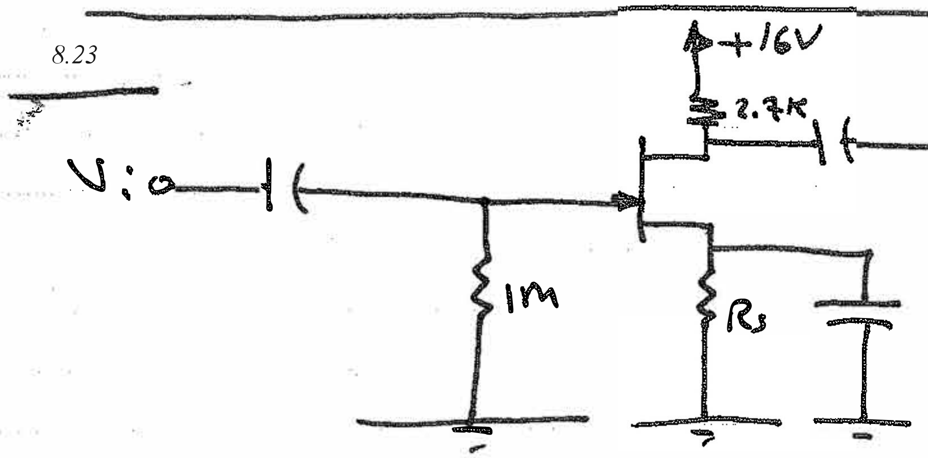
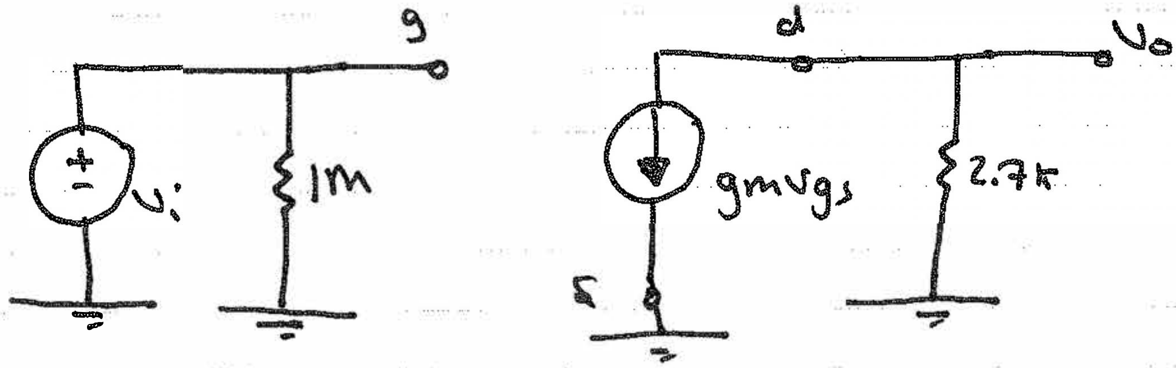
8.23



$I_{DSS} = 9mA$

$V_p = -8V$

ac small signal equivalent circuit :



$$V_o = -g_m V_{gs} (2.7k)$$

$$V_{gs} = V_g - V_s = V_i$$

$$\therefore A_v = \frac{V_o}{V_i} = -g_m (2.7k) = -2$$

$$\therefore g_m = 0.741 \ mA/V$$

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

$$\therefore V_{GS} = -5.37V$$

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

$\therefore\ I_{DS} = 0.973\ mA$

$\therefore\ V_{GS} = V_G - V_S = 0 - R_S I_{DS} = -5.37V$

$\therefore\ R_S = \frac{5.37}{0.973} = 5.5\ K$

b) if $r_{ds} = 30K$

$V_o = -g_m v_{gs}\,(2.7K \| 30K) = -2$

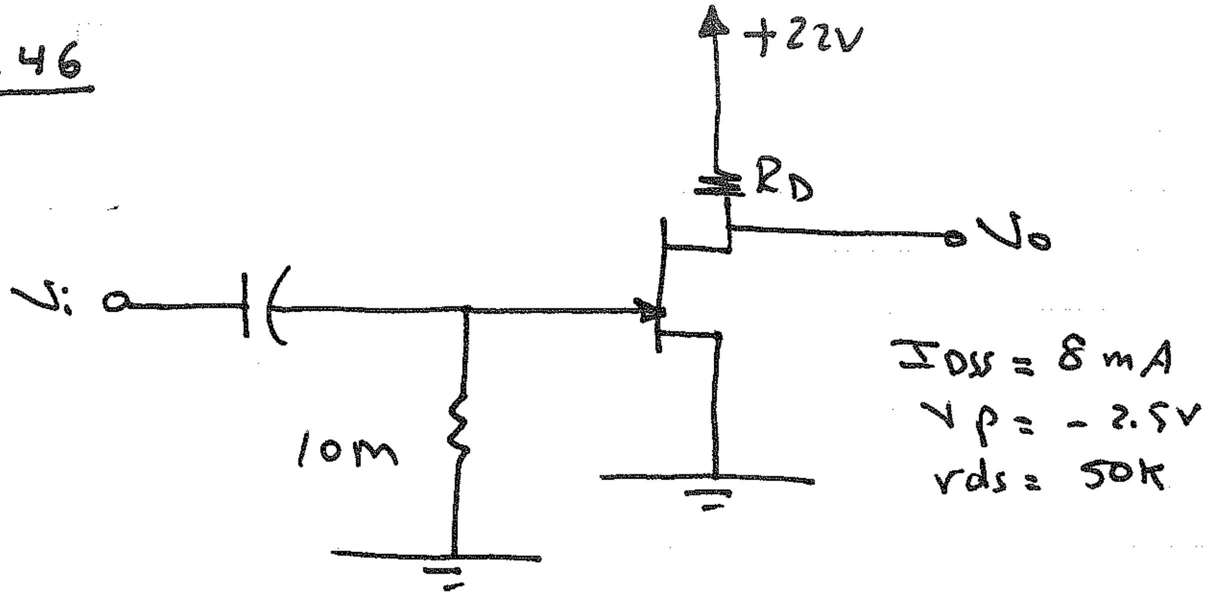
$\therefore\ g_m = 0.8\ mA/V$

$\therefore\ V_{GS} = -5.129\ V$

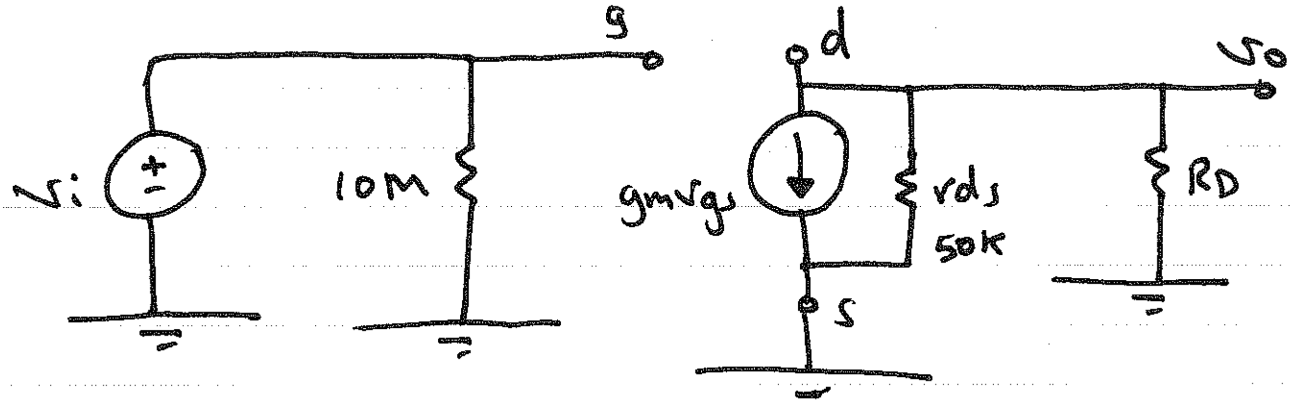
$\therefore\ I_{DS} = 1.159\ mA$

$\therefore\ R_S = 4.425K$

8.46



ac small signal equivalent circuit :



$V_o = -g_m v_{gs} (50K \| R_D)$

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

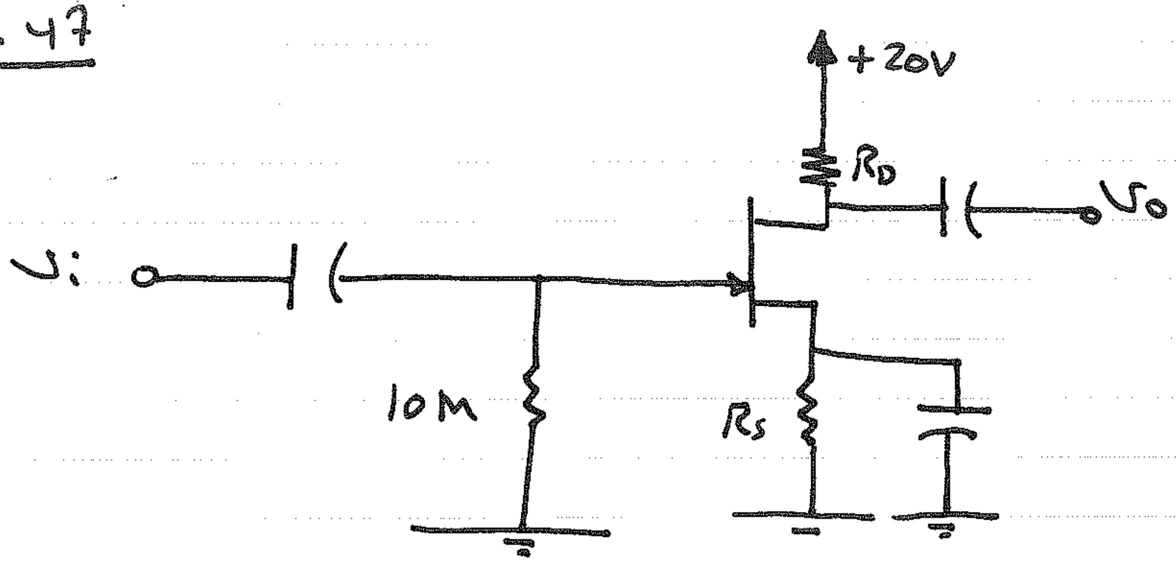
$V_{GS} = 0$

$\therefore g_m = 6.4 \ mA/V$

$A_v = -8 = -g_m (50K \| R_D)$

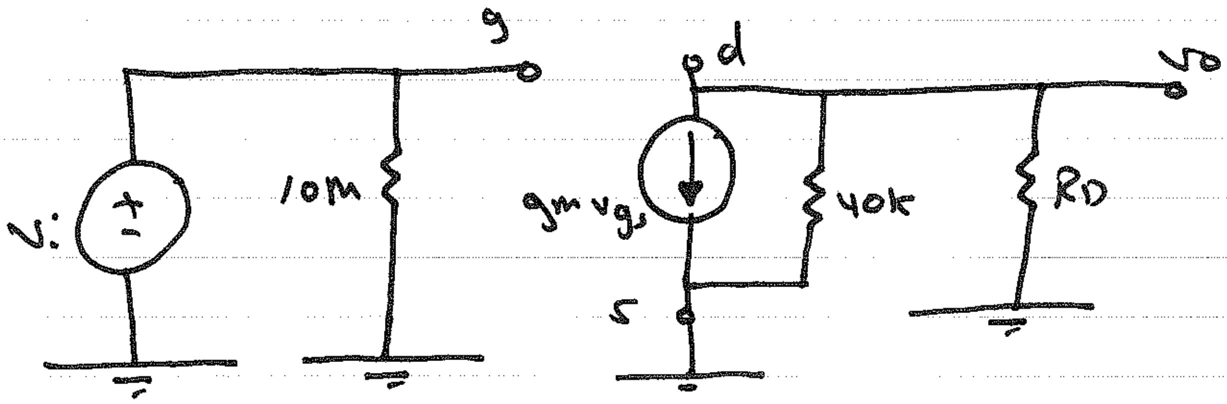
$\therefore R_D = 1.28 \ K$

8.47



$I_{DSS} = 12mA$
$V_P = -3V$
$r_{ds} = 40k$
$V_{GS} = -1V$

ac small signal equivalent circuit:



$$A_v = -g_m (R_D \| 40k) = -10$$

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

$V_{GS} = -1V$

$\therefore g_m = 5.33 \; mA/V$

$\therefore$ for $A_v = -10$

$R_D = 1.97\,K$

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

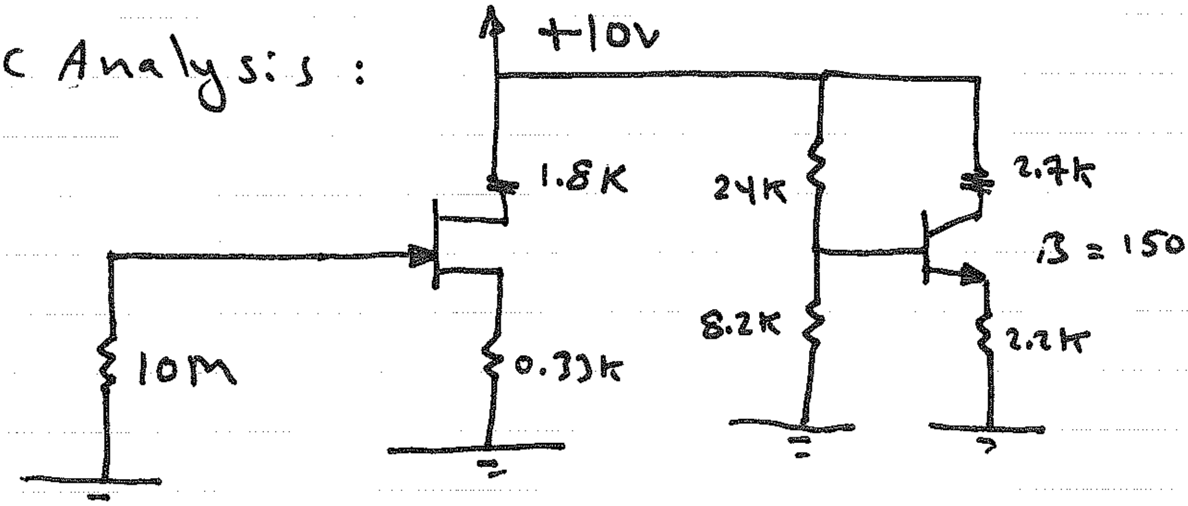
$\therefore I_{DS} = 5.33\ mA$

$V_{GS} = -1 = V_G - V_S = 0 - R_S I_{DS}$

$$\therefore R_S = \frac{1V}{5.33mA} = 0.187\ K$$

8.56

DC Analysis :



$I_{DSS} = 6mA \quad , V_P = -3V$

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

$V_{GS} = V_G - V_S = (-0.33k)\, I_{DS}$

solving for I_{DS}, we get

$I_{DS} = 2.84mA$

$R_{TH} = 24k \| 8.2k = 6.11k$

$$V_{TH} = \frac{8.2k}{8.2k + 24k}(+10) = 2.55V$$

$$\therefore I_E = \frac{2.55 - 0.7}{2.2k + \frac{6.11k}{151}} = 0.824mA$$

$V_{CE} = 10 - 2.7k\, I_C - 2.2k\, I_E \approx 5.96V$

$V_{DS} = 10 - (1.8k + 0.33k)\, I_{DS} = 3.95V$

$V_D = 10 - (1.8k)(2.84mA) = 4.89V$

$V_S = (0.33k)(2.84mA) = 0.937V$

$\therefore V_{DS} = 3.95V \quad ; \quad V_G = 0$

$|V_{DS}| > |V_P| - |V_{GS}|$

$|V_{DS}| > 3 - 0.937 = 2.063$ ✓

8.57

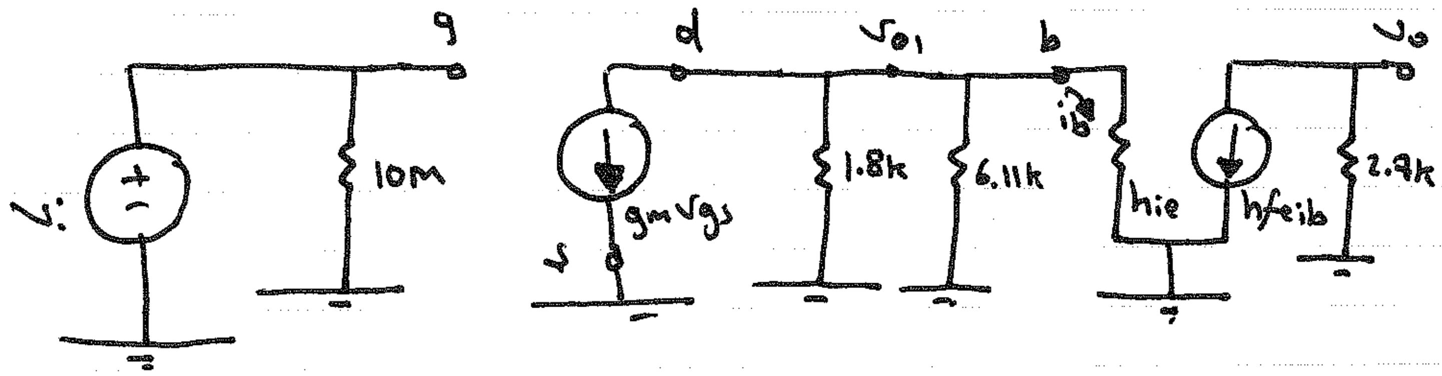
$$h_{ie} = \frac{(\beta+1) V_T}{I_E} = 4.71k$$

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

$$g_m = 2.75 \ mA/V$$

$$V_{GS} = -0.33k \ I_{DS} = -0.937V$$

ac small signal equivalent circuit :



$$A_{v1} = \frac{v_{o1}}{v_i} \ ; \quad v_{o1} = -g_m v_{gs}\left(1.8k \| 6.11k \| h_{ie}\right)$$

$$v_{gs} = v_g - v_s = v_g = v_i$$

$$\therefore A_{v1} = -2.75$$

$$A_{v2} = \frac{v_o}{v_{i2}} = \frac{v_o}{v_{o1}} \ ; \quad v_o = -h_{fe} i_b (2.7k)$$

$$i_b = \frac{v_{o1}}{h_{ie}}$$

$$\therefore A_{v2} = -85.98$$

$$A_{vT} = A_{v1} \cdot A_{v2} = 236.5$$

8.58

$Z_i = 10M\Omega$

$Z_o = 2.7K\Omega$