

中原大學 102 學年度 碩士班 入學考試

102/3/2 10:00 ~ 11:30 電子工程學系光電半導體組

誠實是我們珍視的美德，
我們喜愛「拒絕作弊，堅守正直」的你！

科目：電子學(範圍：元件特性、基本電路)

(共 3 頁第 1 頁)

可使用計算機，惟僅限不具可程式及多重記憶者

不可使用計算機

1. (15%) A forward-bias diode can be approximated as,

$$I_D = I_s \left(e^{V_D/V_T} - 1 \right) \approx I_s e^{qV_D/kT} \quad \text{and} \quad I_s \propto e^{-E_g/kT}$$

where k is Boltzmann's constant = $1.38 \times 10^{-23} \text{ J/K}$

T is the absolute temperature in Kelvins = $273 + \text{temperature in } ^\circ\text{C}$

q is the magnitude of electronic charge = $1.6 \times 10^{-19} \text{ C}$

$E_g/q = 1.12 \text{ V}$

(a) Given a silicon diode with $I_s = 10^{-13} \text{ A}$ at 27°C , determine the diode current, I_D , under forward bias $V_D = 0.6 \text{ V}$.

(b) Follow the above question and determine the diode current, I_D , at 127°C .

(c) Approximately plot the forward-bias I_D - V_D curves of both temperatures, i.e. 27 and 127°C .

2. (12%) Following the above question's assumption and using the same diode in Fig. 1, please find out (a) the diode's incremental resistance or diffusion resistance, r_d , and (b) output voltage, v_o , in the small signal analysis of the circuit at 27°C .

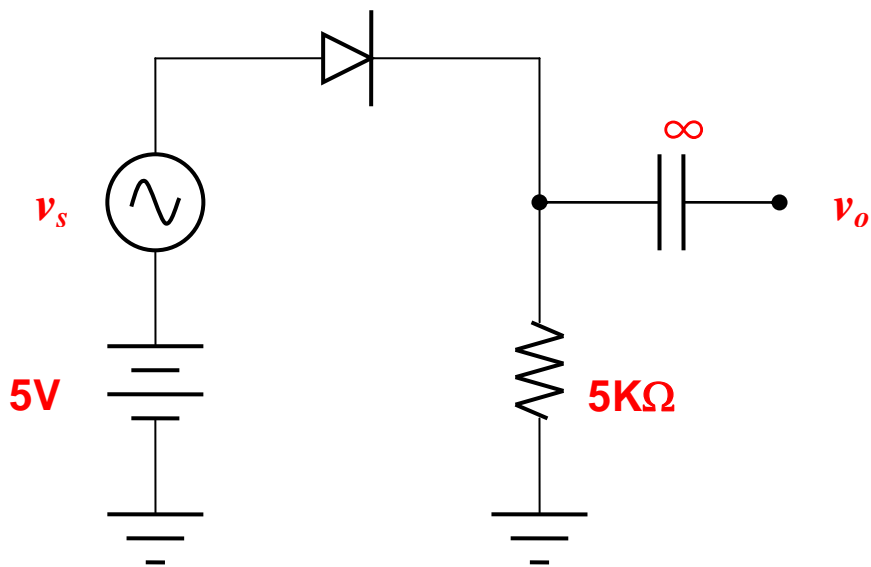


Fig. 1

3. (15%) (a) Explain the physical mechanism that causes “Early Effect” in BJTs. (b) How does it affect the I_C - V_{CE} characteristics in BJTs? (c) Use a transistor equivalent circuit model to demonstrate how Early Effect affects the circuit amplification, i.e. voltage gain, A_V .

4. (14%) Assuming an npn BJT’s $V_{BE} = 0.7V$, $\beta = 100$ and Early voltage $V_A = 100V$ in Fig. 2, please find out (a) the transistor’s transconductance, g_m , and (b) the voltage gain, A_V , in the small signal analysis of the circuit.

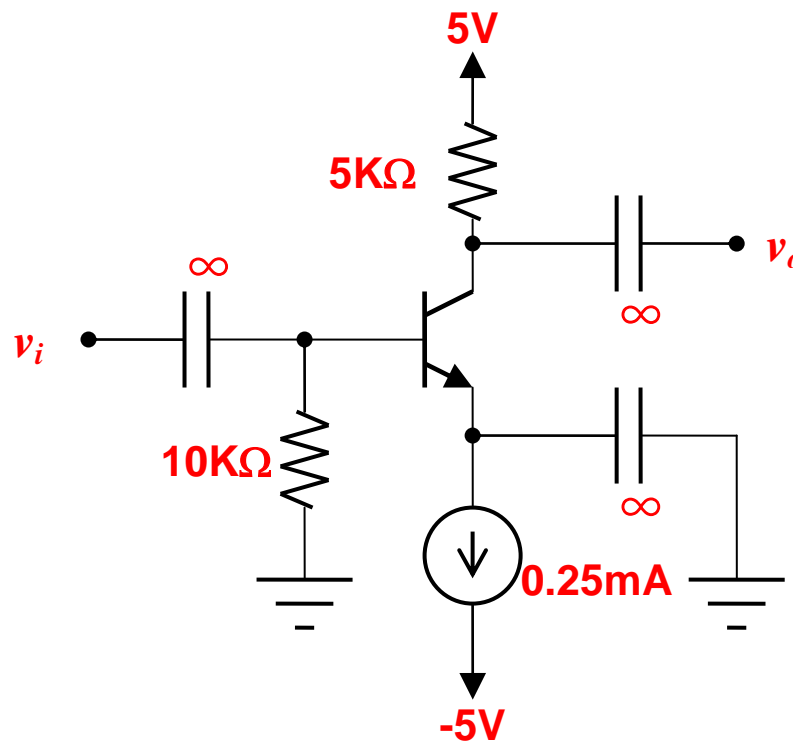


Fig. 2

5. (15%) (a) Explain the physical mechanism that causes “Channel Length Modulation (CLM)” in MOSFETs. (b) Please list the drain current equation including the CLM parameter. (c) How can the effect of CLM be reduced in MOSFET design?

6. (15%) (a) Explain “Body Effect” in MOSFETs. (b) How does it affect the transistor’s characteristics? (c) Please build a transistor equivalent circuit model to include the Body effect.

7. (14%) Neglecting body effect and assuming nMOS, $\mu_n C_{ox} = k'_n = 0.5mA/V^2$, $V_{TH} = 0.7V$, $W = 2\mu m$, $L = 0.5\mu m$, $V_A = 100V$ in Fig. 3, please find out (a) the transistor’s transconductance, g_m , and (b) the voltage gain, A_V , in the small signal analysis of the circuit.

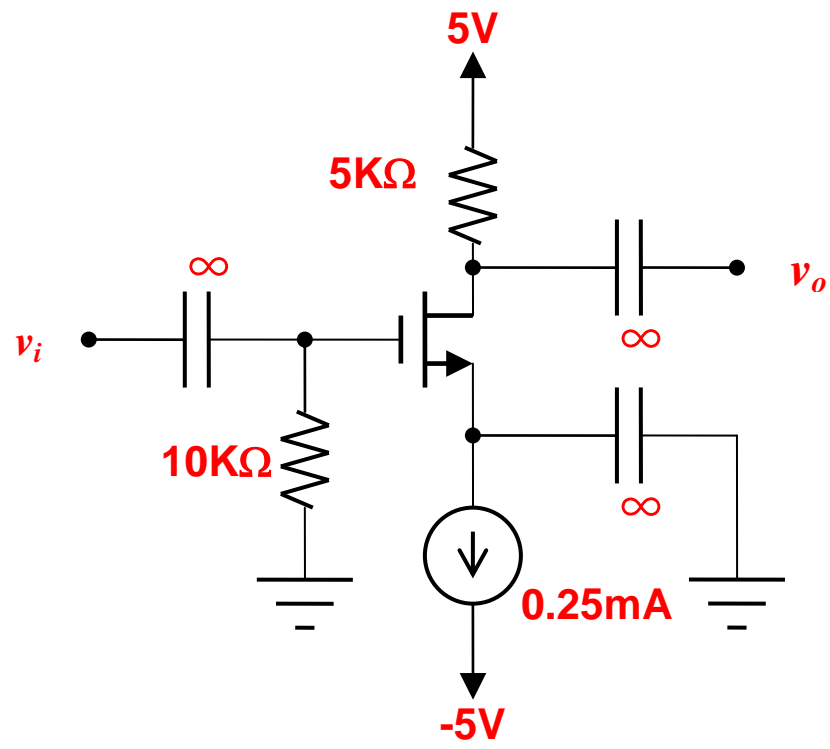


Fig. 3