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 $p = 10^{16} \cdot e^{-x/Lp}$ cm^{-3}, where $Lp = 10^{-3}\ cm$. Assume $D_p = 10\ \text{cm}^2/\text{s}$. 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?

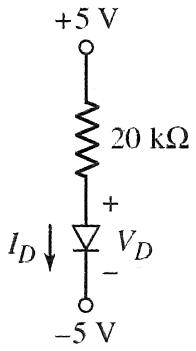

Figure 1

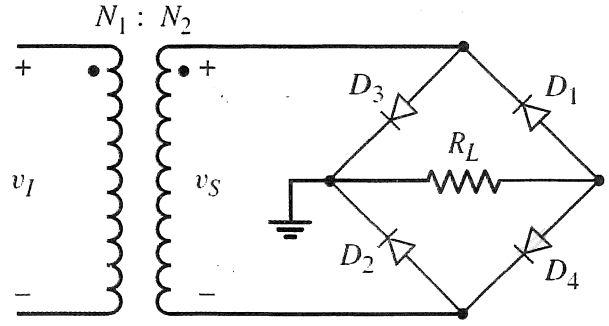

Figure 2

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.

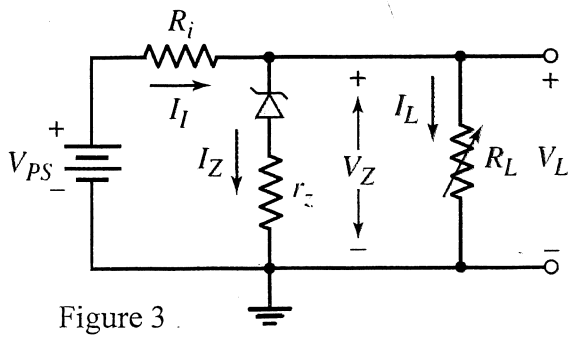

Figure 3

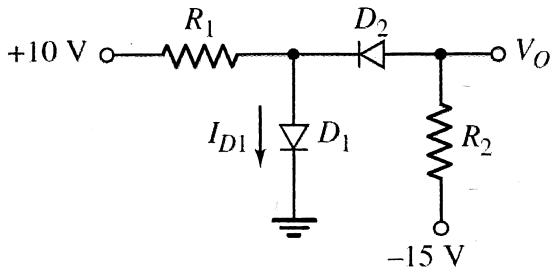

Figure 4

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.

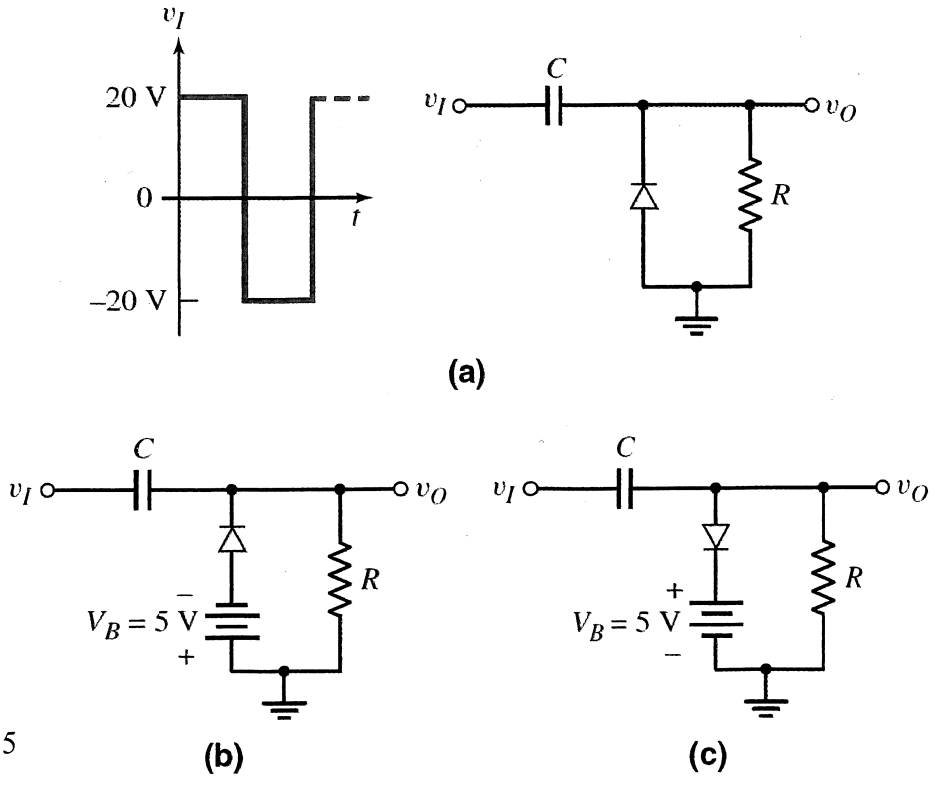

Figure 5