Design & Simulate 8

ECE2204 CRN:82929

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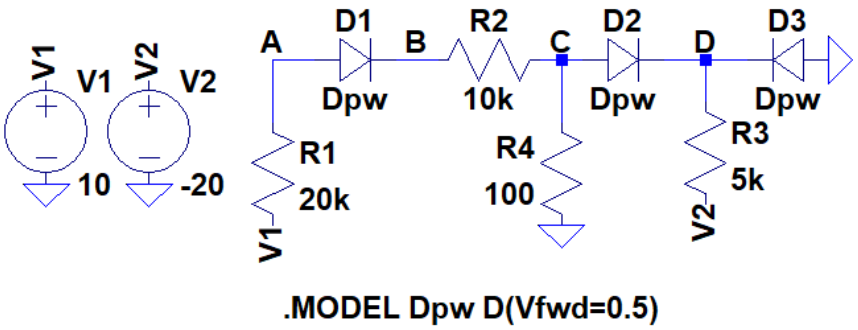
Problem 8.2-11.a.1:

The circuit was a random circuit I threw together in LTSpice.

Design

Using the circuit displayed below, determine the current flowing through D_1, D_2, D_3 and the voltage at points A, B, C, and D. Assume $V_\gamma = 0.5V$.



Assume all diodes are on.

$V_D = -0.5$ $V_A = 10V$, and $V_B = V_C = 0$.

$\frac{10V-0.5V-C}{10k\Omega} = I_{D2} + \frac{-20V-V_C}{5k\Omega}$

As V_C is assumed to be 0. $I_{D2} = 4.95mA$

$V_B = 9.5V\frac{20k\Omega}{10k\Omega} = 3.16V$

$V_A = V_B + 0.5V = 3.66V$

$I_{D1} = \frac{10V-3.66V}{20k\Omega} = 0.317mA$

$I_{D1} = \frac{0-V_C}{100\Omega} + I_{D2}$

$I_{D2} = 0.317mA$

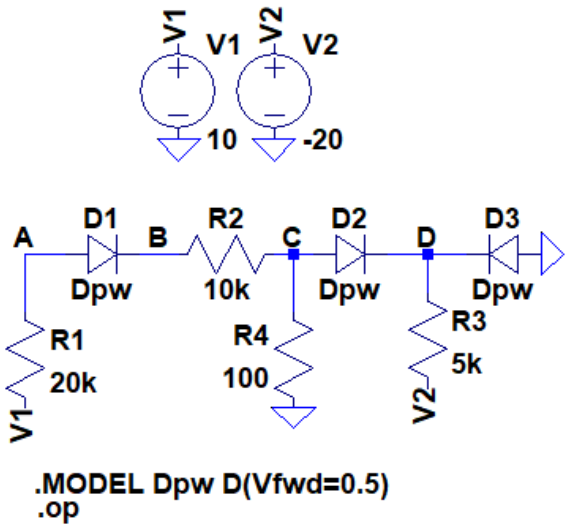
$I_{D2} + I_{D3} = \frac{V_D+20V}{5k\Omega}$

$I_{D3} = 3.583mA$

$V_A = 3.66V, V_B = 3.16V, V_C = 0V, V_D = -0.5V, I_{D1} = 0.317mA, I_{D2} = 0.317mA, I_{D3} = 3.583A$

Validation

LTSpice Implementation (values within $< 1\%$)



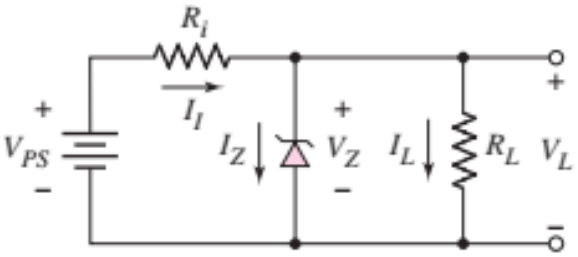
V(a):	3.66666	voltage
V(v1):	10	voltage
V(d):	-0.500004	voltage
V(v2):	-20	voltage
V(b):	3.16666	voltage
V(c):	-3.2666e-006	voltage
I(D3):	0.0035833	device_current
I(D2):	0.000316699	device_current
I(D1):	0.000316667	device_current
I(R4):	3.2666e-008	device_current
I(R2):	-0.000316667	device_current
I(R3):	0.0039	device_current
I(R1):	-0.000316667	device_current
I(V2):	0.0039	device_current
I(V1):	-0.000316667	device_current

Problem 8.2-5.b.1:

Derived by swapping the independent/dependent state of P_Z and $I_L(\max)$ and by changing the values.

Design

Design a voltage regulator using the circuit shown below. The voltage regulator is to power a car radio at $V_L = 10V$ from an automobile battery whose voltage may vary between 14 and $19V$. The current in the radio will vary between 0 (off) to some unknown $I_L(\max)$ at full volume. The Zener diode has a maximum power rating of $P_Z(\max) = 1W$.



$$V_Z = V_{\text{radio}} = 2.5V \tag{1}$$

$$I_Z(\max) = \frac{P_Z}{V_Z} = \frac{1W}{10V} = 0.1A \tag{2}$$

$$I_Z(\max) = \frac{I_L(\max)[V_{PS}(\max) - V_Z] - I_L(\min)[V_{PS}(\min)]}{V_{PS}(\min) - 0.9V_Z - 0.1V_{PS}(\max)} \tag{3}$$

$$\implies I_L(\max) = \frac{I_Z(\max)[V_{PS}(\min) - 0.9V_Z - 0.1V_{PS}(\max)] + I_L(\min)[V_{PS}(\min)]}{V_{PS}(\max) - V_Z} \tag{4}$$

$$= \frac{0.1A[14V - 0.9 \times 10V - 0.1 \times 19V]}{19V - 10V} \tag{5}$$

$$= 34.44mA \tag{6}$$

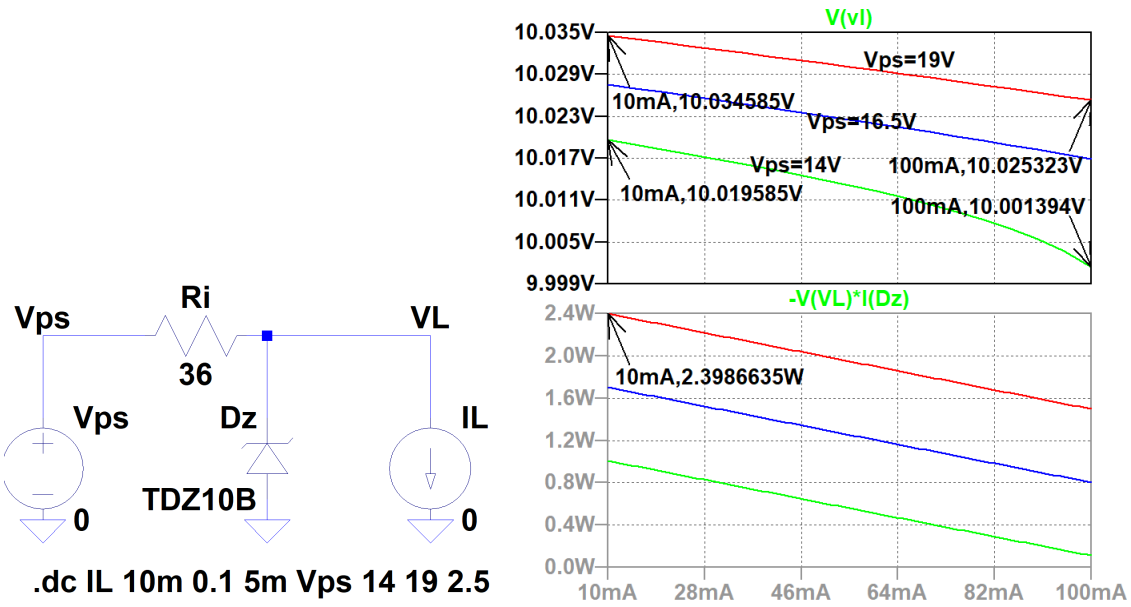
$$R_i = \frac{V_{PS}(\max) - V_Z}{I_Z(\max) + I_L(\min)} = \frac{19V - 10V}{0.1A + 0} = 90\Omega \tag{7}$$

$$P_{R_i}(\max) = \frac{(V_{PS}(\max) - V_Z)^2}{R_i} = \frac{(19V - 10V)^2}{90\Omega} = 0.9W \tag{8}$$

$$I_Z(min) = \frac{V_{PS}(\min) - V_Z}{R_i} - I_L(\max) = \frac{14V - 10V}{90\Omega} - 34.44mA = 10mA \tag{9}$$

Validation

LTSpice Implementation



$Err_P = \frac{|2.5-2.39|}{2.5} = 0.044 = 4.4\%$ High error is due inefficiencies in the circuit.

This assignment should demonstrate a basic understanding of manipulating zener diode voltage regulator circuits and solving multiple diode circuits.

I have neither given nor received unauthorized assistance on this assignment.