Registration no: | | | | | | | | | | |

Total Number of Pages: 02

M.Tech
VLPE206

2nd Semester Regular / Back Examination 2015-16
EMERGING TOPICS IN IC DESIGN
Q.CODE:W932
Time: 3 Hours
Max Marks: 70

Answer Question No.1 which is compulsory and any five from the rest.
The figures in the right hand margin indicate marks.
Assume values wherever missing

Q1 Answer the following questions: **(2 x 10)**

- **a)** What are the drawbacks of JFET? Enlist some alternative configurations
- **b)** Find the maximum width of the depletion region for an ideal MOS capacitor on p-type Si in strong inversion given that the doping concentration is 10^{16} cm^{-3} and the relative dielectric constant is 11.8.
- **c)** Enlist some properties of ideal MIS systems.
- **d)** Calculate the cutoff frequency of a MOSFET given the following information: L = 1μm; n-channel device with a p-type substrate; μ'_n= 1200 cm^2/ (V s); Z = 10 L; V_T =1.1 V; and V_G = 5V.
- **e)** Enlist the important features that arise in short-channel MOSFETs.
- **f)** Mention some key advantages of molecular materials.
- **g)** Differentiate between an Inverting type nMOS super buffer and an Non-inverting type nMOS super buffer
- **h)** Design an AOI Logic Circuit for the given SOP expression: $F = \bar{A}B\bar{C}D + BC\bar{D} + A\bar{B}$.
- **i)** Implement a 2:1 MUX using TG logic.
- **j)** What is hierarchy? How does it help in modular design?

Q2 **a)** Discuss the behavior of a MESFET under different gate bias conditions with suitable illustrations. **(5)**

b) What is a MODFET? Give its basic device structure. What do you understand by 2 DEG? **(5)**

Q3 **a)** Draw and explain the Energy band diagram for an ideal MIS structure in equilibrium. **(5)**

b) Calculate the threshold voltage for a MIS structure given the following information. **(5)**

Let the semiconductor be p-type Si and the metal be Al. The doping concentration is Na = 10^{17} cm^{-3}, the oxide thickness is d = 10 nm, the work

function difference ϕ_{ms} = −1.05 V, the insulator surface charge density is Q_i = $5 \times 10^{10}q$ C/cm^2, and κ_i = 3.9. Determine the depletion region width, W, the flat band voltage, V_{FB} and the threshold voltage, V_T.

Q4 Consider an n-channel MOSFET with the following information: **(10)**
Na=5 × 10^{16} cm^{-3};μ'_n=500 cm^2/(V s); ϕ_{ms} = −0.96 V; Q_i = 5 × 10^{10} q/cm^2; Z = 50μm; d = 30 nm; L = 5 μm; n_i = 10^{10} cm^{-3}; κ_0 = 3.9; Eg = 1.12 eV; κ_s = 11.9.
(i) Determine the drain current at a gate voltage VG = 2 V and a drain voltage V_D =1 V.
(ii) Consider the case where the gate voltage is 3 V and the drain voltage in 4 V.

109

Q5 a) An n-channel MOSFET is to be scaled using constant voltage scaling. If the scaling factor λ is 0.7, determine the new device parameters given that the original device has L = 1.0 μm, Z = 100 mm, d (the oxide thickness) = 25 nm, Na = 5 ×10^{15} cm^{-3}, and the applied voltage is 3 V. **(5)**

109

b) Determine the thickness of the Si active layer in a partially depleted SOI device if the layer is only 50% depleted in equilibrium. Assume that the Schottky barrier height is 0.72 eV, the effective density of states within the conduction band is N_c = 3.22 × 10^{19} cm^{-3}, and the doping concentration is 10^{16} cm^{-3}. Assume that all of the donors are ionized. **(5)**

109

Q6 a) What do you mean by steering logic? Discuss design of any combinational circuit using steering logic. **(5)**

b) Compare between Semicustom and Full custom design strategies. **(5)**

Q7 a) Determine how the Poisson equation scales under: **(5)**
(i) Constant voltage scaling.

109

(ii) Quasi-constant voltage scaling.

b) Compare between CMOS and BICMOS logic. **(5)**

Q8 Write short notes on any two: **(5 x 2)**

a) CMOS static plots

b) Small Signal operation of MOSFETS

109

c) Carbon Nano tubes

d) Moletronics

109

109