

1. Suppose the solar irradiation Q_1 is higher than Q_2 . Draw the V - I characteristic curves of a silicon-based solar cell under the irradiations Q_1 and Q_2 .

(10 Points)

2. (a) An differential OPA circuit is shown in Fig. 1. OPA is ideal. Draw the waveform of output signal v_o if the input signal of the circuit is defined as $v_i = \sin 314t$ (volt). (波形圖請標明座標軸之刻度)

(10 Points)

- (b) Similarly, another OPA circuit is shown in the Fig 2, where all OPA and diodes are ideal. Draw the waveform of output signal v_o if the input signal of the circuit is given as $v_i = \sin 314t$ (volt). (波形圖請標明座標軸之刻度)

(10 Points)

- (c) The band-pass amplifier in Fig. 3 has $f_L = 150\text{Hz}$, $f_H = 180\text{Hz}$, and $A = 10$. If the input signal of amplifier is given by $v_i = \sum_{h=1}^{25} \frac{3}{h} \sin(314ht)$ (volt). Find the mathematic expression of the output signal.

(10 Points)

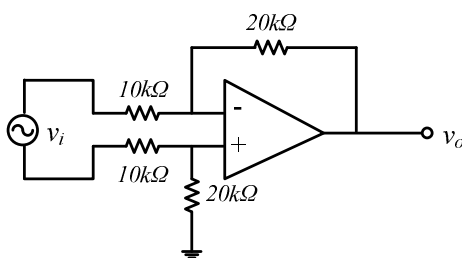


Fig. 1

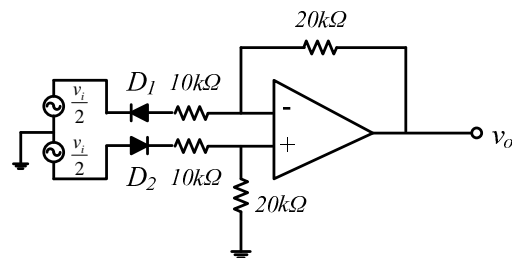


Fig. 2

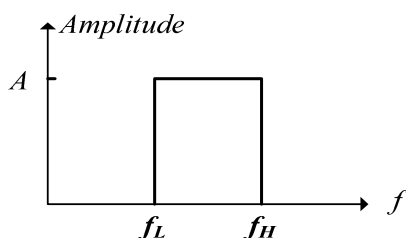


Fig. 3

3. Use the Feedback method to find the voltage gain V_o/V_s , the input resistance R_{in} , and the output resistance R_{out} of the inverting op amp configuration of Fig. 4. (assume the op amp has open-loop gain $\mu=10^4$, $R_{id}=100\text{ K}\Omega$, $R_{icm}\rightarrow\infty$, and $r_o=1\text{ K}\Omega$.) (10 Points)

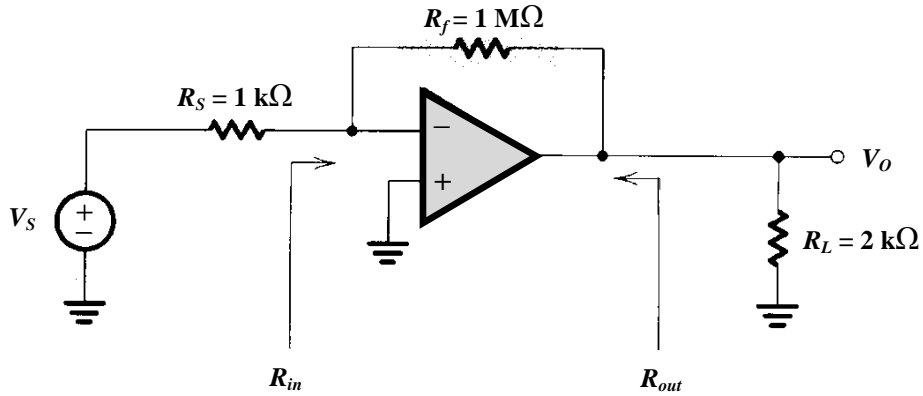


Fig. 4

4. For the circuits in Fig. 5(a)-(c), $\mu_n C_{ox}=2.5\ \mu\text{pC}_{ox}=20\ \mu\text{A}/\text{V}^2$, $|V_t|=1\text{V}$, neglect the channel-length modulation effect, $L=10\ \mu\text{m}$, and $W=30\ \mu\text{m}$, unless otherwise specified. Find the labeled currents (I_1, I_3, I_6) and voltages (V_2, V_4, V_5). (10 Points)

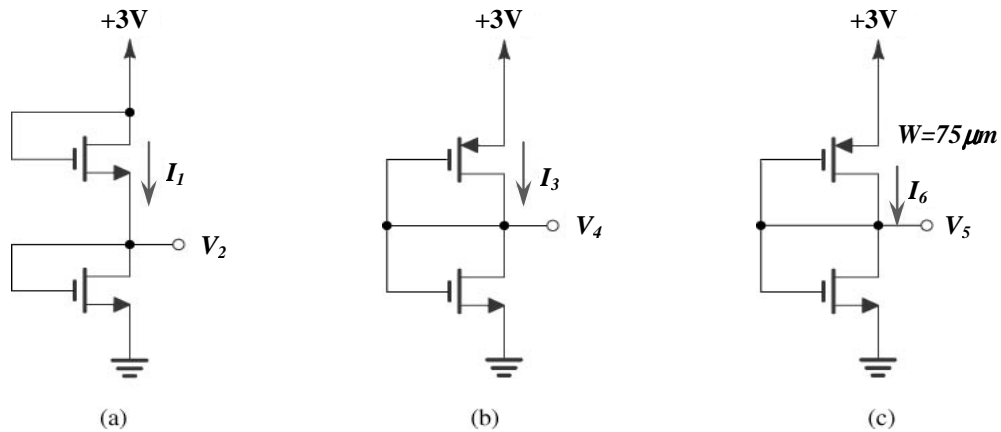


Fig. 5

5. The emitter follower in Fig. 6 is used to connect a source with $R_{sig}=10\text{ k}\Omega$ to a load $R_L=1\text{ k}\Omega$. The transistor is biased at $I=5\text{ mA}$, utilizes a resistance $R_B=40\text{ k}\Omega$, and has $\beta=100$ and $V_A=100\text{ V}$.

- Find R_{in} , G_v , G_{vo} , and R_{out} .
- What is the largest peak amplitude of an output sinusoid that can be used without the transistor cutting off?
- If in order to limit nonlinear distortion the base-emitter signal voltage is limited to 10 mV peak, what is the corresponding amplitude at the output?
- What will the overall voltage gain become if R_L is changed to $2\text{ k}\Omega$?

(20 Points)

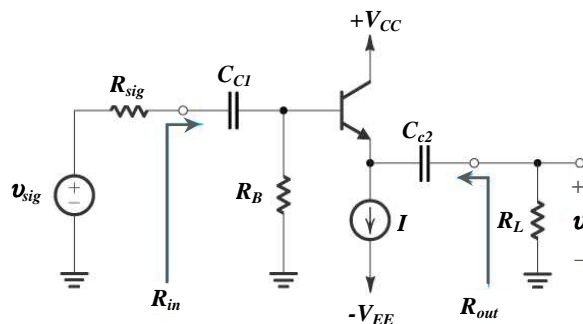


Fig. 6

6. Fig. 7 shows a cascode MOS mirror utilizing devices with $V_t=0.5\text{V}$, $\mu_n C_{ox}=387\mu\text{A}/\text{V}^2$, $V_A=5\text{V}/\mu\text{m}$, $W/L=3.6\mu\text{m}/0.36\mu\text{m}$, and $I_{REF}=100\mu\text{A}$. Find the minimum dc voltage required at the output and the output resistance.

(10 Points)

7. An active-loaded MOS differential amplifier of the type shown in Fig.8 is specified as follows: $(W/L)_n=100$, $(W/L)_p=200$, $\mu_p C_{ox}=0.2\text{mA}/\text{V}^2$, $V_{An}=|V_{Ap}|=20\text{V}$, $I=0.8\text{mA}$, $R_{SS}=25\text{k}\Omega$. Calculate G_m , R_o , A_d , $|A_{cm}|$, and $CMRR$.

(10 Points)

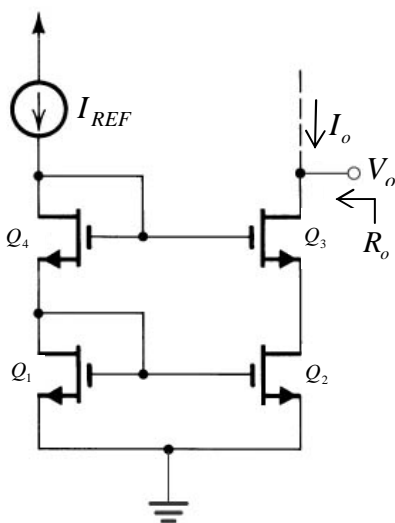


Fig. 7

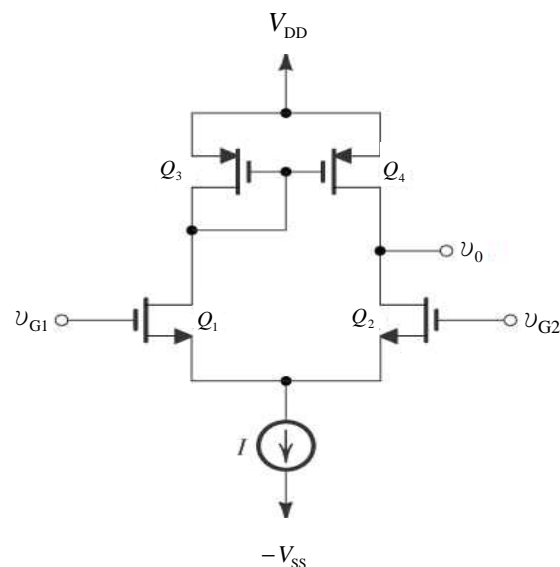


Fig. 8