國立中央大學 110 學年度碩士班考試入學試題

所別： 光電類　　共 2 頁　第 1 頁

科目： 電子學

本科考試可使用計算器，廠牌、功能不拘　　＊請在答案卷(卡)內作答

本試題共四大題計算題，無計算過程不予計分。答案請標示單位。

1. Figure 1 shows an op-amp circuit for 4-bit digital-to-analog converter (DAC), which can convert a 4-bit digital word $a_3a_2a_1a_0$ to an analog output. The value of each bit is represented by a corresponding switch. That is, if a_0 is 1 then switch S_0 connects to the +5-V power supply, while if a_0 is 0 then switch S_0 connects to ground.
   (a) If the output voltage v_o ranges from 0 to -32 V, find R_1, R_2 and R_3. (15%)
   (b) Based on this circuit, please design an op-amp circuit which can convert a 4-bit digital word to an analog output ranging from 0 to 12 V. Any reasonable scheme is allowed. (5%)

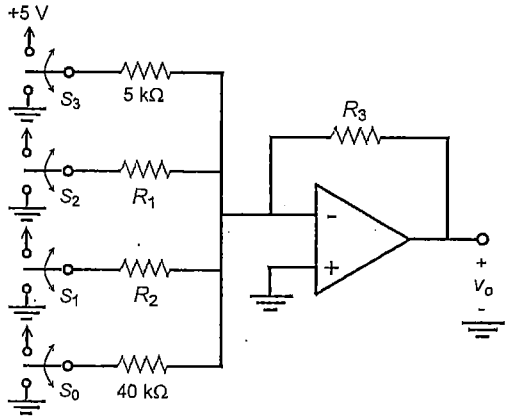

Fig. 1

2. For an active filter shown in Figure 2, please answer the following questions:
   (a) Determine the transfer function $\mathbf{H}(s) = \mathbf{V}o/\mathbf{V}s$, where $s = j\omega$. (5%)
   (b) Show that this active filter is a band-pass filter. (3%)
   (c) For $R_1 = 1$ kΩ and $C_1 = 0.1$ μF, find R_2 and C_2 so that the band-pass filter has a resonant frequency at 1600 Hz and unity peak gain. (6%)
   (d) Draw the Bode plot for the magnitude of the band-pass filter in (c). (5%).
   (e) For the band-pass filter in (c), find the gain of the resonance peak. (3%)
   (f) Find R_2 and C_2 which can increase the peak gain to 10. (8%)

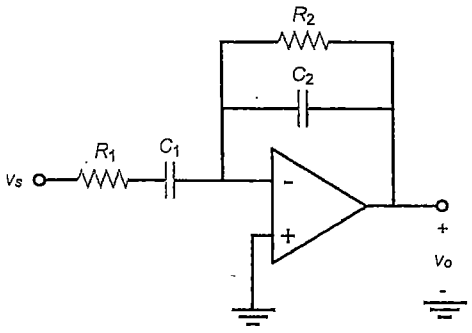

Fig. 2

注意:背面有試題

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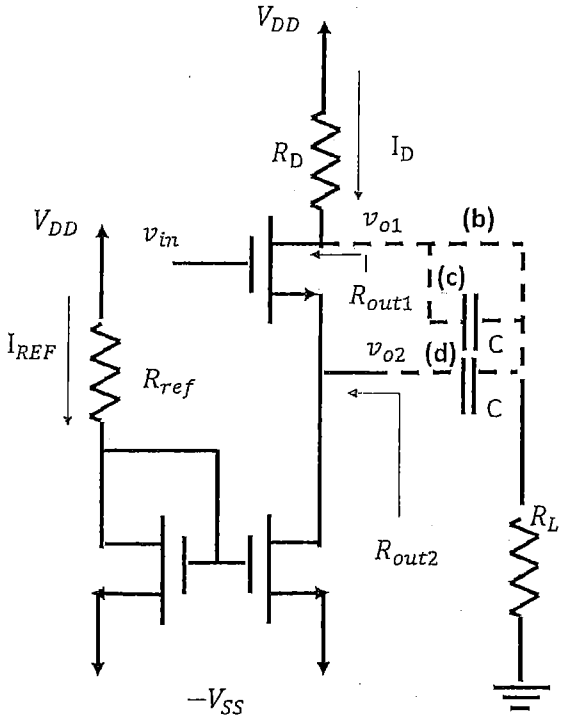
3. (25%) For the following circuit, 3 identical nMOSFETs are used with Vt = 1 V, $k_n = \mu_n C_{ox}(W/L) = 1$ mA/V^2, $V_A = 100$V, $R_{ref} = 3.5$ kΩ, and $V_{DD} = V_{SS} = 5$ V.

5% (a) Please find the reference current (I_{REF}) for the current mirror.

5% (b) If a load 2 kΩ is connected at the drain, please find $|A_V|=|(v_{o1}/v_{in})|$ and output resistance (R_{out1}) if R_D=2 kΩ.

5% (c) If now the load 2 kΩ is connected at the drain with a capacitor C, what is the minimal C to operate this circuit at $f_{L\,(3dB)} < 1$ kHz. You can assume this is the only capacitor seem from this circuit.

10% (d) if now the load 5kΩ is moved from the drain to the source with a capacitor. What are the $|A_V|=|(v_{o2}/v_{in})|$ and output resistor (R_{out})?



4. (25%) A BJT differential pair is shown as below. Two synchronized sinusoidal waves (vsin+ and vsin-) All BJTs are assumed to be the same with β=100 and Early voltage $V_A = \infty$. Please evaluate the following at room temperature (V_T=25mV):

(5%) (a) What is the conducting current (I_{E1} and I_{E2}) for the BJT differential pair?

(5%) (b) Since R1 and R2 are different, what is the resulted offset voltage (V_{OS}) at input? (hints: you can estimate this by dividing the output offset by the differential gain, A_d).

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(15%) (c) Please plot the corresponding output waveforms at v_{c1} and v_{c2} if the synchronized sinusoidal waves are both 10 kHz with amplitude 1mV. You should note the polarity at base is opposite for Q1 and Q2. (hints: you can calculate the DC voltage at v_{c1} and v_{c2} and then calculate amplification at each side.) Assume that the current source is ideal with an infinite resistance.