

FINAL EXAMINATION
December 2000

DURATION: 3 HOURS

Number of Students: 74

Department Name & Course Number: Electronics 97.469A

Course Instructor(s): N.G. Tarr

AUTHORIZED MEMORANDA: calculators **NO BOOKS OR NOTES**

Students **MUST** count the number of pages in this examination question paper **before** beginning to write, and report any discrepancy immediately to a proctor. This question paper has five (5) pages.

This examination question paper **may not** be taken from the examination room.

ANSWER ALL QUESTIONS

WRITE ANSWERS ON THE EXAM PAPER
(If necessary, continue answers on the back of pages)

$q = 1.6 \times 10^{-19} \text{ C}$ $k = 1.38 \times 10^{-23} \text{ JK}^{-1}$ $\epsilon_0 = 8.85 \times 10^{-12} \text{ Fm}^{-1}$ $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ $kT/q = 0.0259 \text{ V}$

Data for silicon at 300K: $n_i = 10^{10} \text{ cm}^{-3}$ $E_G = 1.12 \text{ eV}$ $N_C = 2.8 \times 10^{19} \text{ cm}^{-3}$ $N_V = 1 \times 10^{19} \text{ cm}^{-3}$ $\epsilon_s = 11.9 \epsilon_0$
 $\mu_n = 1350 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ $\mu_p = 480 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ $\epsilon_{ox} = 3.9 \epsilon_0$

Drive-in: $C(x) = \frac{Q}{\sqrt{\pi D t}} \exp\left(-\frac{x^2}{4 D t}\right)$ Ion implant: $C(x) = \frac{Q}{\sqrt{2\pi} \Delta R_p} \exp\left[-\frac{(x-R_p)^2}{2 \Delta R_p^2}\right]$

Triode ($V_{GS} - V_T > V_{DS}$): $I_D = \frac{W}{L} \mu_n C_{ox} (V_{GS} - V_T - \frac{V_{DS}}{2}) V_{DS}$ Saturation ($V_{DS} > V_{GS} - V_T$): $I_D = \frac{W}{L} \mu_n C_{ox} \frac{(V_{GS} - V_T)^2}{2}$

$V_{Tn} = V_{FB} + 2\phi_b + \frac{\sqrt{2\epsilon_s q N_A (2\phi_b + V_{SB})}}{C_{ox}} - \frac{q D_{impl}}{C_{ox}}$ $\Delta V_T = -\frac{q D_{impl}}{C_{ox}}$ $C_{ox} = \frac{\epsilon_{ox}}{t_{ox}}$ $\phi_b = \frac{kT}{q} \ln\left(\frac{N_A}{n_i}\right)$

$\rho = \frac{1}{q \mu_n N}$

