UNIVERSITY OF CALIFORNIA, BERKELEY
College of Engineering
Department of Electrical Engineering and Computer Sciences

EE 130/230M Spring 2013
Integrated Circuit Devices Prof. Liu & Dr. Xu

QUIZ #6
Time allotted: 25 minutes

NAME: _____ _____ _____
(print) Last First Signature

INSTRUCTIONS:
1. Use the values of physical constants provided below.
2. SHOW YOUR WORK, & write legibly!
3. Underline or box numerical answers and SPECIFY UNITS where appropriate.

Problem 1 [12 points]

(a) Indicate how a long-channel MOSFET's performance parameters would be affected (*i.e.* check the appropriate column) **if the channel/body doping is increased by a factor of 2. Explain briefly.**

Parameter	[1 pt each]: **Value would**			**Brief explanation** [2 pts each]
	increase	**decrease**	**not change**	
Subthreshold swing, *S* [units: mV/dec]				
Transconductance, g_m [units: A/V]				

(b) What is a retrograde channel doping profile, and why is it used in short-channel MOSFETs? [3 pts]

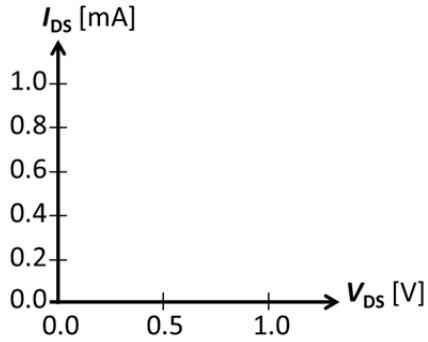
(c) What is the MOSFET short-channel effect, what causes it, and why is it undesirable? [3 pts]

Problem 2 [8 points]

Consider a short n-channel MOSFET with $W = 1$ μm, $L = 0.1$ μm, $C_{oxe} = 10^{-6}$ F/cm^2, and $m = 1$.

(a) Estimate the drain saturation voltage (V_{Dsat}) for $V_{GS} - V_T = 1$ V, assuming $\mu_{eff} = 400$ cm^2/V·s. [3 pts] (Recall that $v_{sat} = 8\times10^6$ cm/s for electrons in Si.)

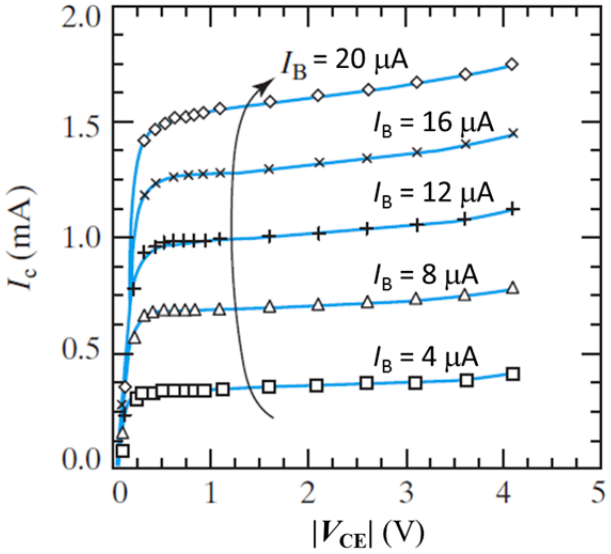
(b) Draw the I_D-V_{DS} curve for $V_{GS} - V_T = 1$ V on the axes provided. Indicate V_{Dsat} and the value of I_D at $V_{DS} = V_{Dsat}$. [3 pts]

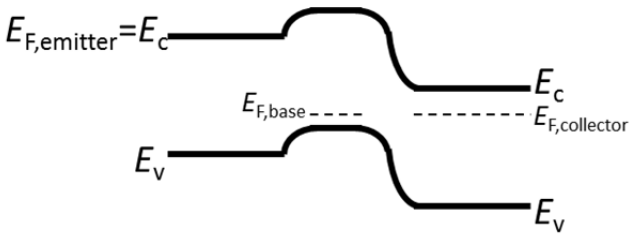


(c) Draw another I_D-V_{DS} curve to qualitatively show how a large source resistance and large drain resistance would affect the *I-V* characteristic. [2 pts]

Problem 3 [5 points]

Suppose that a BJT with the common-emitter output characteristics shown below is operating under applied voltages such that $I_C \cong 1$ mA with the following energy band diagram:





(a) What type of BJT is this (PNP or NPN)? [1 pt]

(b) Indicate (by drawing a large dot) the operating point of this BJT on the *I-V* plot above. [2 pts]

(c) Estimate the d.c. current gain, β_{dc}. [2 pts]