ENEE 303. HW set 2.

1. set up the circuit in Pspice as shown in Fig 1.

a) To graphically determine g_m, we plot I_D vs. V_{GS} at different V_{DS}. (Fig. 2)
To graphically determine r_o, we plot I_D vs. V_{DS} at different V_{GS}. (Fig. 3)

For $V_{GS} = V_{DS} = 3V$, to get g_m, as marked in Fig. 2, g_m is the slope at the point $V_{GS} = V_{DS} = 3V$.

$$g_m = 2.5 \times 10^{-4}\ A/V$$

To get r_o, as marked in Fig. 3, r_o is the slope at $V_{GS} = V_{DS} = 3V$. With the help from the cursor in Pspice, we are able to choose two adjacent points around $V_{GS} = V_{DS} = 3V$. (3.00V, 192.32 uA) and (3.04V, 192.47 uA). the slope we measured from these two points is 2.67×10^5 V/A.

(b). From the Pspice Library bicmos1a. lib, we find $V_{TO} = 0.858V$, $kp = 5.048 \times 10^{-5}$, Lambda $= 1.843 \times 10^{-2}$ for MNmos1's.

thus $g_m = k_p \frac{W}{L}(V_{GS} - V_t)$

$= 2.162 \times 10^{-4}$ A/V

$r_o = \frac{1}{\lambda I_D} = \frac{1}{1.843 \times 10^{-2} I_D}$

and $I_D = \frac{1}{2} k_p \frac{W}{L}(V_{GS} - V_t)^2$

so $r_o = 2.34 \times 10^5$

The above g_m and r_o are for $V_{GS} = V_{DS} = 3V$.

(c) Repeat the slope measurement in Pspice and recalculate g_m, r_o for $V_{GS} = V_{DS} = 4V$,

we get $g_m = 3.0 \times 10^{-4}$ A/V (from graph)

$g_m = 3.172 \times 10^{-4}$ A/V (from formula)

$r_o = 1.13 \times 10^5\,\Omega$ (from graph, the two points chosen are (4.00V, 410.557uA) and (4.04V, 410.911 uA))

$r_o = 1.089 \times 10^5\,\Omega$ (from formula).

2. a). When $V_{DD} = 5V$, $V_{DS} = 3V$, $V_{GS} = 3V$,

we have $I_D = 192$ uA from problem 1.

thus $R_D = \frac{V_{DD} - V_{DS}}{I_D} = 10.4\ k\Omega$

b) The loadline is shown in Fig. 4.

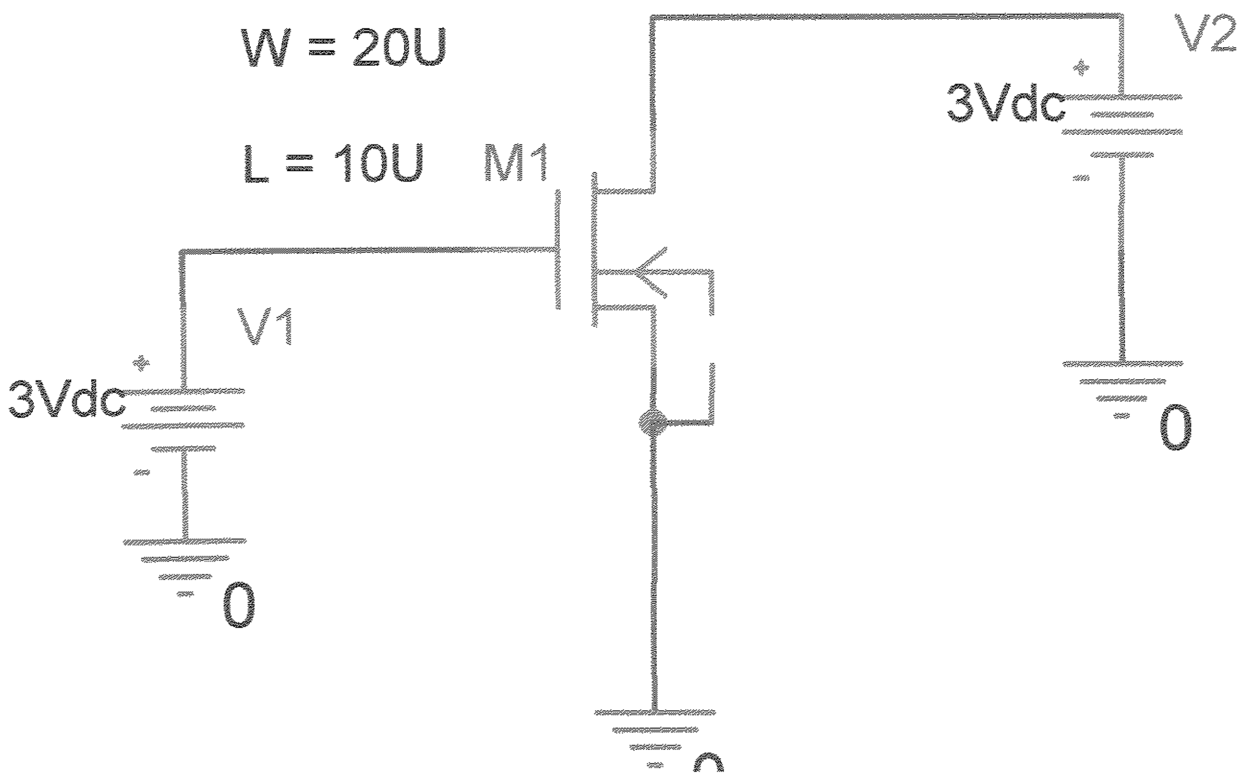

Fig 1.

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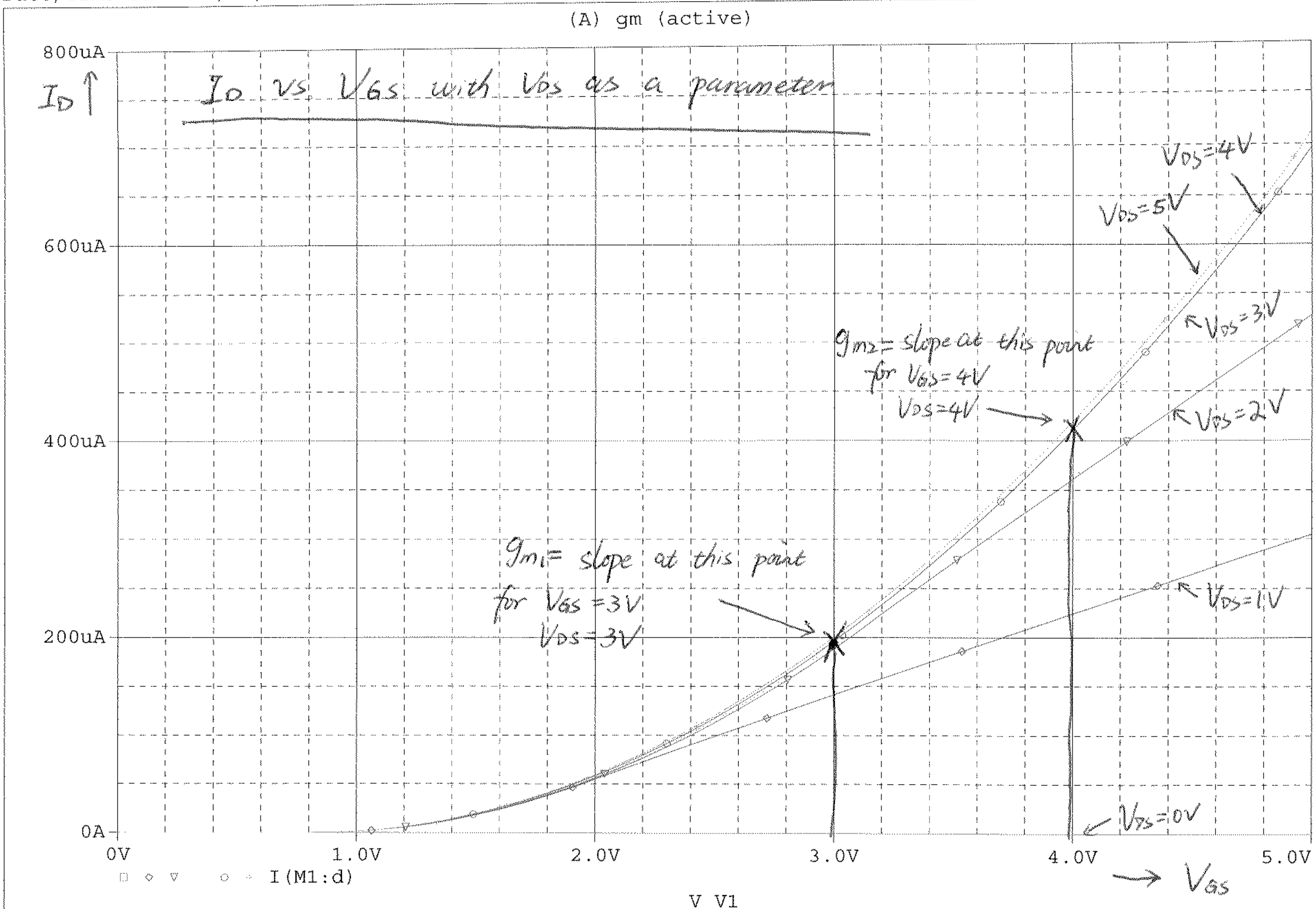

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Fig. 2.

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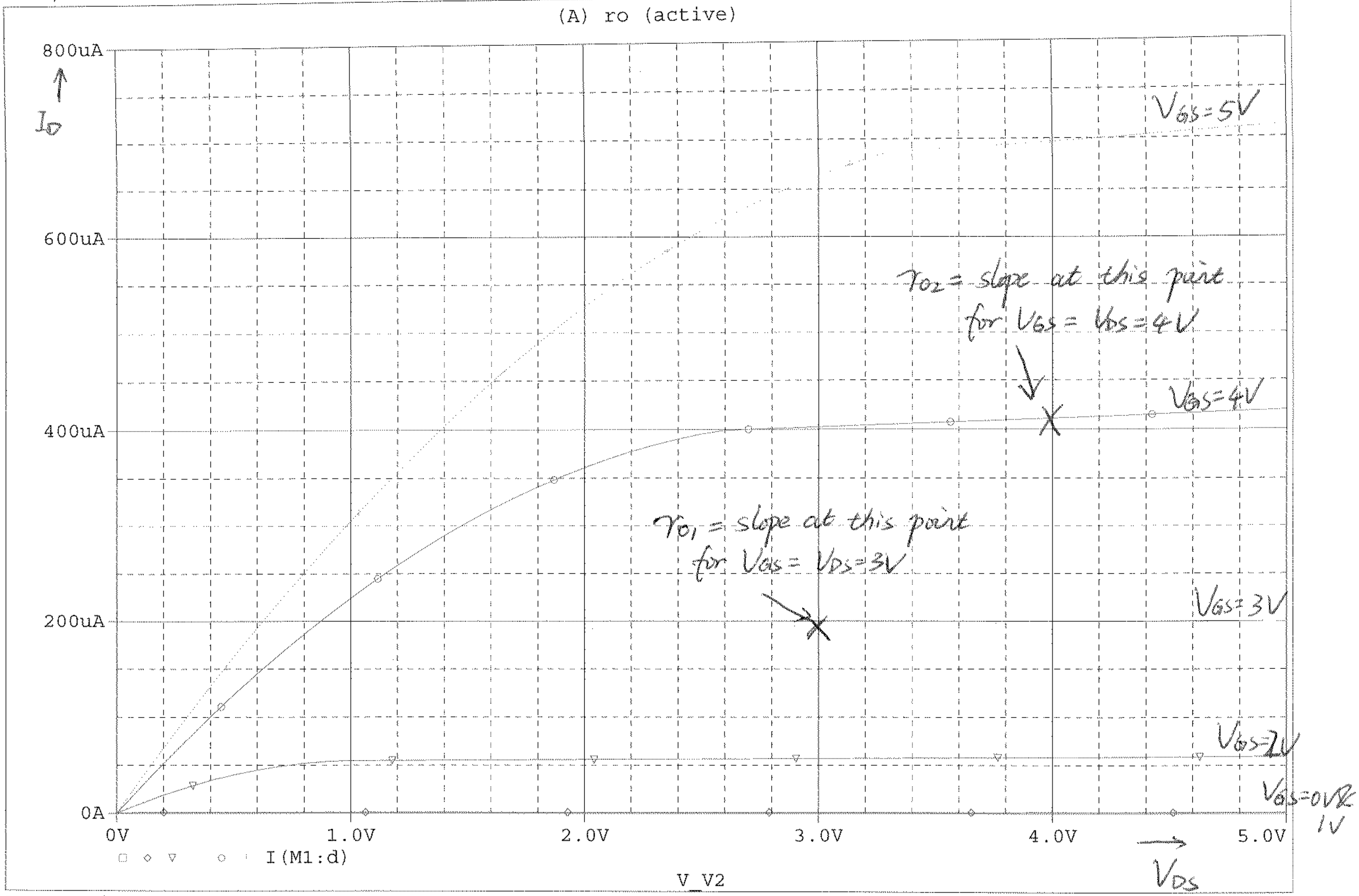

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Fig. 3.

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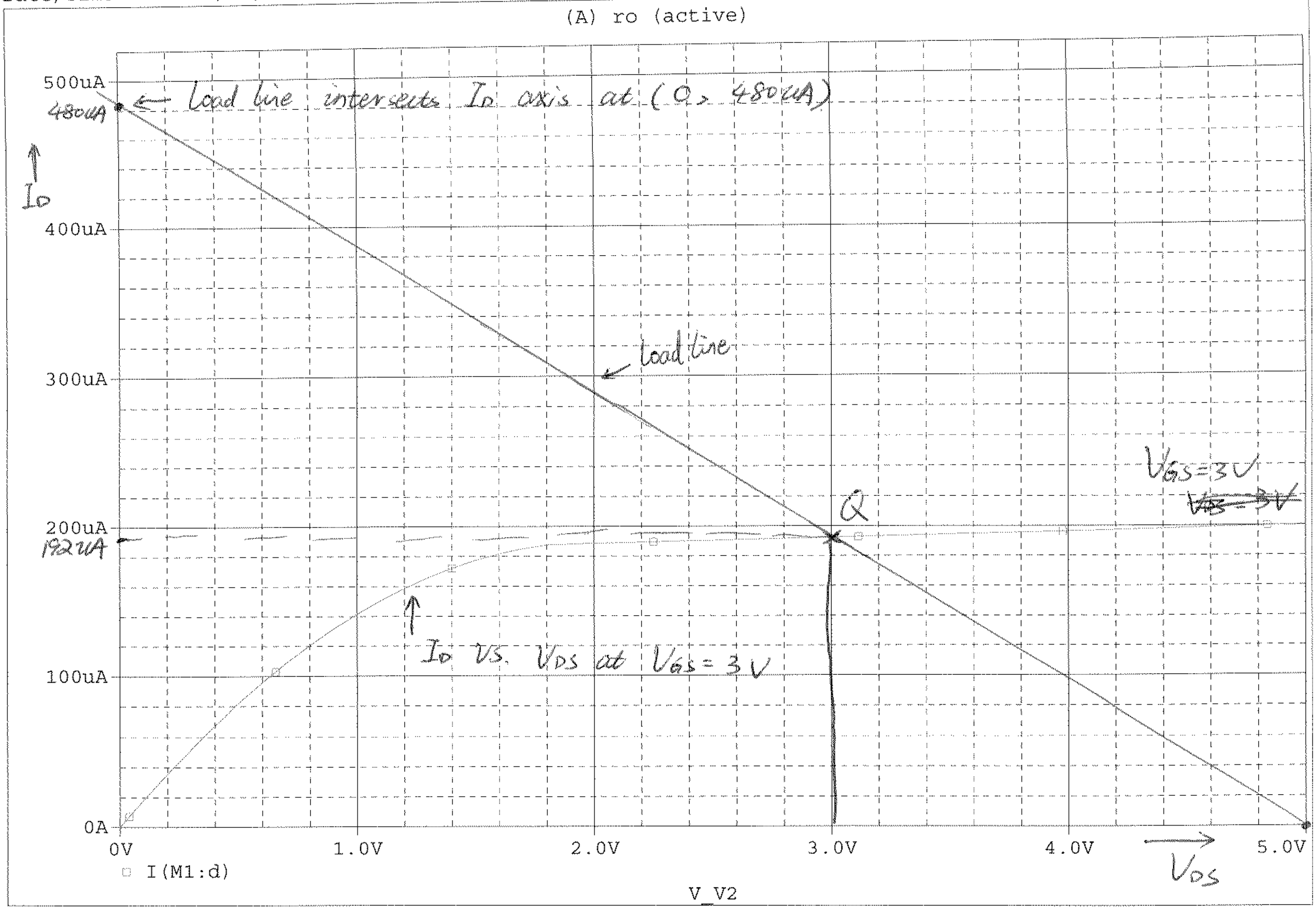

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Fig. 4.