

元智大學 101 學年度研究所 碩士班 招生試題卷

系(所)別： 光電工程學系碩
士班

組別： 不分組

科目： 電子學

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● 不可使用電子計算機

元智大學一百零一學年度 研究所考試 招生試題卷

系別：光電工程研究所 科目：電子學

Parameter: $V_t = 0.026\text{mV}$, $\ln 10 = 2.3$, $e^{30} = 1 \times 10^{13}$; $e^{-1} = 0.37$; $e^{-0.2} = 0.82$; $e^{-3} = 0.05$,
 $2^{1/2} = 1.414$, Parallel connection: // ; $25//8 \text{ ohm} = 6$; $35.2//5.83 = 5$

1. (10%) Consider silicon at $T = 300 \text{ K}$. Assume the hole concentration is given by $p = 10^{16} e^{-x/L_p} (\text{cm}^{-3})$, where $L_p = 5 \times 10^{-3} \text{ cm}$. Calculate the hole diffusion current density at (a) $x = 0$ and (b) $x = 10^{-3} \text{ cm}$. Assume $D_p = 15 \text{ cm}^2/\text{s}$
2. (10%) Consider silicon at $T = 300 \text{ K}$. Assume that $\mu_n = 1350 \text{ cm}^2/\text{V}\cdot\text{s}$ and $\mu_p = 480 \text{ cm}^2/\text{V}\cdot\text{s}$. Determine the conductivity and resistivity if (a) $N_a = 2 \times 10^{15} \text{ cm}^{-3}$ and (b) $N_d = 2 \times 10^{17} \text{ cm}^{-3}$.
3. (10%) A pn junction diode and a Schottky diode have equal cross-sectional areas and have forward-bias currents of 0.5 mA . The reverse-saturation current of the Schottky diode is $I_s = 5 \times 10^{-7} \text{ A}$. The difference in forward-bias voltages between the two diode is 0.6 V . Determine the reverse-saturation current of the pn junction diode.
4. (10%) Consider the circuit shown in Fig.1. Determine I_{BQ} , I_{CQ} , and V_{CEQ} for: (a) $\beta = 75$, and (b) $\beta = 150$.
5. (10%) Determine the quiescent collector current and collector-emitter voltage, and find the small-signal voltage gain of the circuit shown in Fig.2. Assume the transistor parameters are: $\beta = 100$, $V_{BE(\text{on})} = 0.7 \text{ V}$, and $V_A = 100 \text{ V}$.
6. (10%) For a common-collector configuration in Fig 3, please prove

$$A_v = \frac{V_o}{V_s} = \frac{(1 + \beta)(r_e \parallel R_E)}{r_s + (1 + \beta)(r_e \parallel R_E)} \left(\frac{R_i}{R_i + R_s} \right)$$
7. (10%) Calculate the I_{DS} and V_{DS} of a CS circuit with an n-channel enhancement-mode MOSFET in Fig 4. Find the power dissipated in the transistor.
Assume that $R_1 = 30 \text{ k}\Omega$, $R_2 = 20 \text{ k}\Omega$, $R_D = 20 \text{ k}\Omega$, $V_{DD} = 5 \text{ V}$, $V_{TN} = 1 \text{ V}$, and $K_n = 0.1 \text{ mA/V}^2$.
8. (10%) Determine the small-signal voltage gain of a common-source circuit containing a source resistor. Consider the circuit in Figure. 5. The transistor parameters are $V_{TN} = 0.8 \text{ V}$, $K_n = 1 \text{ mA/V}^2$, and $\lambda = 0$. (Hint: $V_{GSQ} = 1.5 \text{ V}$, $I_{DQ} = 0.50 \text{ mA}$, and $V_{DSQ} = 6.26 \text{ V}$.)
9. (20%) Calculate the corner frequency and maximum gain of a bipolar

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common-emitter circuit with a coupling capacitor. For the circuit shown in Figure 6, the parameters are $R_1 = 5.12 \text{ k}\Omega$, $R_2 = 9.6 \text{ }\Omega$, $R_C = 2 \text{ k}\Omega$, $R_E = 0.4 \text{ k}\Omega$, $R_{Si} = 0.1 \text{ k}\Omega$, $C_C = 1 \text{ }\mu\text{F}$, and $V_{CC} = 10 \text{ V}$. The transistor parameters are: $V_{BE}(\text{on}) = 0.7 \text{ V}$, $\beta = 100$, and $V_A = \infty$. (Hint: $I_C = 1.81 \text{ mA}$)

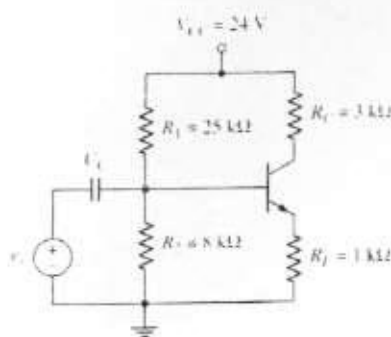


Figure 1

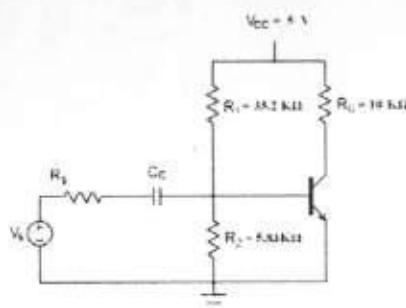


Figure 2

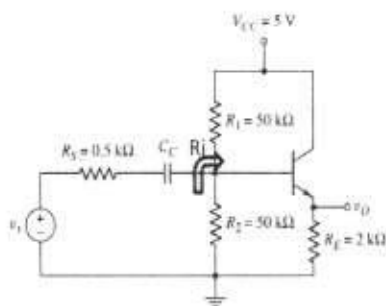


Figure 3

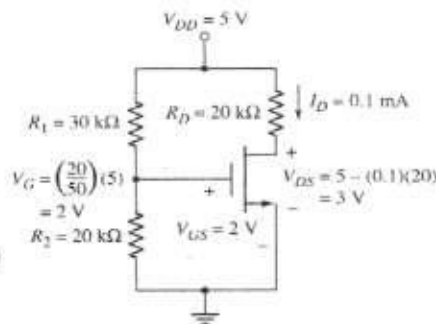


Figure 4

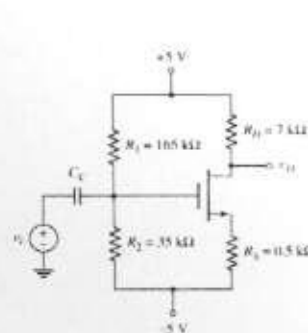


Figure 5

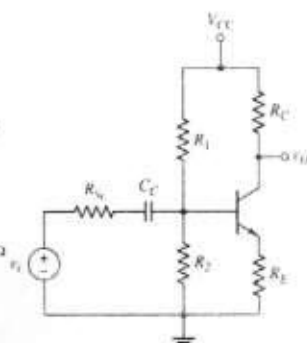


Figure 6