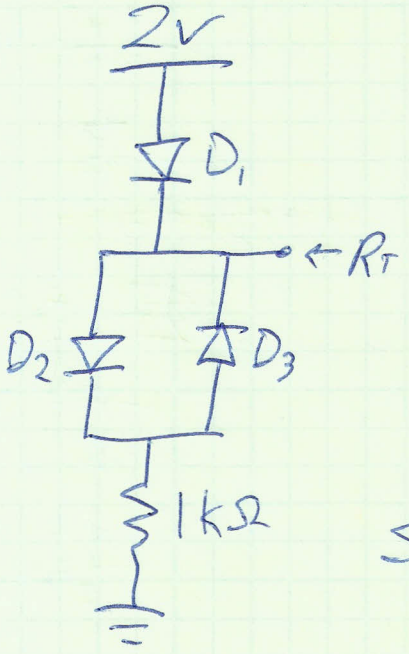
ECE 65 | Quiz 3

Question 1



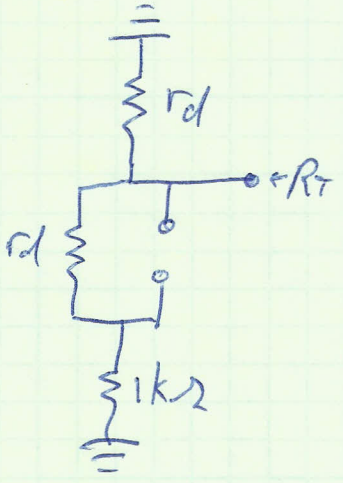
Diodes 1 and 2 are ON

Diode 3 is OFF

$$I_D = \frac{2V - 2\times 0.7V}{1k} = 0.6mA$$

$$r_d = \frac{nV_T}{I_D} = \frac{2\times 25mV}{0.6mA} = 83\Omega$$

Small signal circuit:



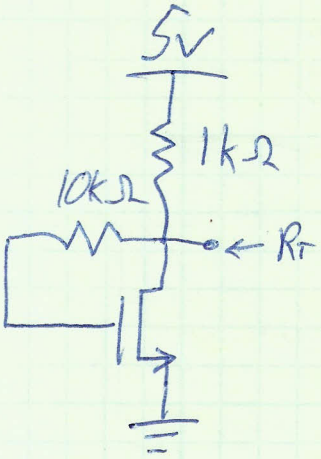
$$R_T = r_d \,||\, (r_d + 1k\Omega)$$

$$= \frac{1}{\frac{1}{83} + \frac{1}{1083}}$$

$$R_T = 77\Omega$$

ECE65 | Quiz 3

Question 2



$V_{DS} = V_{GS}$

$$I_D = \frac{5 - V_{GS}}{1000} = 0.5\times10^{-3}(V_{GS} - 1)^2$$

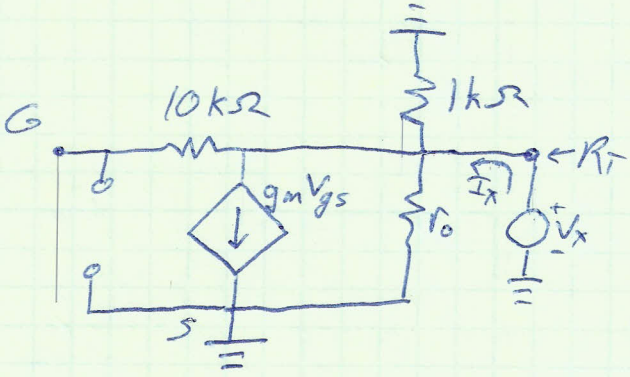
$$10 - 2V_{GS} = V_{GS}^2 - 2V_{GS} + 1$$

$$V_{GS}^2 = 9$$

$V_{GS} = \underline{3}$ or -3 ← not physical

$\underline{I_D = 2\,mA}$

Small signal circuit



apply test voltage V_x

$$V_{gs} = V_x$$

$$I_x = \frac{V_x}{1k} + \frac{V_x}{r_o} + V_x g_m$$

$$R_T = 1k \,\|\, r_o \,\|\, \frac{1}{g_m}$$

$$g_m = \frac{2I_D}{V_{GS} - V_t} = \frac{2\times2mA}{2V} = 2\times10^{-3}\,A/V = \frac{1}{500\Omega}$$

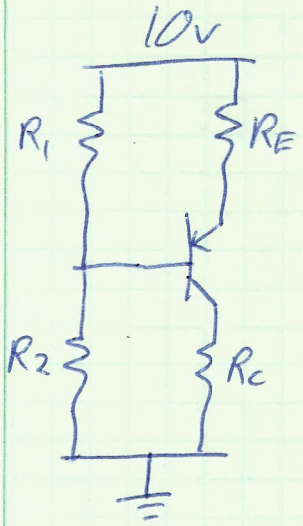
$V_A = \frac{1}{\lambda} = 20V$ → $r_o = \frac{V_A + V_{DS}}{I_D} = \frac{20+3}{2\times10^{-3}} = 11.5\,k\Omega$

$$R_T = 1k\Omega \,\|\, 11.5k\Omega \,\|\, 500\Omega$$

$$R_T = 324\Omega$$

ECE 65 | Quiz 3

Question 3



- Stable for variations in V_{BE} of $\pm 0.1V$

$I_E R_E \gg 0.1V$

$I_E \simeq I_C = 1mA$

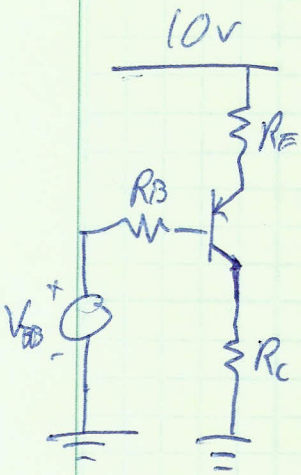
$1mA \cdot R_E \gg 0.1V$

choose $R_E = 1k\Omega$

$I_C (R_C + R_E) + V_{EE} = 10V$

$1mA\,(R_C + 1k\Omega) + 5V = 10V$

choose $R_C = 4k\Omega$



- Stable for variations in β over 50-200

$R_B \ll (1+\beta_{min}) R_E$

$R_B \ll 51k\Omega \rightarrow$ choose $R_B = 5k\Omega$

$V_{BB} = 10V - I_E R_E - V_{D0} = 8.3V$

$\frac{R_1 R_2}{R_1 + R_2} = 5k\Omega$

$\frac{10 \times R_2}{R_1 + R_2} = 8.3V$

$\rightarrow R_1 = \frac{10 \times 5k\Omega}{8.3V}$

choose $R_1 = 6k\Omega$

$10 \times R_2 = 8.3 (R_1 + R_2)$

$R_2 (10 - 8.3) = 8.3 \times 6k\Omega$

choose $R_2 = 29k\Omega$