EE 362 Electronic, Magnetic, & Optical Properties of Materials
Quiz 9 (Spring 2026)

Name KEY A

Instructions: Open book & notes. Place answers in indicated spaces. Show **all** work. Use 4-5 significant figures.

A silicon n-channel MOSFET with a SiO_2 oxide layer is described by the following parameters at 300 K: $t_{ox} = 36$ nm, $L = 2$ µm, $W = 24$ µm, and $\mu_n = 440$ cm^2/V-s. The source and body are grounded. Find the oxide capacitance C_{ox} (F/m^2). If the threshold voltage is $V_T = 0.8$ V and gate-source voltage is $V_{GS} = 1.5$ V, find the saturation drain-source voltage V_{DS}(sat). Then, determine the mode of operation (e.g., cutoff, linear, or saturation) and drain current I_D when $V_{DS} = 1$ V.

From Table B.6, $\varepsilon_r = 3.9$ for SiO_2 at 300 K.

Per (10.35), $C_{ox} = \dfrac{\varepsilon_{ox}}{t_{ox}} = \dfrac{3.9(8.8541878\times10^{-12})}{36\times10^{-9}}$ $\Rightarrow$ **$C_{ox} = 9.59204\times10^{-4}$ F/m^2.**

Per (10.43b) or (10.64), $V_{DS}(\text{sat}) = V_{GS} - V_T = 1.5 - 0.8$ $\Rightarrow$ **V_{DS}(sat) = 0.7 V.**

Since $V_{DS} = 1\text{ V} > V_{DS}(\text{sat}) = 0.7\text{ V}$ & $V_{GS} = 1.5\text{ V} > V_T = 0.8\text{ V}$

$\Rightarrow$ **Saturation mode.**

Per (10.45a) or (10.66),

$$I_D(\text{sat}) = \frac{W\mu_n C_{ox}}{2L}\left(V_{GS} - V_T\right)^2 = \frac{24\times10^{-6}(440\times10^{-4})9.59204\times10^{-4}}{2(2\times10^{-6})}(1.5-0.8)^2.$$

$\Rightarrow$ **I_D(sat) = 1.24083×10^{-4} A = 0.124083 mA = 124.083 µA.**

C_{ox} = **9.592×10^{-4} F/m^2** V_{DS}(sat) = **0.7 V**

Mode of operation is **saturation** I_D = **1.2408×10^{-4} A = 0.12408 mA = 124.08 µA**

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Name __**KEY B**__

Instructions: Open book & notes. Place answers in indicated spaces. Show **all** work. Use 4-5 significant figures.

A silicon n-channel MOSFET with a SiO_2 oxide layer is described by the following parameters at 300 K: $t_{ox} = 28$ nm, $L = 2$ µm, $W = 26$ µm, and $\mu_n = 480$ cm^2/V-s. The source and body are grounded. Find the oxide capacitance C_{ox} (F/m^2). If the threshold voltage is $V_T = 0.7$ V and gate-source voltage is $V_{GS} = 2$ V, find the saturation drain-source voltage V_{DS}(sat). Then, determine the mode of operation (e.g., cutoff, linear, or saturation) and drain current I_D when $V_{DS} = 1.5$ V.

From Table B.6, $\varepsilon_r = 3.9$ for SiO_2 at 300 K.

Per (10.35), $C_{ox} = \frac{\varepsilon_{ox}}{t_{ox}} = \frac{3.9(8.8541878\times10^{-12})}{28\times10^{-9}}$ ⇒ **$C_{ox} = 1.233262\times10^{-3}$ F/m^2.**

Per (10.43b) or (10.64), $V_{DS}(\text{sat}) = V_{GS} - V_T = 2 - 0.7$ ⇒ **V_{DS}(sat) = 1.3 V.**

Since $V_{DS} = 1.5$ V > V_{DS}(sat) = 1.3 V & $V_{GS} = 2$ V > $V_T = 0.7$ V

⇒ **Saturation mode.**

Per (10.45a) or (10.66),

$$I_D(\text{sat}) = \frac{W\mu_n C_{ox}}{2L}\left(V_{GS}-V_T\right)^2 = \frac{26\times10^{-6}(480\times10^{-4})1.233262\times10^{-3}}{2(2\times10^{-6})}(2-0.7)^2.$$

⇒ **I_D(sat) = 6.50274×10^{-4} A = 0.650274 mA = 650.274 µA.**

C_{ox} = **1.2333×10^{-3} F/m^2** V_{DS}(sat) = **1.3 V**

Mode of operation is **saturation** I_D = **6.5027×10^{-4} A = 0.65027 mA = 650.27 µA**