Problem 6 Semiconductor Devices Spring 2015

The standard model for an *n*-channel insulating gate field effect transistor is based on the simple **gradual channel approximation (GCA)**. In a steady state, let's say that the source is grounded, the drain is held at V_d, and the gate at V_g. This type of model yields for the output characteristics the familiar result:

$$J_d = \frac{\mu C}{L}[(V_g - V_T)V_d - \frac{V_d^2}{2}] \qquad \text{for} \qquad 0 \le V_d \le V_g - V_T$$

Here J_d is the lineal drain current density (drain current per unit channel width), μ is the electron mobility, L is the channel length, and C is the gate capacitance per unit area.

Based on the simple GCA that yields the result above, determine the channel potential, $V(x)$, for $0 \le x \le L$, where $x = 0$ corresponds to the source, $V(0) = 0$, and $x = L$ to the drain, $V(L) = V_d$. Also determine the electric field in the channel parallel to the direction of the current, $F_x(x)$. (Your functions $V(x)$ and $F_x(x)$ should depend parametrically only on V_d, V_g, and V_T).

Hints: Electron diffusion is to be neglected. Make sure that your solution satisfies the boundary conditions.