2) a) $k'_n = 300\,\mu A/V^2$ $V_t = 1.0$ $\frac{W}{L} = 10$ 300E-6

7E3

$R_D = 7k\Omega$ $V_{DD} = 5V$

A: Point A is $\boxed{V_t = 1.0V}$

B: Point B = $V_{GS} = V_t + \frac{\sqrt{1 + 2R_D k'_n (W/L) V_{DD}} - 1}{R_D k'_n \left(\frac{W}{L}\right)}$

$R_D k'_n \left(\frac{W}{L}\right) = 1045.53$ $= \frac{\sqrt{1 + 2(1045.53)(5)} - 1}{1045.53} + 1.0$

$\boxed{\text{Point B} = V_{GS} = 1.64\ V}$

- A ☑
- B ☑
- IDQ ☑
- gm ☑
- ro ☑
- model ☐
- VGSQ ☑

Q point (V_{GSQ})

→ halfway between A & B:

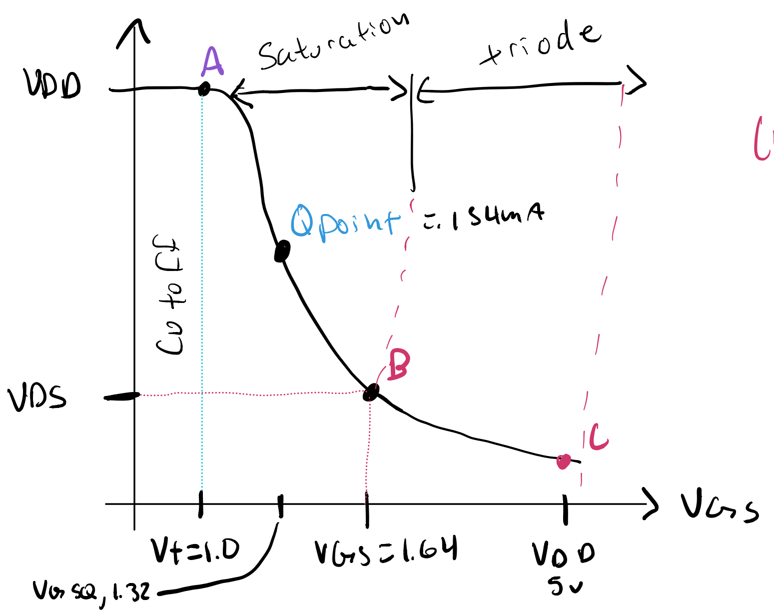
$V_{GSQ} = \frac{1.64 - 1.0}{2} + 1.0$; $\boxed{V_{GSQ} = 1.32V}$

IDQ:

$I_{DQ} = \frac{1}{2} k'_n \frac{W}{L} (V_{GSQ} - V_t)^2$

$I_{DQ} = \frac{1}{2}(300E\text{-}6)(10)(1.32 - 1.0)^2$

$\boxed{I_{DQ} = .154\ mA}$



(not to scale)

Part 2 Small signal model

$\lambda = .01 V^{-1}$

$R_L = 1k\Omega$

$g_m = k'_n \frac{W}{L}(V_{GSQ} - V_t) = (300E{-6})(10)(1.32 - 1.0)$

$\boxed{g_m = .96 \text{ mA/V}}$

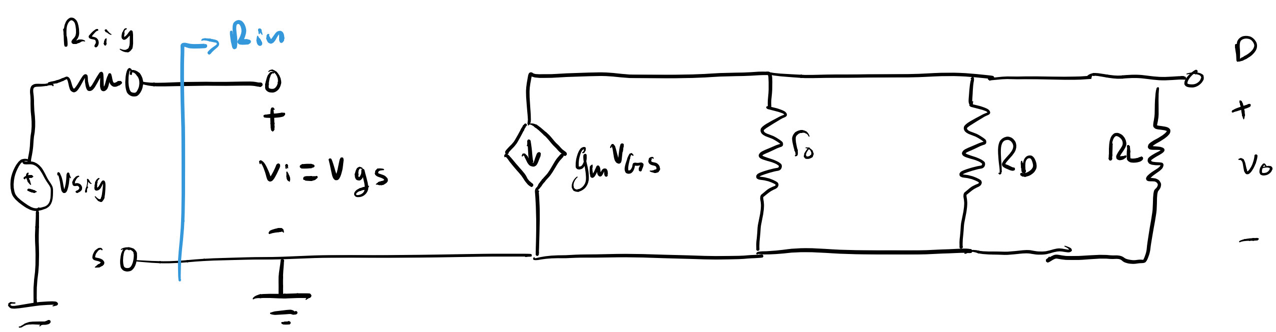
$r_o = \; r_o = \frac{1}{\lambda I_{DQ}} = \frac{1}{.01(.154)} = \boxed{r_o = 649.35k\Omega}$

$G_v = -g_m(r_o \parallel R_D \parallel R_L)$

$G_v = (.96)\left(\frac{649.35 \times 7 \times 1}{649.35 + 7 + 1}\right) = .96\left(\frac{4545}{657.35}\right) = 6.64 \text{ V/V}$

$\boxed{G_v = -6.64 \text{ V/V}}$

Small signal model:



Overall: $A = 1.0V$ $\quad I_{DQ} = .154mA$ $\quad G_v = -6.64 \text{ V/V}$

$B = 1.64V$ $\quad g_m = .96 \text{ mA/V}$

$V_{GSQ} = 1.32V$ $\quad r_o = 649.35k\Omega$

Thanks for a great semester!

Happy Holidays.