國立中央大學通訊工程學系 102 學年度碩士在職專班入學筆試【電子學】試卷

考試地點：通訊館一樓 E1-109 室　　考試時間：100 分鐘　　試題總分：１００分

Please answer the following questions appropriately, and the final score will depend on the completeness of your answers.

Q1. (18 pt) Consider a semiconductor for which the electron concentration in silicon at $T = 300K$ is $n_0 = 5\times10^{15} cm^{-3}$. Please answer the following questions:

(a) (6 pt) Determine the hole concentration.
(b) (6 pt) Is the material n-type or p-type ? why ?
(c) (6 pt) What is the impurity doping concentration ?

Q2. (12 pt) Consider a diode circuit in Fig. 1 with the parameters $v_I = 15\sin(\omega t)(V)$, $R = 10k\Omega$, and $V_B = 2V$. Assume the cut-in voltage for the pn junction diode is $V_r = 0.6V$. Please answer the following questions:

(a) (6 pt) What is the peak inverse voltage of the diode ?
(b) (6 pt) Sketch v_o versus time over two periods of the input signal v_I.

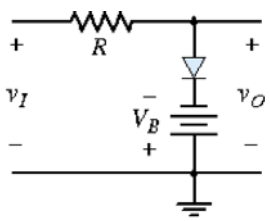

Fig. 1

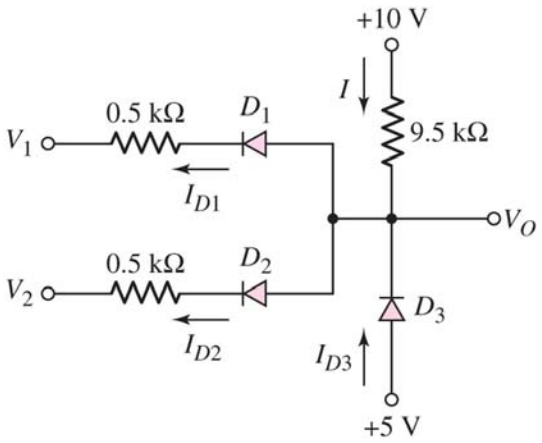

Fig. 2

Q3. (18 pt) Consider the circuit shown in Fig. 2. Assume the cut-in voltage for each diode is $V_r = 0.6V$. Determine the output voltage V_o and the currents I_{D1}, I_{D2}, and I_{D3} for the following input conditions:

(a) (6 pt) $V_1 = V_2 = 0V$
(b) (6 pt) $V_1 = V_2 = 5V$
(c) (6 pt) $V_1 = 5V$, $V_2 = 0V$

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Q4. (24 pt) Consider an amplifier circuit in Fig. 3. Circuit parameters are $V_{DD}=12V$, $R_1=162k\Omega$, $R_2=463k\Omega$, $R_S=0.75k\Omega$, and $R_{Si}=4k\Omega$. The parameters for the n-channel enhancement-mode MOSFET transistor are $V_{TN}=1.5V$, $K_n=4mA/V^2$, and $\lambda=0.01V^{-1}$. Please answer the following questions:

(a) (6 pt) Calculate the quiescent gate-to-source voltage V_{GS} and drain-to-source voltage V_{DS}.

(b) (6 pt) Plot the small-signal model for the amplifier circuit.

(c) (6 pt) Determine the small-signal voltage gain.

(d) (6 pt) Calculate the input resistance and output resistance.

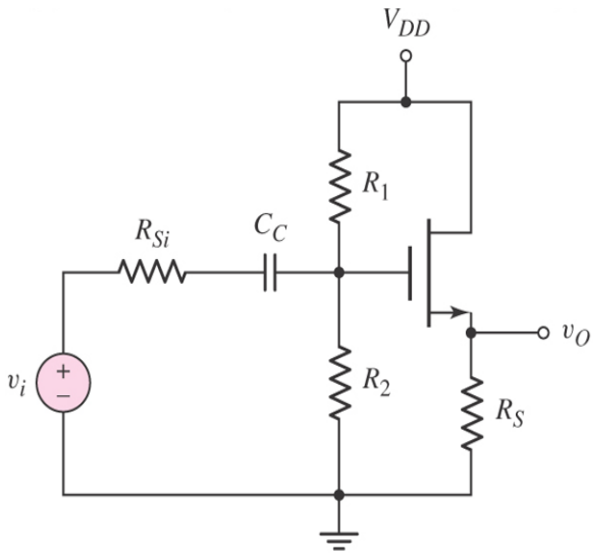

Fig. 3

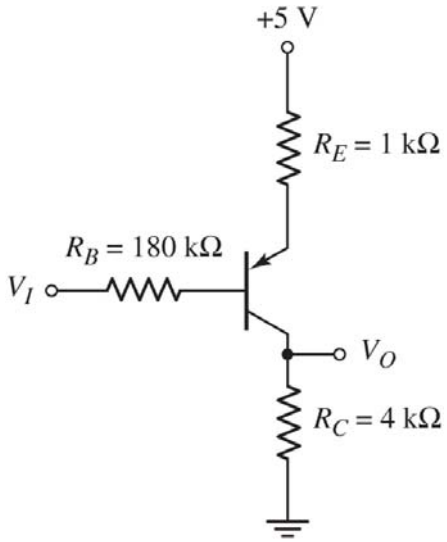

Fig. 4

Q5. (6 pt) Consider the BJT circuit shown in Fig. 4. The circuit parameters R_B, R_E and R_C are respectively given by $180k\Omega$, $1k\Omega$ and $4k\Omega$, and assume the common-emitter current gain of the transistor, β, is given by 100. Plot the voltage transfer characteristics (V_O versus V_I) over the range $0V \le V_I \le 5V$.

Q6. (22 pt) Consider a multistage BJT circuit in Fig. 5. The transistor parameters are $\beta=100$ (common-emitter current gain), $V_A=\infty$ (early voltage) and $V_{BE(on)}=0.7V$. Please complete the DC and AC analysis by answering the following questions:

(a) (5 pt) Calculate the DC current through the elements R_{E1} and R_{C2}.

(b) (5 pt) Plot the small-signal model for the multistage circuit.

(c) (6 pt) Determine the small-signal voltage gain.

(d) (6 pt) Find the small-signal input resistance and output resistance.

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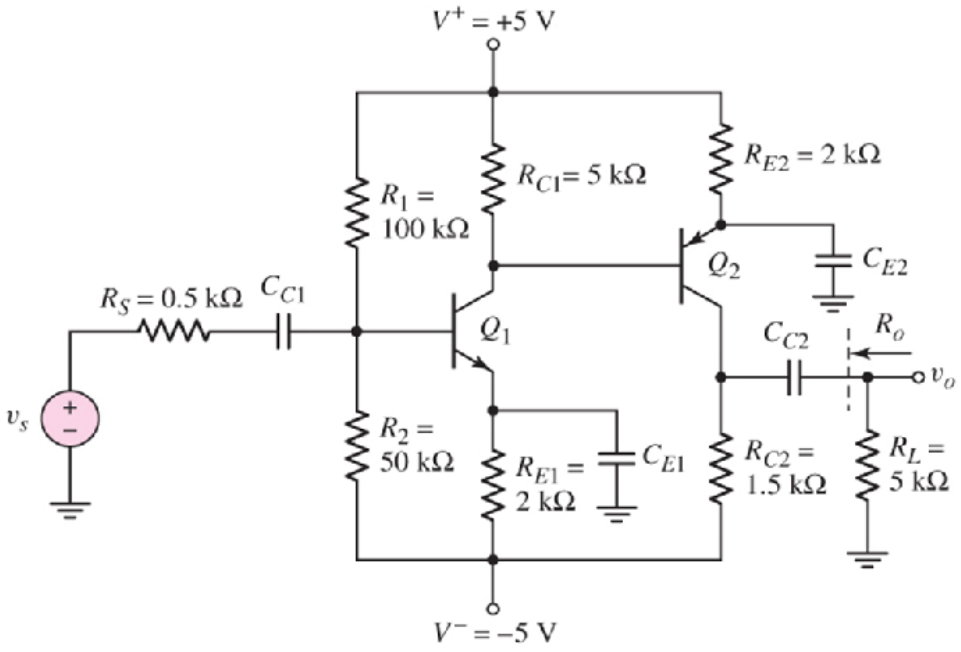
$V^+ = +5$ V
$R_{E2} = 2$ kΩ
$R_{C1} = 5$ kΩ
$R_1 =$ 100 kΩ
Q_2
C_{E2}
$R_S = 0.5$ kΩ
C_{C1}
Q_1
C_{C2}
R_o
v_o
v_s
$R_2 =$ 50 kΩ
$R_{E1} =$ 2 kΩ
C_{E1}
$R_{C2} =$ 1.5 kΩ
$R_L =$ 5 kΩ
$V^- = -5$ V

Fig. 5