電子學（一）第一次期中考 Chapter 1&2　　2018.10.22　　10:20-12:10am

1. (10%) Please explain (a) p-type semiconductor. (b) the relation of conductivity and bandgap energy.

2. (10%) Consider silicon at T=300 K. Assume the hole concentration is given by $p = 10^{16} \cdot e^{-x/Lp}\ \mathrm{cm}^{-3}$, where $Lp = 10^{-3}\ cm$. Assume $D_p = 10\ \mathrm{cm}^2/\mathrm{s}$. Calculate the hole diffusion current density at (a) x = 0 and (b) $x = 10^{-3}\ cm$.

3. (14%) The diode in the circuit shown in Figure 1 has a reverse-saturation current of $I_S = 10^{-13}$ A. (a) Assume the cut-in voltage of the diode is $V_\gamma = 0.7$ V, determine the approximate diode voltage and current using piecewise linear model (5%). (b) what is the exact numbers of diode voltage and current (9%)?

4. (15%) Consider the full-wave rectifier in Figure 2. Assume that turn-on voltage $V_\gamma = 0.7$ V, the input frequency is 60 Hz, and the output resistance is $R_L = 125\ \Omega$. A filter capacitor is connected in parallel with R_L. The magnitude of the peak output voltage is to be 15 V and the ripple voltage is to be 0.3 V. (a) Determine the required amplitude of v_S. (b) Determine the required filter capacitance value. (c) What is the PIV rating of the diodes?

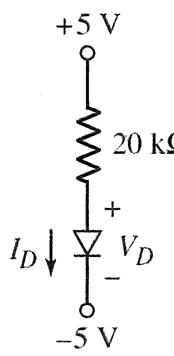


Figure 1

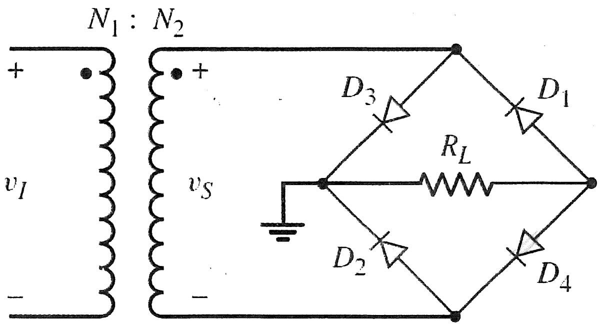


Figure 2

5. (21%) A voltage regulator is to have nominal output voltage of 10 V. The input power supply has a nominal output of $V_{PS} = 20$ V and can vary by ± 25 %. The output load current is to vary between $I_L = 0 \sim 20$ mA. (a) Ignore Zener resistance (r_Z) and consider the Zener diode as an ideal Zener diode with $V_Z = 10$ V. If the minimum Zener current is to be $I_Z = 5$ mA, determine the required R_i. (b) If the specified Zener diode has a rating of 1 W, has a 10 V voltage drop at $I_Z = 25$ mA, and has a Zener resistance of $r_Z = 5\ \Omega$. Determine the maximum variation in output voltage. (c) Determine the percent source regulation (assume minimum load current).

6. (15%) Consider the circuit shown in Figure 4. Assume each diode cut-in voltage is $V_\gamma = 0.7$ V. (a) Determine I_{D1}, V_O and each diode status for $R_1 = 10$ kΩ, and $R_2 = 5$ kΩ. (b) Repeat part (a) for $R_1 = 5$ kΩ, and $R_2 = 10$ kΩ.

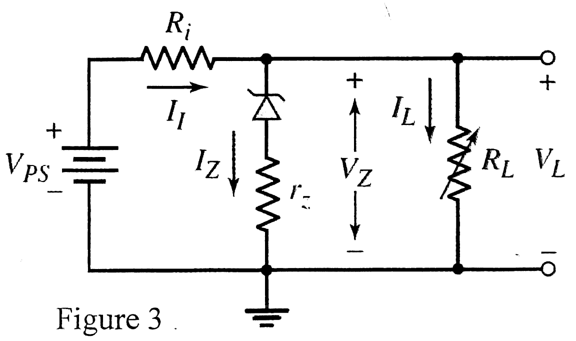


Figure 3

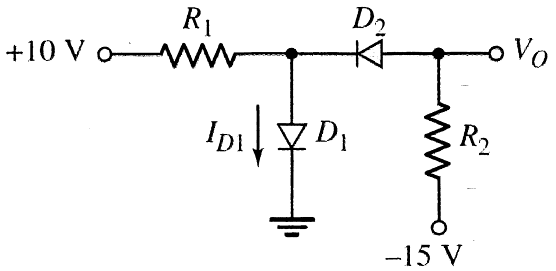


Figure 4

7. (15%) Sketch the steady-state output voltage v_O versus time for each circuit in Figure 5 with the input voltage given. Assume $V_\gamma = 0$ and RC time constant is large.

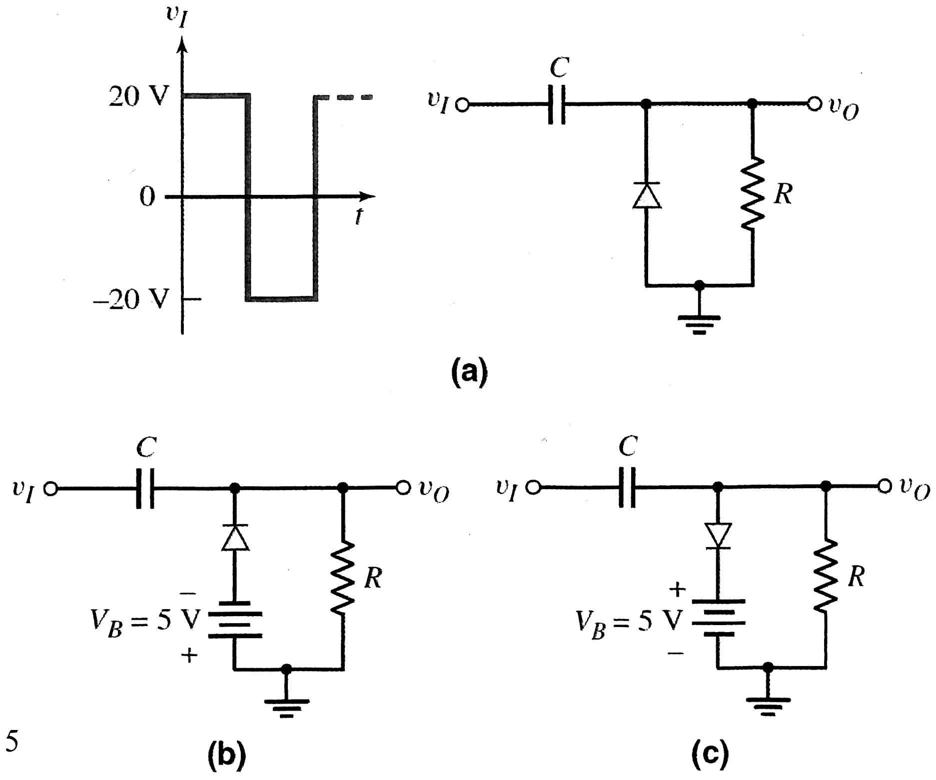


Figure 5

電子學(一) 第一次期中考 Chapter 1 & 2

NO.

DATE / /

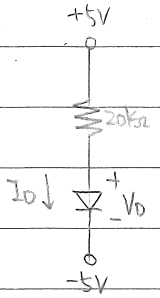
1. (a) P型半導體 (b) 導電度和能隙的關係

2. $T = 300°K$ $p = 10^6 e^{-x/L_p}$ where $L_p = 10^{-3}cm$ $D_p = 10cm^2/s$

(a) $x = 0$ $J_p = -eD_p\frac{dp}{dx} = -1.6\times10^{-19}\times10\times10^6e^0\times\frac{-1}{10^{-3}} = 1.6\times10^{-9}A/cm^2$

(b) $x = 10^{-3}$ $J_p = -eD_p\frac{dp}{dx} = -1.6\times10^{-19}\times10\times10^6e^1\times\frac{-1}{10^{-3}} = 4.35\times10^{-9}A/cm^2$ #

3.



$I_S = 10^{-13}A$ $V_\gamma = 0.7V$

(a) piecewise linear model

$I_D = (10-0.6)/20k = 0.47mA$

$V_D = (10-20k\times0.47m) = 0.6V$

(b) $I_D = \frac{10-V_D}{20k}$, $I_D = I_S(e^{\frac{V_D}{V_T}}-1)$

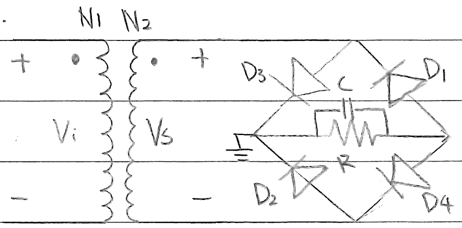
$V_D = V_T\ln(\frac{I_D}{I_S}-1)$

$V_D = 0.5V \Rightarrow I_D = 0.475mA \Rightarrow V_D = 0.5793V$

$V_D = 0.5793V \Rightarrow I_D = 0.471mA \Rightarrow V_D = 0.579V$ $V_D = 0.579V$

$I_D = 0.471mA$ #

4.



$V_\gamma = 0.7V$ $F = 60Hz$ $R_L = 125\Omega$

$V_{op} = 15V$ $V_r = 0.3V$

(a) $15 = V_S - 0.7\times2 \Rightarrow V_S = 16.4V$

$V_S(t) = 16.4\sin377t$

(b) $0.3 = \frac{15}{2\times60\times125\times C} \Rightarrow C = \frac{15}{2\times60\times125\times0.3} = 3.33mF$

(c) $PIV = 0.7+15 = 15.7V$ #

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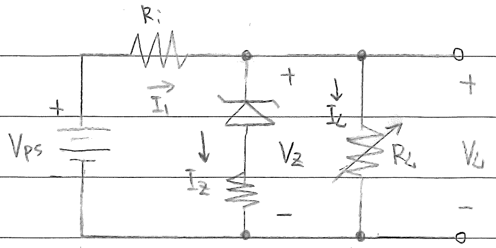
5.



$V_{PS} = 20V \pm 25\%$ (15~25)

$I_L = 0 \sim 20mA$

(a) $V_Z = 10V$ $I_{Z(min)} = 5mA$

$R_i = \frac{15-10}{5m+20m} = \frac{5}{25m} = 0.2k\Omega$

(b) $10 = V_{Z_i} + 5 \times 125m$

$V_{Z_i} = 9.845V$

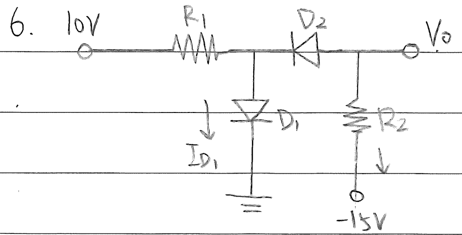
$V_{PS} = 15V$ $I_Z = \frac{15-9.845}{240+5} = 20.9mA$ $V_Z = 9.845 + 5 \times 20.9m = 9.98V$

$V_{PS} = 25V$ $I_Z = \frac{25-9.845}{240+5} = 61.9mA$ $V_Z = 9.845 + 61.9m \times 5 = 10.183V$

$10.183 - 9.98 = 0.203V$

(c) percent source $= \frac{10-10.163}{24-16} \times 100\% = \frac{0.163}{8} \times 100\% = 2.03\%$ #

6.



(a) $R_1 = 10k\Omega$ $R_2 = 5k\Omega$

設 D_1 on D_2 on

$I_{R_1} = \frac{10-0.7}{10k} = 0.93mA$

$I_{R_2} = \frac{1.4-(-15)}{5k} = 3.28mA$

$V_{D_2} = -15 + 3.28m \times 5k - 0.7 = -2.1$ (不合)

D_1 on D_2 off

$I_{R_1} = 0.93mA$ $V_{D_2} = -15 - 0.7 < 0$ (合)

$V_o = -15V$

(b) $R_1 = 5k\Omega$ $R_2 = 10k\Omega$

設 D_1 on D_2 on

$I_{R_1} = 1.86mA$ $I_{R_2} = 1.64mA$

$I_{D_2} = -(1.86m - 1.64m) = -1.22mA$ (不合)

設 D_1 on D_2 off

$I_{R_1} = 1.86mA$ $I_{R_2} = 0mA$

$V_o = -15V$ #

7. 很簡單