

科目：電子學

適用：電機系

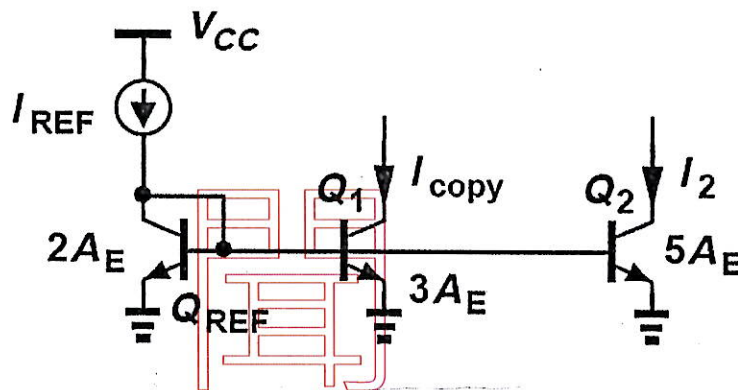
編號：341

考生注意：

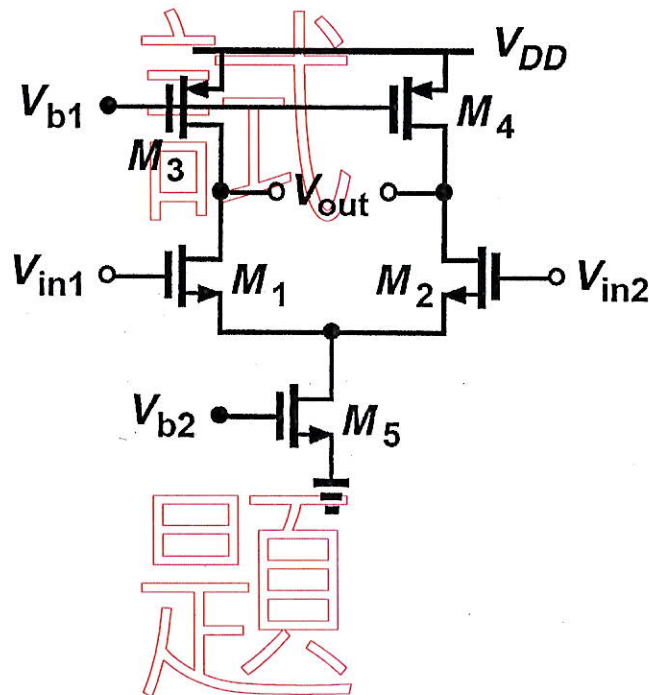
1. 依次序作答，只要標明題號，不必抄題。
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1. A PN junction has the following doping levels: $N_A = 5 \times 10^{16} \text{ cm}^{-3}$ and $N_D = 2 \times 10^{17} \text{ cm}^{-3}$, where N_A and N_D are the acceptor and donor density, respectively. Assume the intrinsic density $n_i = 10^{10} \text{ cm}^{-3}$.
 - (a) Determine the electron and hole densities in both side of the PN junction. [5%]
 - (b) Determine the junction's built-in potential (V_0). Use $V_T = 25 \text{ mV}$ and $\ln(10) \approx 2.3$ [5%]
2. All transistors shown in the current mirror below have the same value of β , and A_E is the emitter area of the transistor.
 - (a) If base current is neglected and I_{REF} is equal to 2mA, determine the value of I_{copy} . [5%]
 - (b) Taking base currents into account, derive I_{copy} in terms of I_{REF} . [5%]



3. Assuming the same (equilibrium) overdrive voltage for all of the MOS transistors and a power dissipation of 2 mW, design the differential pair shown below to provide a gain of 48. What are the (W/L) sizes of all the MOS? Assume $\lambda_n = (1/8) \text{ V}^{-1}$, $\lambda_p = (1/12) \text{ V}^{-1}$, $\mu_n C_{\text{ox}} = 100 \mu\text{A/V}^2$, $\mu_p C_{\text{ox}} = 50 \mu\text{A/V}^2$, and $V_{\text{DD}} = 2 \text{ V}$. [15%]



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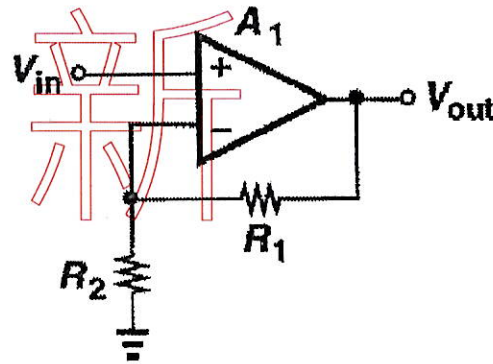
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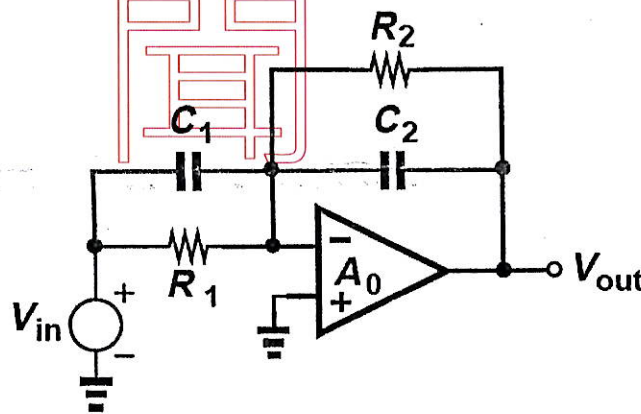
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4. A non-inverting amplifier is shown below.

- (a) If the op-amp is ideal, find the voltage gain of the amplifier ($A_v = V_{out}/V_{in}$). [5%]
 (b) If the op-amp is not ideal with open-loop gain of A_1 and the amplifier is designed for a nominal voltage gain of 10, determine the required minimum value of A_1 for a gain error of 1%. Assume $(1+x)^{-1} \approx 1-x$. [5%]

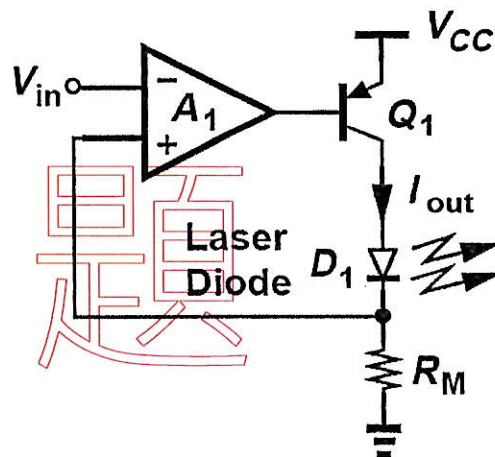


5. (a) Calculate the transfer function, $H(s) = V_{out}(s)/V_{in}(s)$ of the circuit if $A_0 = \infty$. [10%]
 (b) What choice of component values reduces $|V_{out}/V_{in}|$ to unity at all frequencies? [5%]



6. The circuit shown below can deliver a well-defined current to laser diode, D_1 , where resistor R_M measures the current flowing through D_1 and amplifier A_1 subtracts the resulting voltage drop from V_{in} . Assume R_M is very small and amplifier A_1 is ideal.

- (a) Determine the open-loop gain, loop gain and the closed-loop gain. [10%]
 (b) Compute the open-loop and closed-loop output impedances. [5%]



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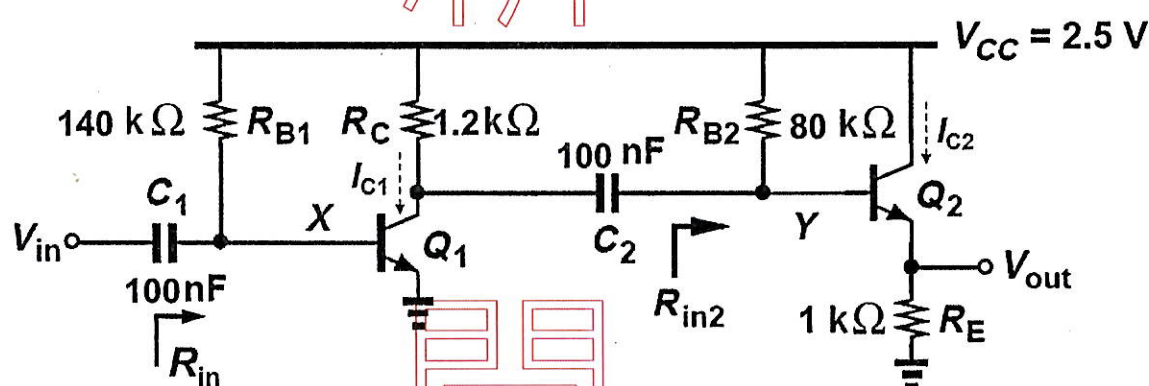
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7. The two-stage amplifier shown below incorporates capacitive coupling both at the input and between the stages. Assume the transistors have $\beta = 100$ and $V_A = \infty$. Also, the bias current of the two transistors are $I_{C1} = 1.25$ mA and $I_{C2} = 1$ mA, respectively.
- (a) Assume the two capacitors are large enough for the frequency interested. Use hybrid- π model to draw the small signal equivalent model of the amplifier. Use $V_T = 25$ mV for the calculation of small signal parameters. [5%]
- (b) Following (a), determine the voltage gain of the amplifier. [5%]
- (c) Determine the low-frequency cut-off of the circuit. [5%]



8. All the diodes in the circuit are ideal. *A*, *B*, *C* are logic input, and *OUT* is logic output. The logic 0 voltage is within 0~1V and the logic 1 is 4~5V.
- (a) Assume $R_1 = 5 \cdot R_2$, what is the logic function of *OUT*? [5%]
- (b) What problem would happen if $R_1 = R_2$? [5%]

