1. The drain characteristics of a short-channel MOSFET are shown below.

(a) Find the transconductance $g_m$ in $\mu$S and the output resistance $r_o$ in k$\Omega$ at operating point A.
(b) Find the transconductance $g_m$ in $\mu$S and the output resistance $r_o$ in k$\Omega$ at operating point B.

2. A two-port device is characterized by the following equations

$$I_1 = 10 \cdot e^{\frac{V_1}{4}} + 20 \cdot (V_2 - 3)^3$$
$$I_2 = 12 \cdot V_1 \cdot V_2$$

(a) Determine the quiescent currents $I_1$ and $I_2$ if $V_{1Q} = 0.5V$ and $V_{2Q} = 4V$
(b) Determine the small-signal model of the device at the operating point defined in part (a)

3. (a) Determine the small-signal parameters of a NMOS transistor biased in the triode region
(b) Compare the transconductance ($\frac{\partial I_{DS}}{\partial V_{GS}}$) of a transistor biased in the triode region with one biased in saturation
(c) Use SPICE to plot the transconductance of the transistor below as $V_{DS}$ is swept from 0V to 3V.

If using HSPICE, the model for the transistor should look like the following:

```
.MODEL {name} NMOS VT={value} KP={value}
```

Does your simulated result agree with your hand-calculated results from parts (a) and (b)? Note any discrepancies that you observe, if any.

(W/L) = 10
$V_{to} = 0.8$ V
$u_{nC_{ox}} = 60$ $\mu$A/V^2