

GUJARAT TECHNOLOGICAL UNIVERSITY**M. E. - SEMESTER – I • EXAMINATION – WINTER 2012****Subject code: 714203N****Date: 12-01-2013****Subject Name: Advanced MOSFET Modeling****Time: 02.30 pm – 05.00 pm****Total Marks: 70****Instructions:**

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Briefly explain/define following: 1. Poisson's equation for one dimension, 2. Drift current 3. Diffusion current, 4. Velocity saturation effect, 5. Sheet resistance, 6. Contact potential, 7. Transit time **07**
- (b) Draw I_D - V_{DS} characteristics for n-channel MOSFET on a log and linear I_D axis for various values of V_{GS} . Clearly indicate all three regions in your plot; 1. Strong inversion, 2. Moderate inversion and 3. Weak inversion. **07**

- Q.2** (a) Draw p-type substrate two terminal MOS structure and its band diagram for four different regions of operation; 1. Flat-band, 2. Accumulation, 3. Depletion and 4. Inversion. **07**
- (b) Describe various types of parasitic charges that exist in MOS system and define flat-band voltage. Discuss dependence of surface potential on V_{GB} for a p-type substrate MOS capacitor. **07**

OR

- (b) Derive expression for Q'_B and C'_b in MOS capacitor without assuming depletion approximation. **07**
- Q.3** (a) Obtain expression for inversion charge for three-terminal p-type MOS structure operating weak inversion region. **07**
- (b) Derive the strong inversion drain current model which is the basis of "level 3" model implemented in Berkeley Spice simulator. **07**

OR

- Q.3** (a) Explain how the Fermi level split occurs in three-terminal p-substrate MOS structure when V_{CB} is increased from a level of 0. Draw necessary energy band diagram. Obtain expression for electron concentration at the surface for p-type substrate three-terminal MOS structure. **07**
- (b) Discuss following for MOSFET device: 1. Various scattering phenomena and their effect on mobility, and 2. Effect of increasing temperature on mobility and leakage current. **07**

- Q.4** (a) Define α parameter used in simplified charge sheet model. Discuss the effect of α parameter on the accuracy of simplified strong inversion model. **07**
- (b) Explain constant field downscaling technique. Show that the voltage drop across metal line does not change with downscaling. **07**

OR

- Q.4** (a) What do you understand by punchthrough? What is the effect of bulk punchthrough on I_D - V_{GS} characteristics? What are the different types **07**

of punchthrough and how can you avoid them?

- (b) Show that due to velocity saturation effect, the drain current in short-channel MOSFET does not follow square-law. Also justify that the ratio of (W/L) of PMOS and NMOS devices is less than 2 for equal driving capability in short-channel devices. **07**

- Q.5** (a) The gate of MOSFET is applied with pulse signal having finite rise and fall time. Assume that the rise time is greater than the fall time. Also assume that the frequency of input signal is very low and MOSFET operates in quasi-static region. Plot drain and source currents as a function time. Make important comments. **07**

- (b) What are the different benchmark tests to evaluate MOSFET models? **07**
What should be the behavior of I_D , Q , and capacitances model equations at $V_{DS} = 0$ V? Draw the test setup to verify the same.

OR

- Q.5** (a) Explain the computation of terminal currents in MOSFET device in time domain under assumption of quasi-static operation. **07**

- (b) How would you measure/estimate ΔL , ΔW , and summation of drain and source resistance? Explain in detail with necessary diagrams and equations. **07**
