

元智大學 100 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

用紙第 / 頁共 2 頁

●不可使用電子計算機

元智大學一百學年度 研究所考試 招生試題卷

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Parameter: $V_t = 0.026\text{mV}$, $\ln 10 = 2.3$, $e^{-1} = 0.37$, $e^{-3} = 0.05$, $2^{1/2} = 1.414$, $15 \parallel 770 = 14.7$,

1. The hole concentration in silicon is given by $p(x) = 10^4 + 10^{15} \exp(-x/L_p)$, $x \geq 0$. The value of L_p is $10 \mu\text{m}$. The hole diffusion coefficient is $D_p = 5 \text{ cm}^2/\text{s}$. Determine the hole diffusion current density at (a) $x=0$, (3%) (b) $x=10 \mu\text{m}$ (3%), and (c) $x = 30 \mu\text{m}$. (4%)
2. (a) The applied electric field in p-type silicon is $E=10 \text{ V/cm}$. The semiconductor conductivity is $\sigma = 1.5 (\text{ohm}\cdot\text{cm})^{-1}$ and the cross-sectional area is $A=10^{-3} \text{ cm}^2$. Determine the drift current. (5%) (b) The cross-sectional area of a semiconductor is $A = 2 \times 10^{-4} \text{ cm}^2$ and the resistivity is $\rho = 0.4 (\text{ohm}\cdot\text{cm})$. If the drift current is $I = 1.2 \text{ mA}$, what applied electric field must be applied? (5%)
3. Consider the rectifier circuits shown in Figure 1 and 2. Assume the input voltage is from a 110 V (rms) , 60 HZ ac source. The desired peak output voltage v_o is 10 V , and the diode turn on voltage is assumed to be $V_f = 0.7 \text{ V}$. Compare the characteristics of (a) and (b) in these two full-wave rectifier circuits:
 - (a) transformer turns ratio. (10%)
 - (b) peak inverse voltage. (5%)
4. Determine the current in each diode and the voltages of V_A and V_B in the multidiode circuit shown in Figure 3. Let $V_f = 0.7\text{V}$ for each diode. (10%)
5. (a) Please describe the "Body effect" in MOSFET. (5%)
 (b) Please describe the "Early Voltage" in Bipolar Junction Transistor. (5%)
 (c) For small signal consideration, an NMOS transistor biased in the saturation region, with a drain current of I_{DQ} , prove $g_m = 2(K_n I_{DQ})^{1/2}$ in MOSFET. (5%)
6. For the circuit in Figure 4 let $\beta = 100$, $V_A = 200\text{V}$, $V_{CC} = 10\text{V}$, $V_{BE(\text{on})} = 0.7\text{V}$, $R_C = 15 \text{ k}\Omega$, $R_B = 100 \text{ k}\Omega$, and $V_{BB} = 0.96\text{V}$. (a) Determine the small-signal hybrid- π parameters r_x , g_m , and r_o (6%). (b) Find the small-signal voltage gain $A_v = V_o/V_s$. (4%)
7. (a) What is the transfer function of Figure 5 (in dB format)? (5%)
 (b) Please draw Bode Plot. (5%)
 (c) What is the value of corner frequency? (5%)
 (d) What is slope below 3dB frequency? (5%)
8. Determine the small-signal voltage gain of a common-source circuit containing a source resistor. Consider the circuit in Figure 6 with parameters: $V_{TN} = 0.8\text{V}$, $K_n = 1\text{mA/V}^2$, and $\lambda = 0$. (Note: $V_{GSQ} = 1.5\text{V}$, $I_{DQ} = 0.5 \text{ mA}$, and $V_{DSQ} = 6.25 \text{ V}$) (10%)

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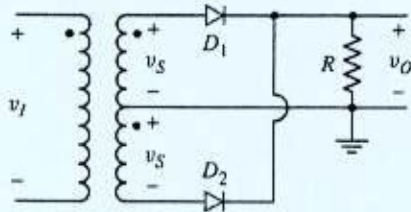


Figure 1

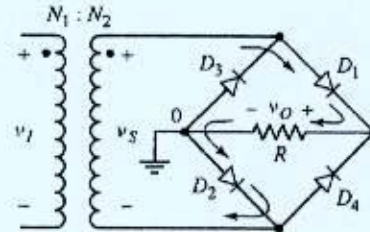


Figure 2

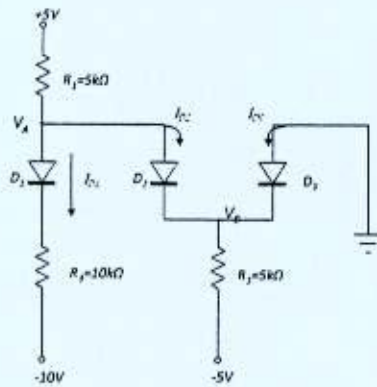


Figure 3

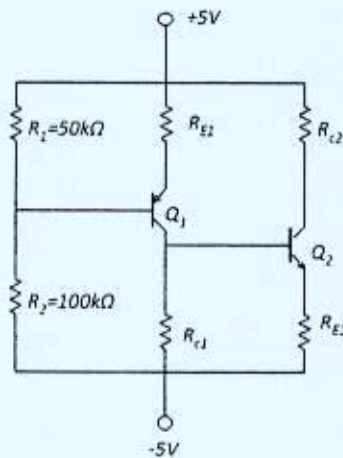


Figure 4

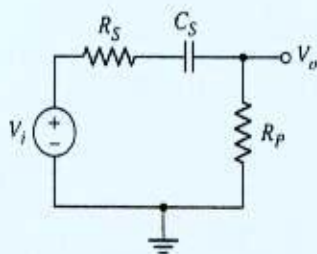


Figure 5

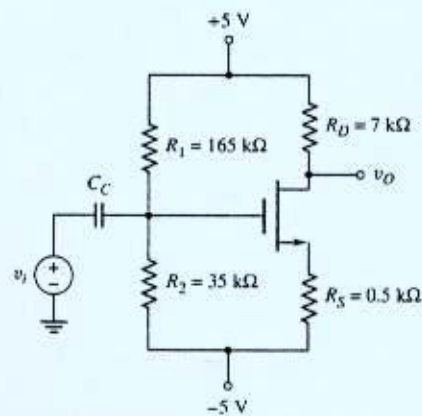


Figure 6