ENEE2360 CH9 Homework Solution

First semester 2023-2024

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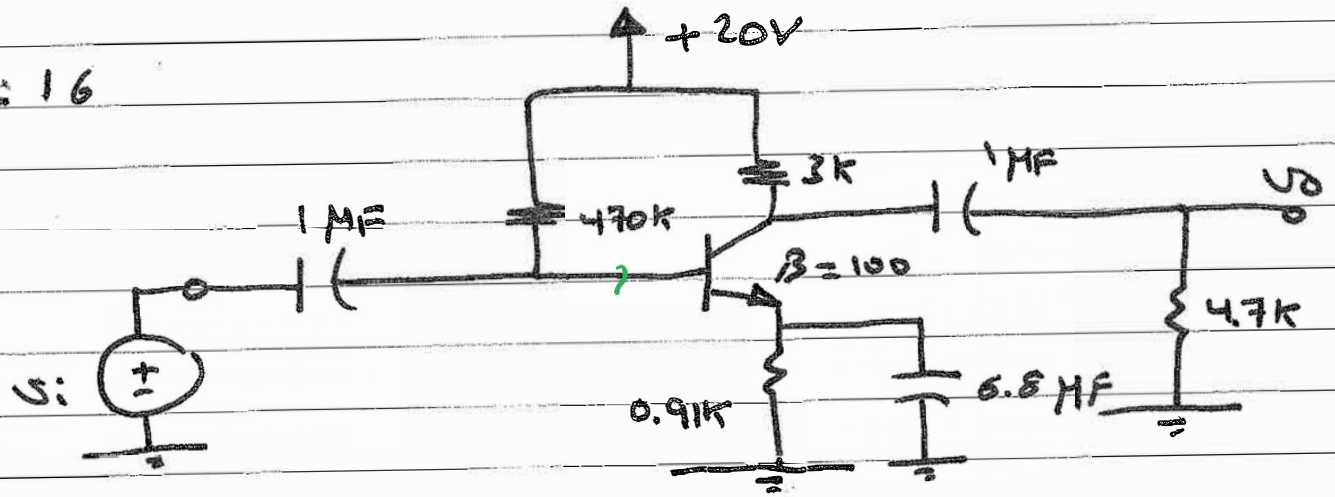


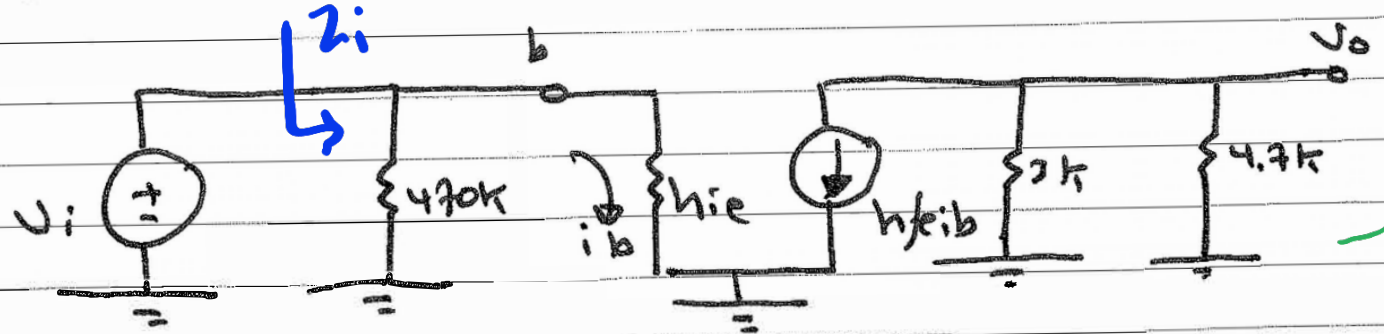
DC Analysis : to Find hie

$$I_B = \frac{20 - 0.7}{470k + 0.91k(101)} = 0.034\ mA$$

$$I_C = \beta I_B = 3.47\ mA$$

$$hie = \frac{\beta V_T}{I_{CQ}} = 0.74k$$

ac Small Signal Analysis :



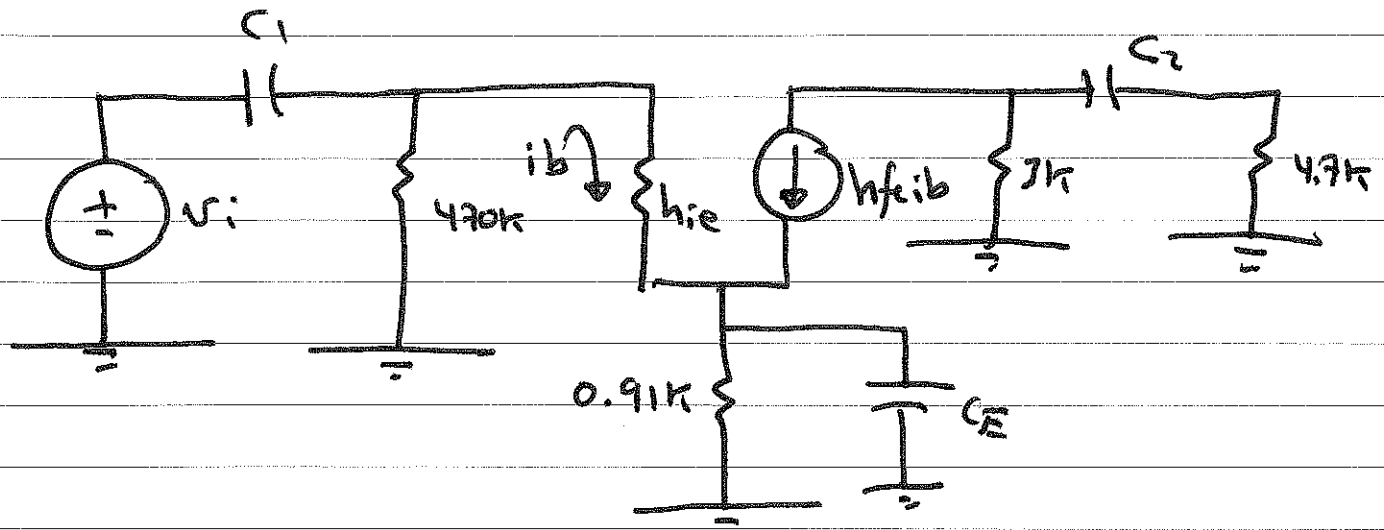
$$Vo = -hfe\,ib\,(3k \| 4.7k)$$

$$ib = \frac{Vi}{hie}$$

$$\therefore Av = -\frac{hfe}{hie}(3k \| 4.7k) = -247.46$$

$Z_i = 470K \parallel h_{ie} \simeq 739\ \Omega$

ac small signal Low frequency equivalent ckt:



remember
$\omega = 2\pi f$

$$\omega_{C_1} = \frac{1}{C_1 R_{TH_1}}$$

$R_{TH_1} = 470k \parallel h_{ie} = 0.739k$

$\therefore \omega_{C_1} = 1353\ r/s$

$$f_{C_1} = \frac{\omega_{C_1}}{2\pi} = 215.37\ Hz$$

$$\omega_{C_2} = \frac{1}{C_2 R_{TH_2}}$$

$R_{TH_2} = 3k + 4.7k = 7.7k$

$\therefore \omega_{C_2} = 177.33\ r/s$

$\therefore f_{C_2} = 21.27\ Hz$

$$\omega_{CE} = \frac{1}{R_{TH_2} C_E}$$

$$R_{TH_2} = 0.91K \parallel \frac{h_{ie}}{h_{fe+1}}$$

$$R_{TH_2} = 7.34\,\Omega$$

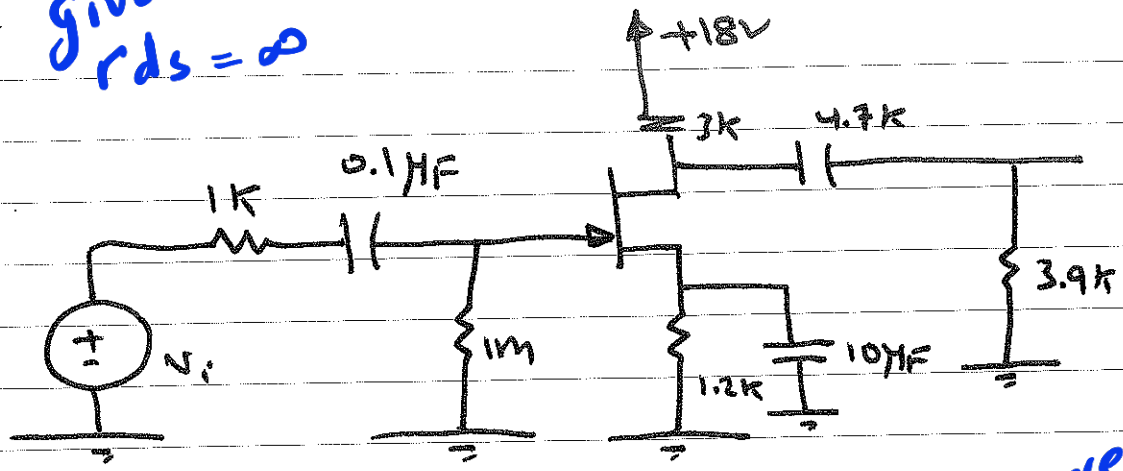
$$\therefore \omega_{CE} = 20.035\ K\ v/s$$

$$f_{CE} = 3.19\ KHz$$

$$21.52\ Kv/s > \omega_L > 20.035\ K\ v/s$$

given $r_{ds} = \infty$

9.23



$I_{DSS} = 6mA$, $V_p = -6V$

These caps affect WH not WL

$C_{wi} = 3pF$	$C_{gd} = 4pF$	$C_{ds} = 1pF$
$C_{wo} = 5pF$	$C_{gs} = 6pF$	

DC Analysis:

$$I_{DS} = I_{DSS}\left(1 - \frac{V_{GS}}{V_p}\right)^2 \quad \text{---- (1)}$$

$V_{GS} = V_G - V_S$

$V_G = 0$, $V_S = 1.2K\, I_{DS}$

$\therefore V_{GS} = -1.2K\, I_{DS}$ ---- (2)

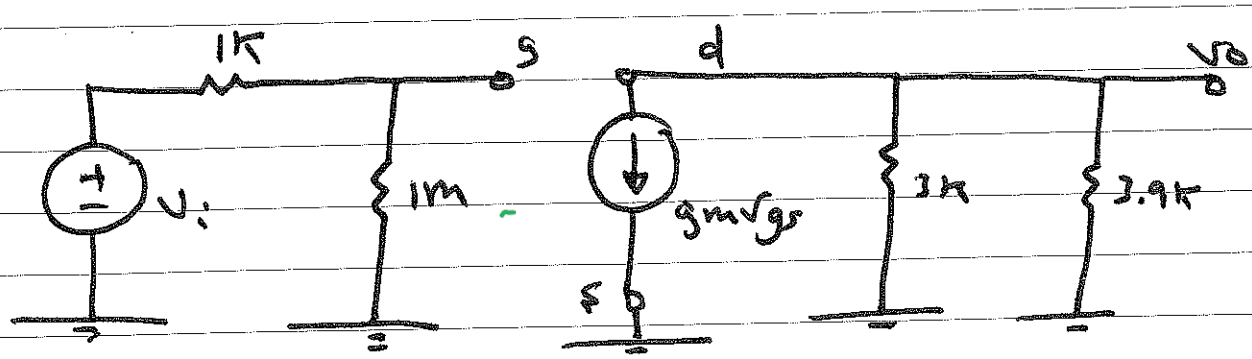
Sub (2) into (1), we get

$I_{DS} \simeq 2.1mA$

$\therefore V_{GS} = -2.48V$

$$g_m = -\frac{2I_{DSS}}{V_p}\left(1 - \frac{V_{GS}}{V_p}\right) = 1.17mS$$

ac small signal equivalent CKT: to Calculate Av(mid)



$$V_o = -g_m V_{gs} (3K \| 3.9K)$$

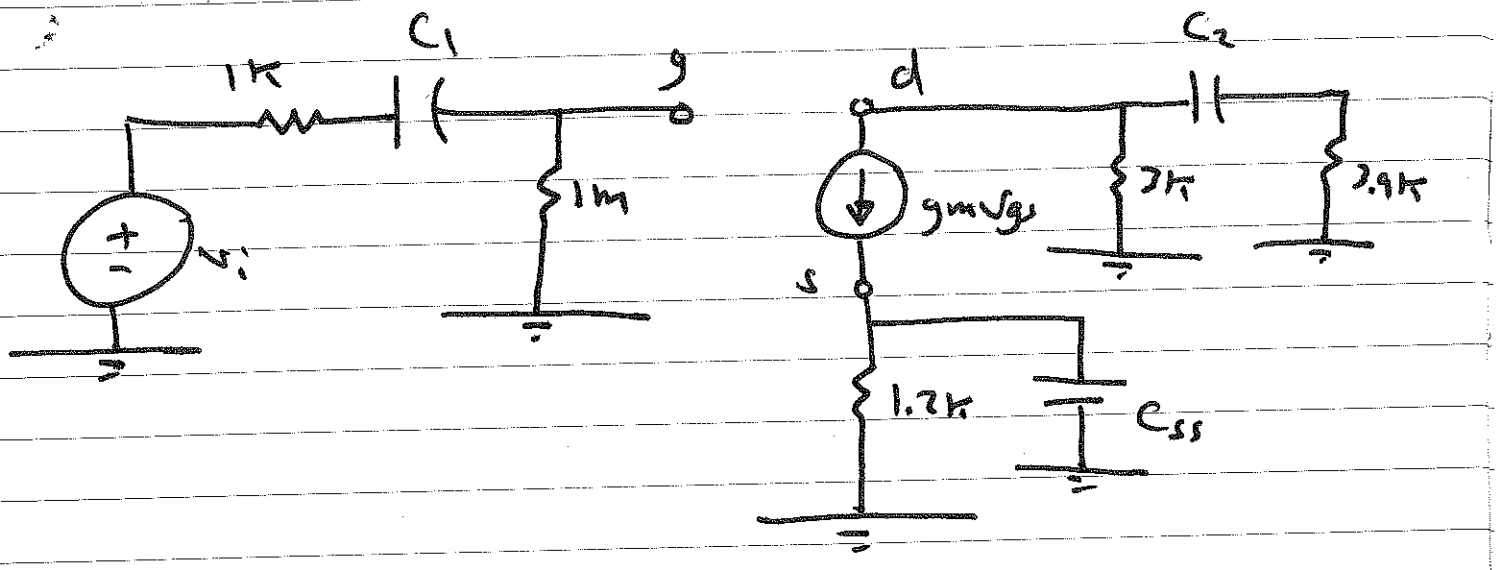
$$V_{gs} = V_g - V_s = V_g = \frac{1M}{1M+1K} V_i$$

$$\therefore A_V = \frac{V_o}{V_i} = -1.98 = Av(mid)$$

$$Z_i = 1M\Omega$$

ac small signal Low-frequency equivalent ckt

to Estimate ω_L



$$\omega_{c_1} = \frac{1}{R_{TH_1} C_1}$$

$R_{TH_1} = 1M + 1K = 1001\ K$

$\therefore \omega_{c_1} = 9.99\ v/s$

$\therefore f_{c_1} = 1.5899\ Hz$

$$\omega_{c_2} = \frac{1}{R_{TH_2} C_2}$$

$R_{TH_2} = 3K + 3.9K$

$\therefore \omega_{c_2} = 30.84\ v/s$

$\therefore f_{c_2} = 4.91\ Hz$

$$\omega_{C_{SS}} = \frac{1}{R_{TH_3} C_{SS}}$$

$$R_{TH_3} = 1.2K \parallel \frac{1}{g_m} = 0.499K$$

$$\therefore \omega_{C_3} = 200.29 \text{ r/s}$$

$$\therefore f_{C_{SS}} = 31.88 \text{ Hz}$$

$$241.12 \text{ r/s} > \omega_L > 200.29 \text{ r/s}$$

$$38.38 \text{ Hz} > f_L > 31.88 \text{ Hz}$$