※注意：請於試卷上依序作答，並應註明作答之大題及小題題號。

共四大題

Problem 1: (24 pts, 3 pts each, 填充, 中英皆可)

(a) Why both of the inputs of an ideal op amp are "virtual short"? (　　)

(b)

(1)Draw a non-inverting amplifier by using an ideal op amp and two resistors

(　　)

(2) What happens to the output of the non-inverting amplifier if the "+" "-" inputs of the ideal op amp are swapped? (　　)

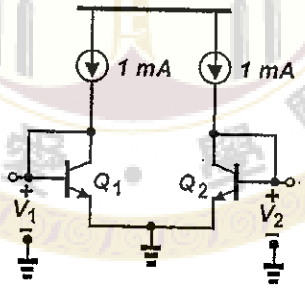
(c) For a differential amplifier, please specify TWO conditions such that the small-signal model can be approximated by its half circuits.

(　　) (　　)

(d) For the following circuits, when its operation temperature increases from 27^{0}C to 100 ^{0}C,

(1) Will V_1 increase or decrease or unchange? Assume both of 1 mA current sources are ideal. (　　)

(2) Calculate the *change* of (V_1-V_2) from 27^{0}C to 100 ^{0}C if k=1.38e-23 Joule/K and q=1.6e-19 coul. Assume Q_2 is 8 times larger than Q_1. → (　　)



(e) For a MOSFET and a BJT, both of them have the same DC bias current. What's the ratio of $\frac{g_{m,BJT}}{g_{m,MOS}}$ if $V_{GS} - V_{TH} = 0.3V$ for MOSFET and both of them are operated at 27^{0}C? (　　)

Problem 2: (26 pts) For a 2-stage CMOS+BJT differential amplifier, please calculate the design parameters. Note that NMOS has $\mu_n C_{ox} \frac{W}{L} = 16mA/V^2$ and $V_{TH} = 0.5V$. For BJT, their $V_T = 25mV$. Please neglect channel-length modulation and Early effect. Assume V_{in} is biased at 1.2-V DC.

(a) (6 pts) In order for the CMOS differential pair to operate in saturation region, what is the maximum allowable R_1? In this case, you can assume β of BJT is infinite.

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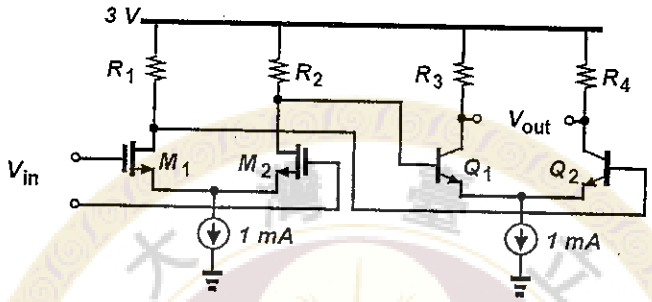
(b) (12 pts) Now, for the load, $R_1 = R_2 = 2k\Omega$ and $R_3 = R_4 = 1k\Omega$. Assume β of BJT is finite, derive the overall small-signal gain in terms of β. Then, draw small-signal gain with respect to β from 1 to 200. Find out what is the minimum β required to establish larger than 100 DC gain.

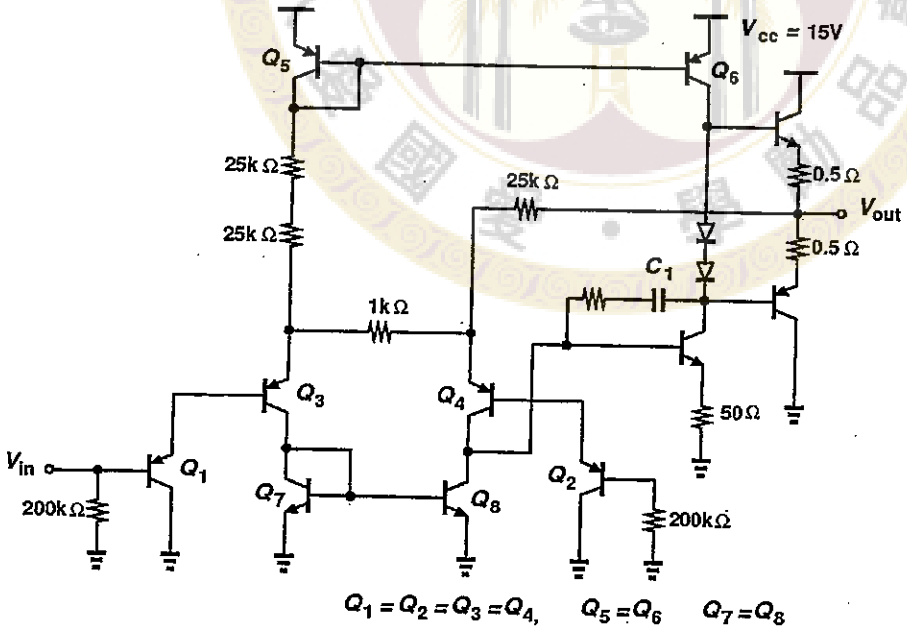
(c) (8 pts) Let's assume R_4 has some deviation to 1.1 kΩ, estimate the input offset voltage if β=100. (It means that you need to apply a small voltage at the input such that the differential output is zero).



Problem 3: (25 pts) Consider the following circuit.

(a) Determine DC level of V_{out}. (10%)

(b) Estimate voltage gain V_{out}/V_{in}. (15%)



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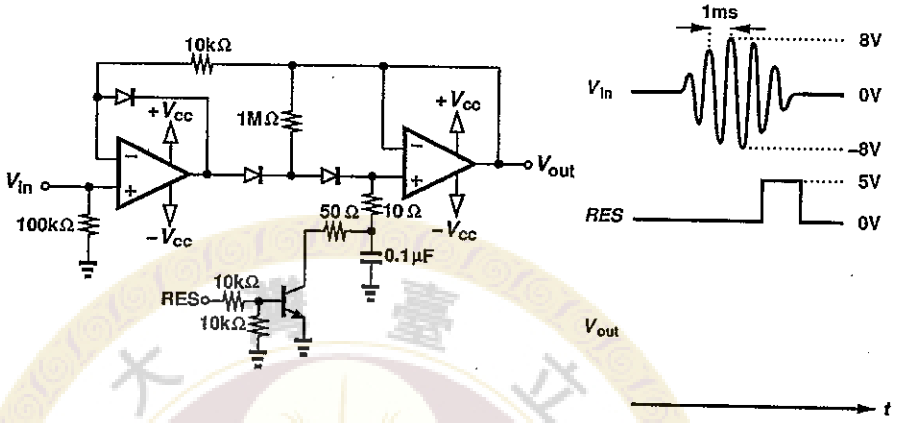
Problem 4: (25 pts) Consider the following circuit. V_{CC} = +15V, $-V_{CC}$ = −15V, $V_{diode,on}$ = 0.7V. Draw $V_{out}(t)$ under the given V_{in} and RES signal (25%).



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