Faculty of Science, Engineering and Technology

Swinburne University of Technology

EEE20004 : Analogue Electronics 1

Tutorial 1 : Diodes.

1. Consider the circuit shown in Figure 1. Determine the diode current I_D and diode voltage V_D for (a) $V_\gamma = 0.6$ V and (b) $V_\gamma = 0.7$ V.

(Problem 1.42 of text : (a) $I_D = 0$, $V_D = 0.50$ V (b) $I_D = 0$, $V_D = 0.50$ V)

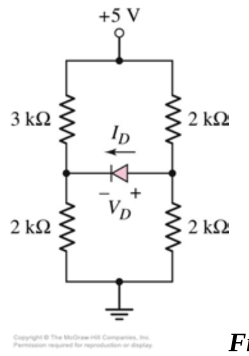

Figure 1 (Fig. P1.42 of text)

2. The cut-in voltage of the diode shown in the circuit in Figure 2 is $V_\gamma = 0.7$ V. The diode is to remain biased "on" for a power supply voltage in the range $5 \leq V_{PS} \leq 10$ V. The minimum diode current is to be $I_D(\text{min}) = 2$ mA. The maximum power dissipated in the diode is to be no more than 10 mW. Determine appropriate values of R_1 and R_2.

(Problem 1.43 of text : $R_1 = 0.41$ kΩ, $R_2 = 82.5$ Ω)

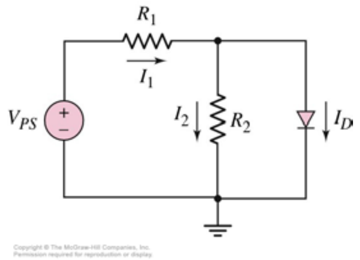

Figure 2 (Fig. P1.43 of text)

3. The diode cut-in voltages is $V_\gamma = 0.7$ V in the four circuits shown in Figure 3. Find I and V_O in each of the circuits.

(Problem 1.44 of text : (a) 0.215 mA, 0.7 V(b) 0.2325 mA, -0.35 V (c) 0.372 mA, 0.14 V(d) 0 A, -5 V)

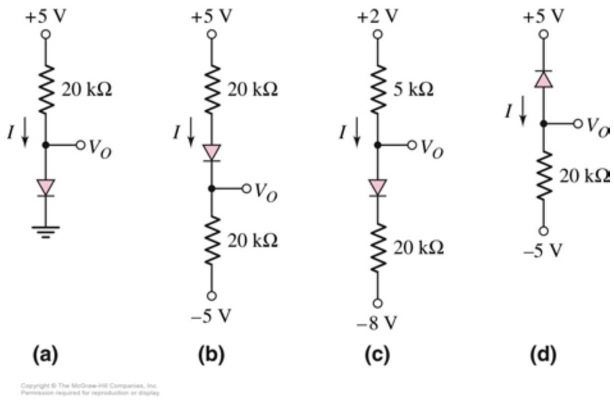

Figure 3 (Fig. P1.44 of text)

4. Assume each diode in the circuit of Figure 4 has a cut-in voltage of $V_\gamma = 0.65$ V.

(a) The input voltage $V_I = 5$ V. Determine the value of R_1 required such that I_{D1} is one half the value of I_{D2}. What are the values of I_{D1} and I_{D2}?

(b) If $V_I = 8$ V and $R_1 = 2$ kΩ, determine I_{D1} and I_{D2}.

(Problem 1.47 of text : (a) $R_1 = 2.35$ kΩ, $I_{D1} = 0.65$ mA, $I_{D2} = 1.30$ mA (b) $I_{D1} = 2.375$ mA, $I_{D2} = 3.025$ mA)

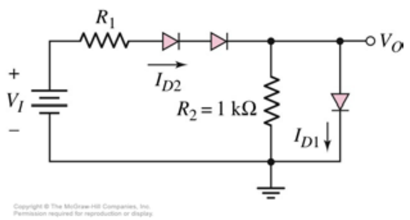

Figure 4 (Fig. P1.47 of text)

5. The diode in the circuit shown in Figure 5 is biased with a constant current source I. A sinusoidal signal v_s is coupled through R_S and C. Assume that C is large so that it acts as a short circuit to the signal.

(a) Show that the sinusoidal component of the diode voltage is given by

$$v_o = v_s\left(\frac{V_T}{V_T + IR_S}\right)$$

(b) If $R_S = 260\ \Omega$, find v_o/v_s for I = 1 mA, and I = 0.01 mA. Assume $V_T = 26$ mV.

(Problem 1.49 of text : (b) I = 1 mA, $v_o/v_s = 0.0909$; I = 0.01 mA, $v_o/v_s = 0.909$)

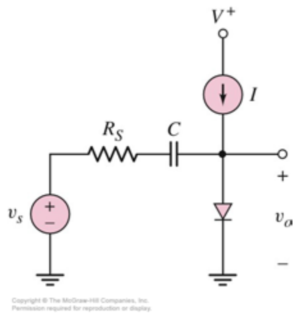

Figure 5 (Fig. P1.49 of text)

6. Consider the Zener diode circuit shown in Figure 6. The Zener breakdown voltage is $V_Z = 5.6$ V at $I_Z = 0.1$ mA, and the incremental Zener resistance $r_z = 10\ \Omega$.

(a) Determine V_O with no load ($R_L = \infty$).

(b) Find the change in the output voltage if V_{PS} changes by ±1 V.

(c) Find V_O if $V_{PS} = 10$ V and $R_L = 2$ kΩ.

(Problem 1.53 of text : (a) $V_O = 5.685$ V (b) $\Delta V_O = 0.0392$ V (c) $V_O = 5.658$ V)

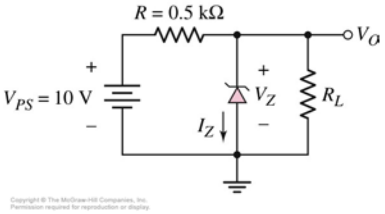

Figure 6 (Fig. P1.53 of text)

7. Consider the Zener diode circuit shown in Figure 6. The Zener breakdown voltage is $V_Z = 6.8$ V at $I_Z = 0.1$ mA, and the incremental Zener resistance $r_z = 20\ \Omega$.

(a) Determine V_O with no load ($R_L = \infty$).

(b) Find the change in the output voltage when a load resistance $R_L = 1$ kΩ is connected.

(Problem 1.55 of text : (a) $V_O = 6.921$ V (b) $\Delta V_O = -0.13$ V)

8. Consider the voltage regulator circuit shown in Figure 7. 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 change of 1 V in V_{CC} is

$$\frac{\Delta V_O}{\Delta V_{CC}} = \frac{\eta V_T}{V_{CC} + \eta V_T - 0.7} \quad \textit{where } V_T \textit{ is the thermal voltage.}$$

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

(b) Generalise 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 $V_O = 0.7m$ V).

(c) Calculate the value of line regulation for the case $V_{CC} = 10$ V (nominally) and (i) m =1 and (ii) m= 3. Use $\eta = 2$.

((c) (i) 5.35 mV/V (ii) 18.63 mV/V)

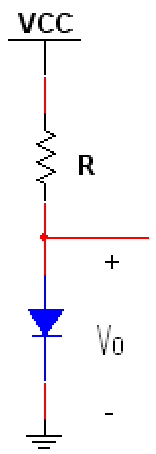

Figure 7