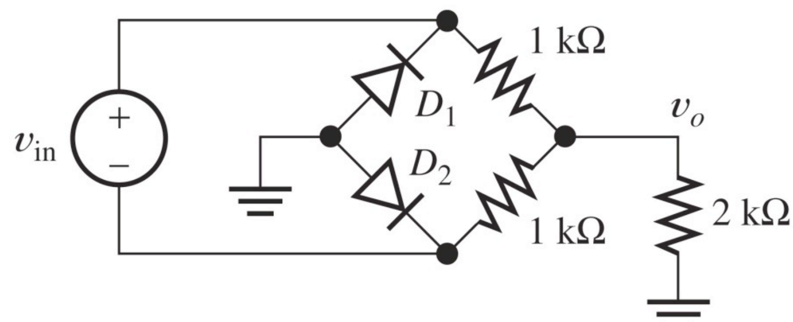
b) Determine the average charging current for the battery. (Hint: the average current is the charge that flows through the battery in one cycle, divided by the period.)

$$v_s(t) = 20\text{ V} \cdot \sin(200\pi t), \qquad R = 80\ \Omega, \qquad V_B = 12\text{ V}$$



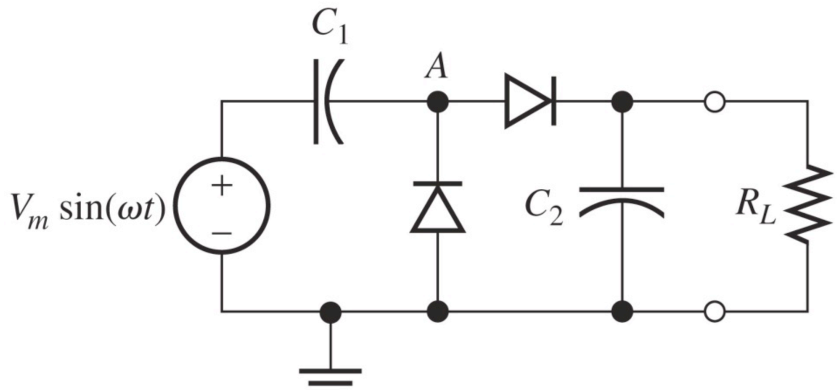
Problem 8: Wave Shaping (Hambley P10.66)

Sketch the transfer characteristic (v_o vs. v_{in}) to scale for the circuit shown in the figure. Allow v_{in} to range from -5 V to +5 V and assume that the diodes are ideal.



Problem 9: Voltage Doubler (Hambley P10.71)

Consider the circuit shown. The capacitors are very large, so they discharge only a very small amount per cycle. (Thus, no AC voltage appears across the capacitors, and the AC input plus the DC voltage of C_1 must appear at point A.) Sketch the voltage at point A versus time. Find the voltage across the load. Why is this called a voltage doubler? What is the peak reverse voltage across each diode?



Problem 10: Small-Signal Equivalent Circuit (Hambley P10.77, P10.80)

a) A certain diode has $I_{DQ} = 4$ mA and $i_d(t) = 0.5\cos(200\pi t)$ mA. Find an expression for $i_D(t)$, and sketch it to scale versus time.

b) With what should we replace a DC current source in a small-signal AC equivalent circuit? Justify your answer.