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CS/B.Tech (CSE)/SEM-8/CS-801D/2011 2011 VLSI DESIGN

Time Allotted: 3 Hours Full Marks: 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP - A (Multiple Choice Type Questions)

 $1. \quad \hbox{Choose the correct alternatives for any $\it ten$ of the following:}\\$

 $10 \times 1 = 10$

- i) The composition of the aluminium-copper-silicon alloy used to reduce the electromigration effects is
 - a) 89% Al, 5% Cu and 6% Si
 - b) 95% Al, 4% Cu and 1% Si
 - c) 70% Al, 10% Cu and 20% Si
 - d) 89% Al, 10% Cu and 5% Si.

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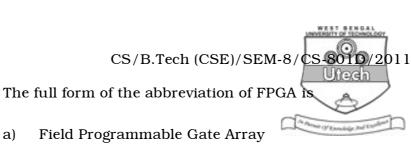
- ii) NMOS enhancement mode transistors are faster than PMOS transistors, because
 - a) the electron mobility is higher than the hole mobility
 - b) the hole mobility is higher than the electron mobility
 - c) concentration of electron is greater than holes
 - d) none of these.
- iii) Gate current of a MOSFET is smaller than that of a JFET, because
 - a) the insulating oxide layer offers a very high input resistance
 - b) the insulating oxide layer offers a very low input resistance
 - c) the insulating oxide layer offers a very high output resistance
 - d) none of these.
- iv) For a symmetric CMOS inverter, Z_{pd} : Z_{pu} =
 - a) 1.5 : 1

b) 2.5:1

c) $2 \cdot 1 : 1$

d) 2:1.

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Function Programmable Gate Array b)

v)

a)

- Field Programmable Graphics Array c)
- d) Field Programmable Graphics Adaptor.
- Ingots of single crystal silicon are produced from molten vi) polycrystalline silicon by
 - Czochralski method CVD method a) b)
 - CCD method d) c) None of these.
- vii) One property of fuse-based FPGA is
 - a) one-time programmable
 - two-time programmable b)
 - three-time programmable c)
 - d) none of these.
- viii) For pseudo nMOS logic ratio of Z (pull-up) and Z (pulldown) is

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- a) 4:1b) 3:1
- c) 2:1d) 1:1.

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ix)	Maximum fan-outs of CMOS inverter circuit are			
	a)	4	b)	10 An Annual Of Exemple of Exemple of
	c)	14	d)	20
x)	For a given process if all dimensions are in term λ rule, then minimum dimension is of			
	a)	2 λ	b)	4 λ
	c)	6 λ	d)	8 λ.
xi)		ch design rule is I design ?	scalab	le in the context of
	a)	λrule	b)	μ rule
	c)	σrule	d)	none of these.
xii)	For	nMOS transistor the	source	and drain should be
	a)	n type	b)	p type
	c)	m type	d)	none of these.
xiii)	i) Which of the following devices is expected to have highest input impedance?			is expected to have the
	a)	BJT		
	b)	JFET		
	c)	MOSFET.		
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- xiv) The source self-bias technique cannot be used for
 - a) JFETs
 - b) enhancement MOSFETs
 - c) depletion MOSFETs.
- xv) A depletion MOSFET differs from a JFET because it has no
 - a) gate
 - b) channel
 - c) p n junction.

GROUP – B (Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

- 2. Give the CMOS implementation of an XOR gate.
- 3. Compare between CMOS technology and BiCMOS technology.
- 4. Explain how two cross-coupled inverters function like a flip-flop.
- 5. What is scaling in VLSI? What are the two scaling models used in VLSI? What is ion implantation?
- 6. Describe the procedures for "placement" and "Routing" in VLSI physical design.

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(Long Answer Type Questions)

Answer any three of the following.



7. a) Show that the resistance of an enhancement mode *N*-MOSFET for low drain-source voltage is

$$R = \frac{LD}{\mu \xi W(V_{GS} - V_{TH} - V_{DS}/2)}$$

where the symbols have their usual meanings.

- b) How is the drain current related to the gate-source voltage in the saturation region ? 10 + 5
- 8. a) Derive an expression for the inverter logic threshold voltage V_{INV} for an N-MOS inverter and hence show that for V_{INV} to lie midway between the drain supply voltage and ground, $Z_{pu}:Z_{pd}=4:1$.
 - b) An *N*-MOS transistor with $k = \mu \xi/D = 25 \times 10^{-6} \, \text{A/V}^2$ and $V_{TH} = 1.5 \, \text{V}$ is operated at $V_{GS} = 5 \, \text{V}$, $I_D = 50 \mu \, \text{A}$ and $V_{GS} = 0.25 \, \text{V}$. Find the value of W/L and the power dissipated by the transistor. If $V_{DD} = 5 \, \text{V}$, calculate the load resistance R to be connected in series with the drain.

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- 9. a) Explain the operation of a basic NMOS inverter.
 - b) Why is a depletion mode MOSFET used in the place of resistor as a pull-up in the inverter circuit?
- 10. a) What do you mean by the transfer characteristic of an inverter?
 - b) Explain the characteristic.
 - c) Explain the following terms:
 - i) Inverter logic threshold voltage
 - ii) Gain
 - iii) Aspect ratio.
 - d) How do the logic threshold voltage and the gain of an inverter behave as increase? 2 + 4 + 2 + 2 + 2 + 3
- 11. a) What is the function of a Programmable Logic Array (PLA) ?
 - b) Mention its advantages and disadvantages.
 - c) Draw the circuit diagram of a PLA and explain its operation.
 - d) How are the AND/OR combinational logic requirements realized in the MOS fabrication of the PLA?

2 + 3 + 6 + 4