

國立臺灣科技大學答案卷

National Taiwan University of Science and Technology Answer Sheet

姓名/Name _____ 學號/Student ID _____ 班級/Class _____

科目/Course title _____ 日期/Date _____

| 評 分 Score | 教 師 簽 章 Signature of Lecturer |
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記分欄

從此處開始寫起。試卷用紙務須節用，非經主試認可不得續用其他紙張作答。/Please write from here.

$$1. (a) \quad V_E = -10 + I_E \times 4000 \Rightarrow -I_B \times 0.5k - 0.7 = -10 + 10 I_B \times 4k$$

$$0 - I_B \times 0.5k - 0.7 = V_E \Rightarrow 404.5 I_B = 9.3$$

$$I_B = 2.3 \mu A \Rightarrow I_C = 2.3 \mu A$$

$$g_m = \frac{I_C Q}{V_T} = 88.4 \mu A/V$$

$$r_{\pi} = \frac{V_T}{I_B Q} = 1.13k \Omega$$

$$(b) \quad f = 1Hz = \frac{1}{2\pi\tau} \Rightarrow \tau = \frac{1}{2\pi} = C_E R_E \Rightarrow C_E = 3.98 \times 10^{-5} F$$

$$(c) \quad \tau = C_E R_E \times \frac{r_{\pi}}{r_{\pi} + (1 + \beta) R_E} = 4.44 \times 10^{-4} \Rightarrow f = \frac{1}{2\pi\tau} = 358.41 Hz$$

$$2. (a) g_m = 2\sqrt{0.5\text{mA} \times 1.2\text{mA}} = 1.549 \text{ mA/V}$$

$$R_o = R_s \parallel \frac{1}{g_m} = 0.282 \text{ k}\Omega.$$

$$\tau = (R_o \parallel R_L) C_L \quad \& \quad f_H = \frac{1}{2\pi\tau} \approx 5 \text{ MHz}$$

$$C_L = \frac{\tau}{R_o \parallel R_L} = \frac{1}{2\pi(5 \times 10^6)(0.282 \parallel 4) \times 10^3} \Rightarrow C_L = \underline{121 \text{ pF}} \#$$

$$(b) \tau_1 = 10 \mu\text{F} \times (2\text{k} + (166 \parallel 234)) = 991.1$$

$$f_1 = \frac{1}{2\pi\tau_1} = 0.16 \text{ Hz}$$

$$\tau_2 = 10 \mu\text{F} \times (0.282 + 4) = 42.82.$$

$$f_2 = \frac{1}{2\pi\tau_2} = 3.71 \text{ Hz}$$

$$(c) f_2 = 3.71 \text{ Hz}.$$

記分欄

轉頁從此開始寫起。

$$3. (a) V_o = -g_m V_{gs} (R_D \parallel R_L) \quad g_m = 3.54 \text{ mA/V} \rightarrow g_m = 2k_p (V_{SG} + V_{TP})$$

$$(b) C_m = C_{gd} (1 + g_m (R_D \parallel R_L)) \\ = 3 (1 + (3.54) (2115)) = 18.2 \text{ pF} \neq$$

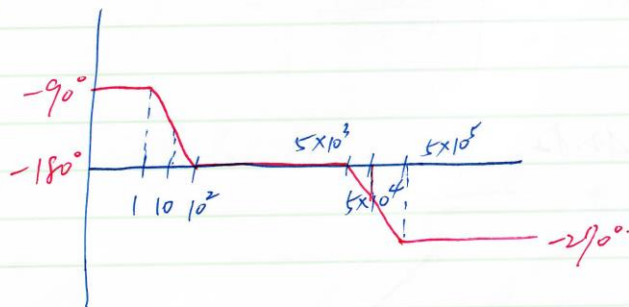
$$(c) \tau = R_{eq} (C_{gs} + C_M) \\ R_{eq} = R_1 \parallel R_2 = 0.5 \parallel 8122 = 0.461 \text{ k}\Omega \\ \tau = (0.461 \times 10^3) (15 + 18.2) \times 10^{-12} \\ = 1.53 \times 10^{-8} \text{ s}, f_H = \frac{1}{2\pi\tau} = 10.4 \text{ MHz} \neq$$

$$4. (a) T(j\omega) = 5 \times \frac{sT_1}{1+sT_1} \times \frac{1}{1+sT_2}$$

$$= 5 \times \frac{(s/10)}{(1+s/10)(1+\frac{s}{5 \times 10^4})}$$

$$\text{or } 2.5 \times 10^5 \times \frac{s}{10+s} \times \frac{1}{5 \times 10^4 + s}$$

(b)



記分欄

轉頁從此開始寫起。

$$5. (a) A_v = -\frac{R_2}{R_1} \cdot \frac{1}{\left[1 + \frac{1}{A_{od}} \left(1 + \frac{R_2}{R_1}\right)\right]} = -\frac{150}{25} \cdot \frac{1}{1 + \frac{1}{1000}} = 6 \times \frac{1000}{1001} \\ = -5.98V$$

$$(b) V_o = A_{od} (V_2 - V_1) = -A_{od} V_1$$

$$V_1 = \frac{V_o}{A_{od}} = \frac{5.958}{1000} = 5.958 \times 10^{-3} V = 5.958 mV$$

6.

$$(a) -(V_i \div (R_1 + \frac{1}{sC_1})) \times R_2 = V_o \Rightarrow -\frac{V_i}{\frac{sC_1 R_1 + 1}{sC_1}} \times R_2 = V_o$$

$$V_o = -V_i \times \frac{sC_1}{sC_1 R_1 + 1} \times R_2, A_v = \frac{V_o}{V_i} = -\frac{sC_1 R_2}{sC_1 R_1 + 1} \neq$$

$$(b) A_{sw} = \infty, A_v = -\frac{R_2}{R_1}$$

$$(c) |A_v| = \frac{R_2}{R_1} \cdot \frac{\omega R_1 C_1}{\sqrt{1 + (\omega R_1 C_1)^2}} = \frac{1}{\sqrt{2}}, \omega = \frac{1}{R_1 C_1} \Rightarrow f = \frac{1}{2\pi R_1 C_1}$$

記分欄

轉頁從此開始寫起。

$$7. (a) \bar{I} = \frac{V_{I_2} - V_{I_1}}{R_1}$$

$$V_o = (V_{o_2} - V_{o_1}) \times \frac{R_e}{R_3}$$

$$= (V_{I_2} - V_{I_1}) \times \left(1 + \frac{2R_2}{R_1}\right) \left(\frac{R_e}{R_3}\right)$$

$$A_d = \left(1 + \frac{2 \times 50}{2}\right) \left(\frac{90}{30}\right) = 153 \text{ (max)}$$

$$A_d = \left(1 + \frac{2 \times 50}{100}\right) \left(\frac{90}{30}\right) = 6 \text{ (min)}$$

$$6 \leq A_d \leq 153$$

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$$(b) V_{I_1} = V_{cm} - \frac{1}{2} V_d$$

$$V_{I_2} = V_{cm} + \frac{1}{2} V_d$$

$$V_{o_1} = V_{I_1} - \bar{I}_1 R_2 = V_{cm} - 5.5 V_d$$

$$V_o = \left(1 + \frac{R_4}{R_3}\right) \left(\frac{\frac{R_4}{R_3}}{1 + \frac{R_4}{R_3}} \right) V_{o1} - \left(\frac{R_4}{R_3} \right) V_{o2}$$

$$= (1+3) \left(\frac{\frac{3}{1.5}}{1 + \frac{3}{1.5}} \right) V_{o1} - 3 V_{o2}$$

$$= 4 \times \left(\frac{2.857}{3.857} \right) (V_{cm} + 5.5V_d) - 3 (V_{cm} - 5.5V_d)$$

$$= -0.0371 V_{cm} + 32.79 V_d$$

$$CMRR = \left| \frac{32.79}{-0.0371} \right| = 884 \quad \#$$

$$CMRR_{(dB)} = 58.9 \quad \#$$