# 國立臺灣科技大學答案卷

National Taiwan University of Science and Technology Answer Sheet

| 評分 Score | 教師簽章 Signature of Lecturer |
|---|---|
| 102 | |

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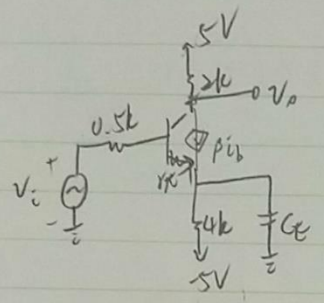
科目/Course title 電子學 日期/Date 112.4.12

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.




$r_o = \infty$

$\beta = 100$

$$I_B = \frac{[0-0.7-(-5)]}{0.5k+404k} = 10.63\mu A$$

$$r_\pi = \frac{V_t}{I_{BQ}} = 2.446k\Omega$$

$$f_M = \frac{1}{2\pi(1/\mu\ 4k)} = 39.79\ Hz \quad \#1$$

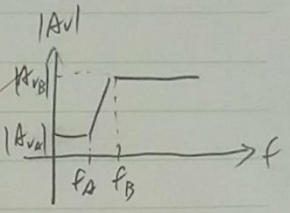
$$f_B = \frac{1}{2\pi[1/\mu(4k//(\frac{r_\pi+0.5k}{1+\beta}))]} = 5.496\ KHz \quad \#1$$

$$|A_{vA}| = \left|\frac{v_o}{v_i}\right| = \left|\frac{r_\pi+404k}{0.5k+r_\pi+404k}\cdot\frac{1}{r_\pi+404k}\cdot\beta(-4k)\right| = 0.4915\ V/V$$

$$|A_{vB}| = \left|\frac{v_o}{v_i}\right| = \left|\frac{r_\pi}{0.5k+r_\pi}\cdot\frac{1}{r_\pi}\cdot\beta(-4k)\right| = 67.89\ V/V$$

$$\Rightarrow |A_{vA}|_{dB} = 20\log_{10}|A_{vA}| = -6.17\ dB \quad \#1$$

$$\Rightarrow |A_{vB}|_{dB} = 20\log_{10}|A_{vB}| = 36.64\ dB \quad \#1$$




使 E 端等效開路的頻率：

$4k//|\frac{1}{sC_E}| = \infty$

$\Rightarrow |\frac{1}{sC_E}| = -4k$

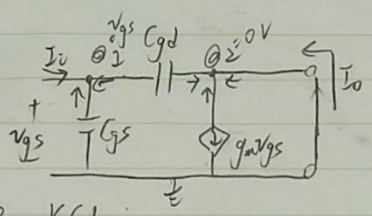
$\Rightarrow -j\frac{1}{2\pi f\cdot C_E} = -4k$

$\Rightarrow -\frac{1}{2\pi\cdot 1\mu(-4k)}\angle 90° = f_M$

$\Rightarrow |f_M| = 39.79\ Hz$

+20

2.




By KCL:

@1: $I_i + \frac{-V_{gs}}{\frac{1}{sC_{gs}}} + \frac{-V_{gs}}{\frac{1}{sC_{gd}}} = 0 \Rightarrow I_i = v_{gs}(s(C_{gs}+C_{gd}))$

@2: $I_o + (-g_m v_{gs}) + \frac{V_{gs}}{\frac{1}{sC_{gd}}} = 0 \Rightarrow I_o = v_{gs}(g_m - sC_{gd}) \xrightarrow{g_m \gg sC_{gd}} v_{gs}\cdot g_m$

($g_m$: $10^{-3}$; $sC_{gd}$: $10^{6}\cdot 1\cdot 10^{-12}$)

$\Rightarrow A_i = \frac{I_o}{I_i} = \frac{g_m}{s(C_{gs}+C_{gd})}$

$\Rightarrow |A_i| = \frac{g_m}{2\pi f(C_{gs}+C_{gd})}$

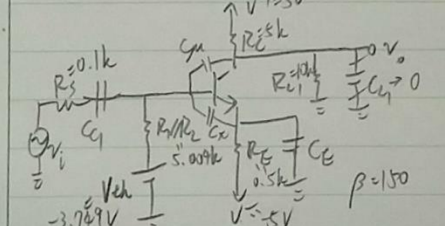
+15

By the definition, $f_T$ is the frequency at which $|A_i| = 1$:

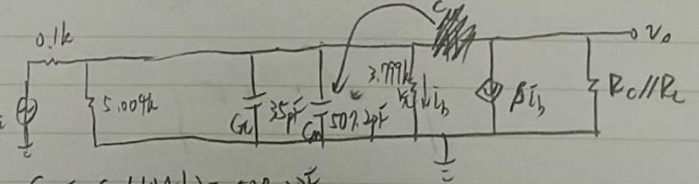
$$f = f_T = \frac{g_m}{2\pi(C_{gs}+C_{gd})}\ Hz \quad \#2$$

+20

3.




high freq:




$C_M = C_{\mu e}(1+|A_v|) = 507.2pF$

$$f_H = \frac{1}{2\pi[(35p+507.2p)(0.1k//5.004k//3.799k)]} = 3.071\ MHz \quad \#3$$

$$V_{eh} = [5-(-5)]\cdot\frac{5.12k}{40k+5.12k} - 5 = -3.749V$$

$$I_B = [-3.749-0.7+5]\cdot\frac{1}{R_1//R_2+151\cdot 500} = 6.844\mu A$$

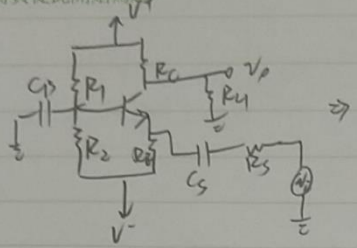
$$\Rightarrow r_\pi = \frac{V_t}{I_{BQ}} = 3.799k\Omega$$

$$|A_{v(max)}| = \left|\frac{v_o}{v_i}\right| = \left|\frac{5.004k//3.799k}{0.1k+5.004k//3.799k}\cdot\frac{1}{3.799k}\cdot\beta^{150}(-5k//10k)\right| = 125.8\ V/V \Rightarrow |A_{v(max)}|_{dB} = 41.99\ dB \quad \#3$$

轉頁背寫

記分欄 轉頁從此開始寫起。

4.



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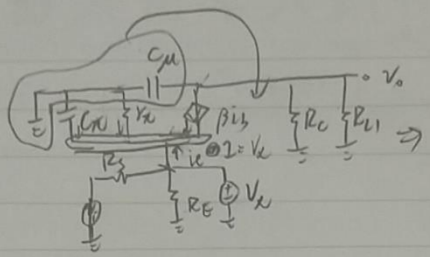
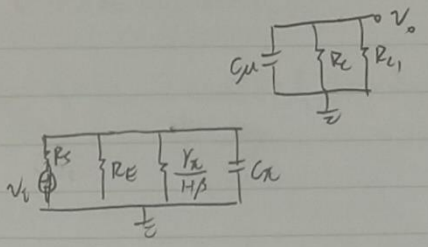


⇒



By KCL:

@1: $\beta i_b + i_e + \frac{-V_x}{r_\pi} + \frac{-V_x}{\frac{1}{sC_\pi}} = 0 \Rightarrow i_e = V_x\left(\frac{\beta}{r_\pi} + \frac{1}{r_\pi} + \frac{1}{\frac{1}{sC_\pi}}\right)$

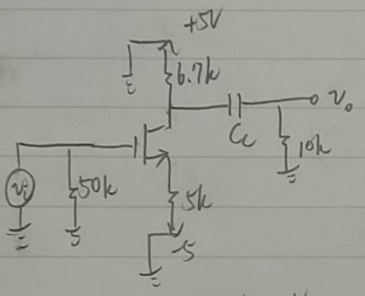
$\Rightarrow \frac{V_x}{i_e} = \frac{1}{\frac{1+\beta}{r_\pi} + sC_\pi} = r_e // \frac{1}{sC_\pi}$

$f_{H\pi} = \frac{1}{2\pi\left[C_\pi\left(R_s // R_E // \left(\frac{r_\pi}{1+\beta}\right)\right)\right]}$ Hz #4

$f_{H\mu} = \frac{1}{2\pi\left[C_\mu\left(R_c // R_{L_1}\right)\right]}$ Hz #4

+15

5.



$\tau_c = C_c(6.7k+10k)$

$f_{L_1} = \frac{1}{2\pi \cdot C_c(6.7k+10k)} = 20\,Hz \Rightarrow C_c = 476.5nF$ #5

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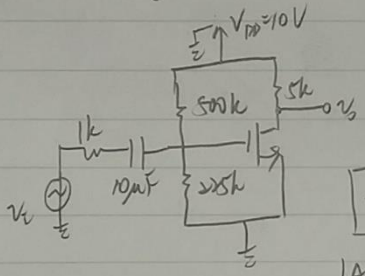
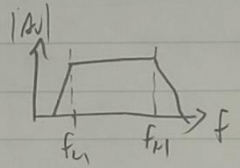
6.



$k_n = 1\,mA/V^2$ $V_{TN} = 2V$ $\lambda = 0$

$C_{gs} = 50pF$, $C_{gd} = 8pF$



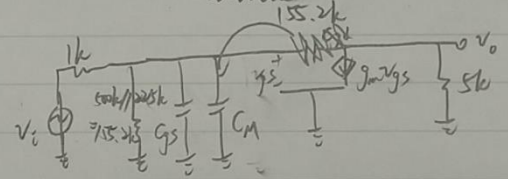
$f_{L_1} = \frac{1}{2\pi\left[10\mu\left(1k + 500k // 225k\right)\right]} = 0.1019$ Hz #6

$|A_V| = \left|\frac{v_o}{v_i}\right| = \frac{500k // 225k}{1k + 500k // 225k} \cdot g_m \cdot 5k = 10.96\,V/V$

$V_{GSQ} = 10 \cdot \frac{225}{500+225} = 3.103V$

$\Rightarrow I_{DQ} = I_{on}\left(V_{GSQ} - V_{TN}\right)^2 = 1.218mA$

$\Rightarrow g_m = 2\sqrt{k_n I_{DQ}} = 2.207\,mS$



$f_H = \frac{1}{2\pi\left[(C_{gs} + C_M)(155.2k // 1k)\right]} = 1.1$ MHz #6

$C_{gs}$: 50p, $C_M$: 8p · 11.96

+20