1. a. Consider the following long channel NMOS transistor. Derive the current (I_D) flowing through the device in the linear region of operation (V_{GS} > V_T; V_{DS} < V_{GS} - V_T). V_T is the transistor threshold voltage, t_ox is the gate oxide thickness, \( \varepsilon \) is the permittivity of oxide, W is the width of the transistor, and L is the length of the transistor. Also assume that the drift velocity of carriers is proportional to the electric filed, and the proportionality constant is mobility, \( \mu \).

b. Determine the current when the transistor is in saturation region, (V_{GS} - V_{DS}) \leq V_T. Ignore channel length modulation. Clearly state all assumptions.

2. Consider the simple inverter shown in the following inverter. Determine the output voltage when the input is 2V. Assume \( \beta = \mu I / t_{ox} = 50 \mu A/V^2 \). And W/L of the transistor is equal to 2. \( V_i = 1V \). It is important that you justify your results.

3. For the following circuit, determine the output voltage. Assume body effect is negligible.