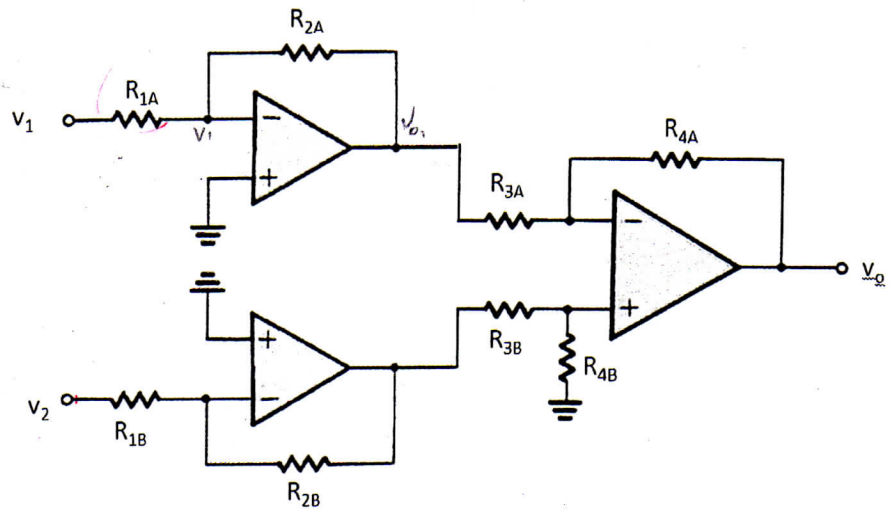
991 Microelectronic Circuits I (Midterm)

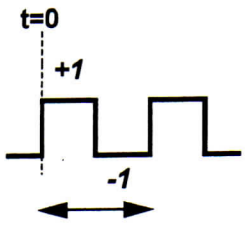
date: 2010/11/11 (Thur)
time:15:30 ~ 17:20

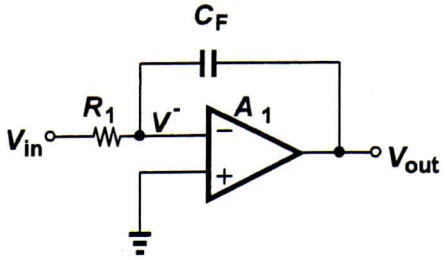
ps. 試題可帶回，可使用計算機。

1. Given that $R_{1A} = R_{1B} = 10\ K\Omega$, $R_{2A} = R_{2B} = 50\ K\Omega$, $R_{3A} = R_{3B} = 5\ K\Omega$, $R_{4A} = R_{4B} = 15\ K\Omega$.
   (1) Assume the opamps are ideal, find the common-mode gain and differential-mode gain of the circuit. [5%]
   (2) Assume the opamps have a finite open-loop gain of A_0, find the common-mode gain and differential-mode gain of the circuit. [10%]
   (3) If R_{1A} is 10.5 KΩ, repeat (1). [5%]
   (4) If R_{3A} is 5.5 KΩ, repeat (1). [5%]



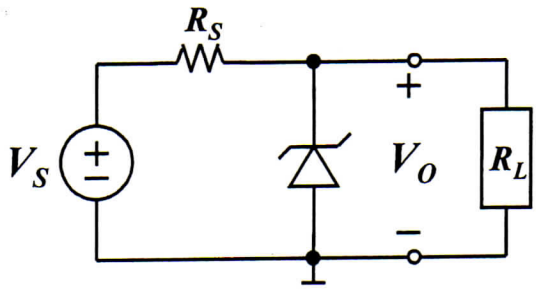
2. An integrator is implemented as follows. Note that $R_1 = 1K$ and $C_F = 1nF$. The maximum/minimum output of the op amp are 12V/-12V, respectively. Assume $V_{out}(t = 0) = 0$.
   (1) With such input waveform, please draw the output V_{out} and V^- waveform. Please label all of the transition voltage levels. [6%]
   (2) Now, the input voltage is scaled by a factor of 2 so that its high and low level are 2/-2V respectively. Repeat part (1). [6%]
   (3) For the rest of questions, let's assume the op amp has finite gain, A_1. Please derive its transfer function. $V_{out}(s) / V_{in}(s)$. You can still assume the bandwidth of the op amp is infinite. [6%]
   (4) If $A_1 = 10$, repeat part (1). [7%]





3. A p^+n junction is one in which the doping concentration in the p region is much greater than in the n region. In such a junction, the forward current is mostly due to hole injection across the junction. Show that $I \sim I_P = Aqn_i^2 \frac{D_P}{L_P N_D}(e^{\frac{V}{V_T}}-1)$. For the specific case in which $N_D = 10^{16}/cm^3$, $D_P = 10\ cm^2/s$, $L_P = 10\ \mu m$, and $A = 10^4\ \mu m^2$, find I_S and the voltage V obtained when I = 0.5 mA. Assume operation at 300K where $n_i = 1.5\times10^{10}/cm^3$. [10%]

4. In Figure shown below, the Zener diode is specified to have V_Z = 8V at I_Z = 10 mA, r_Z = 10 Ω, and I_{ZK} = 0.1 mA. The supply voltage (V_S) is 12 V, but can vary by ±1 V. R_S = 200 Ω.
   (1) If no load (R_L = infinite) and V_S is at the nominal value (12 V), find V_O. [4%]
   (2) Find the line regulation of this circuit. [4%]
   (3) Find the load regulation of this circuit. [4%]
   (4) If R_L = 4 KΩ and V_S = 12 V, find V_O. [4%]
   (5) What is the requirement on the value of R_L, for the circuit to operate properly across the possible range of V_S? [4%]



5. The rectifier is one of the most important applications for diode circuits. Using the constant-voltage-drop (V_D) diode model, please answer the following questions:
   (1) Please draw the bridge rectifier circuit. [2%]
   (2) If the input waveform (after transformer) is shown as Fig. 1, please draw the output waveform. [2%]
   (3) Please find the peak-inverse-voltage and find the peak diode current of diodes in the bridge rectifier. [4%]
   (4) Assume $V_D \approx 0.7\,\text{V}$, and the load resistance $R = 100\Omega$. If the input sinusoid with VP = 12 V, please calculate the quantities of (3). [4%]
   (5) If the input waveform fluctuates by as much as 10%, please find the required PIV of the diodes (Consider the safety factor 50%). [2%]

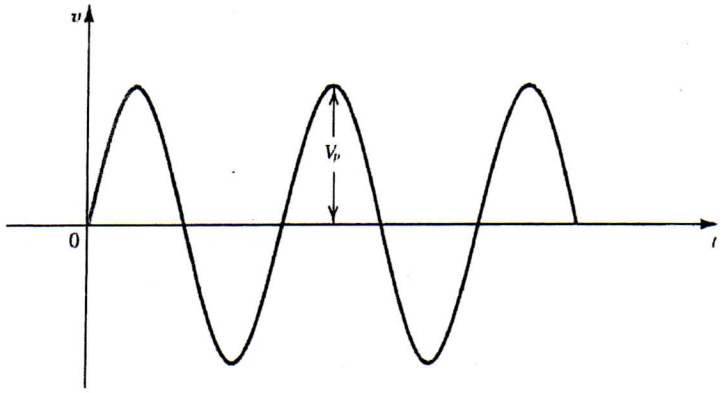


Figure 1

6. The Fig. 2 shows a diode rectifier circuit. Assume the constant-voltage-drop diode model and the input waveform is the same as Fig. 1. Please draw the output voltage waveform of C1 and C2. [6%]

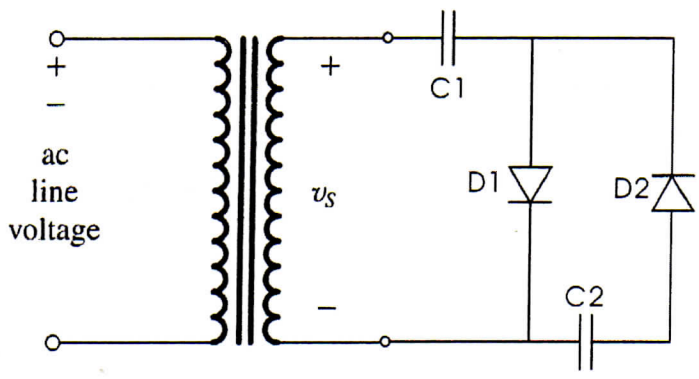


Figure 2