Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER–I(New course)• EXAMINATION – WINTER- 2015

Subject Code: 2712605 **Date: 02/01/2015**

Subject Name: Physics of MOS Transistor

Time:2:30 pm to 5:00 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)**	Draw I_D-V_{GS} characteristics for p-channel MOSFET on a log and linear I_D axis for three different values of V_{BS} (e.g. $V_{BS1} < V_{BS2} < V_{BS3}$). How can we obtain threshold voltage and body bias parameters from I_D-V_{GS} characteristics?	**07**
	(b)	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, and 7. Depletion approximation.	**07**
Q.2	**(a)**	Draw p-type substrate two terminal MOS structure and derive the exact expression for channel charge (Q'_C).	**07**
	(b)	Define surface potential and show mathematically that the inversion charge in MOS capacitor is an exponential function of V_{GB} when the device is operating in weak inversion region.	**07**
		OR	
	(b)	Derive expression for Q'_B and C'_b in MOS capacitor without assuming depletion approximation.	**07**
Q.3	**(a)**	Explain the working of three-terminal MOSFET device from the "V_{CB} control point of view" and derive expressions for following critical voltage levels: V_Q, V_W, and V_U.	**07**
	(b)	What do you understand by charge sheet approximation? Derive complete charge sheet drain current model for MOSFET device.	**07**
		OR	
Q.3	**(a)**	Draw energy band diagram for three-terminal MOS structure (p-type substrate) for 1. $V_{CB} = 0$ and 2. $V_{CB} > 0$. Assume $V_{GB} > V_T$. Also, obtain expressions electrons and holes concentration as a function of V_{CB} and surface potential.	**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)	Derive the relationship between drain current expression with and without considering velocity saturation effect.	**07**
		OR	
Q.4	**(a)**	Define drain-induced barrier lowering (DIBL). Derive the expression for the drop in threshold voltage due to DIBL in short-channel MOSFET device compared to long-channel device for deep source/drain regions.	**07**
	(b)	Discuss mathematically the effect of using shallow-trench isolation technique on narrow channel effect. Briefly compare the above effect with that in case of LOCOS technique.	**07**

Q.5	**(a)**	How would you measure/estimate ΔL, ΔW, and summation of drain and source resistance? Explain in detail with necessary diagrams and equations.	**07**
	(b)	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**

OR

Q.5	**(a)**	What are the different types of MOSFET models? Discuss merits and demerits of each type of MOSFET models.	**07**
	(b)	What do you understand by quasi-static operation of MOSFET device? Derive various charge expressions as a function of terminal voltages for strong inversion region under the assumption of quasi-static operation. (No need to carry out integration)	**07**

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