考生注意: 1. 依次序作答，只要標明題號，不必抄題。
2. 答案必須寫在答案卷上，否則不予計分，並限以藍黑色筆作答。
3. 試題隨卷繳回。(餘請詳閱試場規則)

1. (15%)Two diodes are connected in parallel as shown in Fig. 1. Diode A has a reverse saturation current of $1.0\text{X}10^{-7}$ A, while diode B has a reverse saturation current of $1.0\text{X}10^{-8}$ A at 300 K. Calculate the current in each diode.

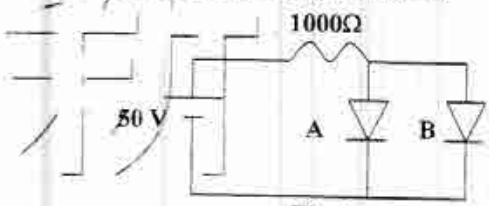

Fig. 1

2. (20%)One curve of an n-channel MOSFET is characterized by following parameters: $I_d(sat)=2\text{X}10^{-4}$ A, $V_{ds}(sat)= 4$V and $V_T= 0.8$ V.
(a) What is the gate voltage?
(b) What is the value of conduction parameters K_n, if $I_d(sat)= K_n (V_{gs} - V_T)^2$?
(c) If Vg=2V and Vds = 2V determine Id?
(d) If Vg=3 V and Vds=1 V determine Id?

3. (15%)Consider a uniformly doped silicon pn junction with doping concentrations $N_a=5\text{X}10^{17}$ and $N_d=10^{17}$ cm^{-3}. The junction area is 10^{-4} cm^2 and a reverse-bias of 5 V is applied. Calculate
(a)The junction built-in voltage
(b)Width of depletion region
(c)Total junction capacitance.

4. Fig. 2 shows a cascode amplifier designed using bipolar transistor. Suppose $V_{\pi 1} \approx V_{\pi_2}$, in which $V_{\pi 1}$ and V_{π_2} represents the voltage across the base-emitter capacitances $C_{\pi 1}$ and $C_{\pi 2}$, respectively, of transistors Q_1 and Q_2.

(a) Prove the mid-band gain is given by $A_M = \dfrac{V_O}{V_S} \approx -g_{m2} R_L \dfrac{r_{\pi 1}}{r_{\pi 1} + r_{x1} + R_S}$, in which $r_{\pi 1}$ and r_{x1} represents the base-emitter junction diffusion resistance and the series resistance in the base terminal, respectively, of transistor Q_1. (10 points)

(b) In the case the input circuit produces a dominant high-frequency pole, prove the upper 3-dB frequency ω_H is given by $\omega_H \approx \dfrac{1}{[r_{\pi 1} \| (r_{x1} + R_S)](C_{\pi 1} + 2C_{\mu 1})}$. (10 points)

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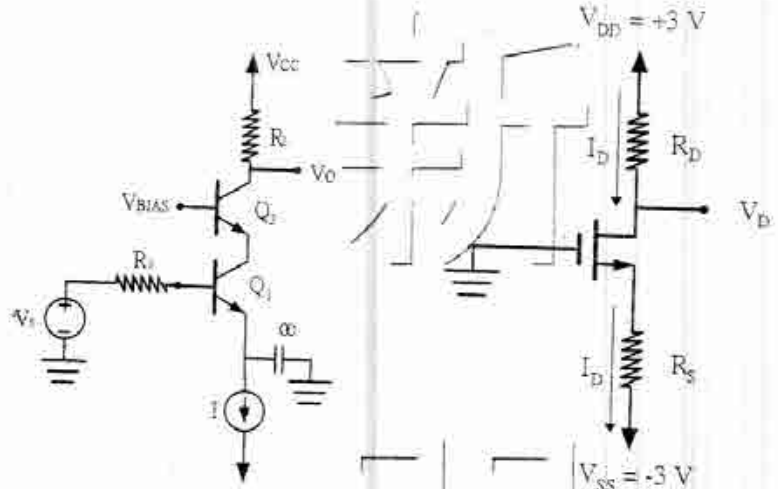

Fig. 2

Fig. 3

5. Design the circuit of Fig. 3 so that the transistor operates at $I_D = 0.4$ mA and $V_D = 1$ V. The NMOS transistor has $V_t = 1$ V, $\mu_n C_{ox} = 20\ \mu A/V^2$, $L = 10\ \mu m$, and $W = 400\ \mu m$. Neglect the channel-length modulation effect. (10 points)

6. Fig. 4 shows a non-inverting op amp.
   (a) Assume that the op amp has infinite input resistance and zero output resistance. Find an expression for the feedback factor β. (5 points)
   (b) If the open-loop voltage gain $A=10^4$, find R_2/R_1 to obtain a closed-loop voltage gain A_f of 10. (5 points)
   (c) What is the amount of feedback in decibels? (5 points)
   (d) If A decreased by 20%, what is the corresponding decrease in A_f? (5 points)

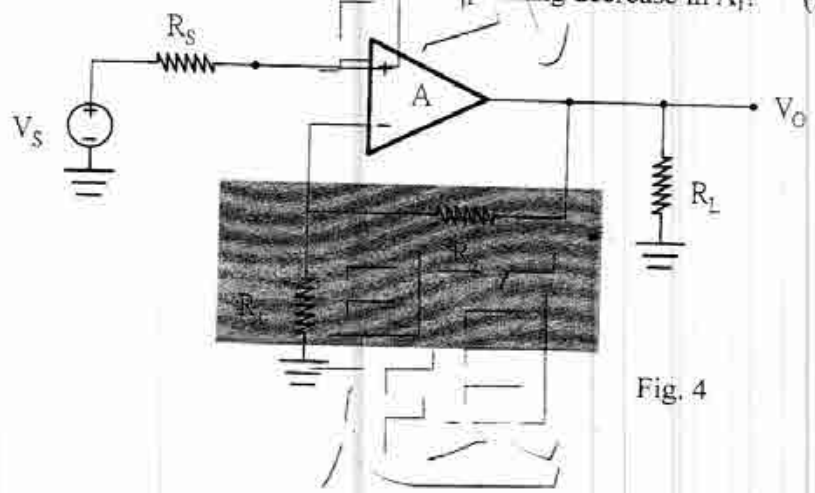

Fig. 4