Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/M.TECH(ECE-VLSI)/SEM-2/MVLSI-205D/2013

2013

ADVANCED MICRO & NANO DEVICES

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.

Answer Q. No. **1** and any *four* from the rest. 5 × 14 = 70

1. Answer any *seven* of the following : 7 × 2 = 14

   a) State the time-independent Schrödinger equation with proper notation.

   b) Write down the proper potential distribution of a particle is trapped in 1D potential well.

   c) Draw the Energy distribution, possible wave functions and probability distributions of electron in 1D infinite potential well.

   d) Draw the band diagram of GaAs/AlGaAs HEMT with appropriate notations.

e) Classify the CVD process according to the classification of operating pressure and physical characteristics of vapour used during CVD.

f) Give the importance of high-k dielectrics with examples.

g) What is EOT ?

h) What are the differences between homo-junction and heterojunction ? Is the metal-semiconductor conduct heterojunction ?

i) Write the effects of gate-oxide tunneling.

2. a) Solve the 1D Schrödinger equation for 1D infinite quantum well.

b) Write down the expression of wavefunction and energy of Nano Dot and Nano Wire and Nano Sheet. 8 + 6

3. a) Describe the Transmission Coefficient (T) and Reflection Coefficient (R) of Finite 1D Quantum Well with the Solution of respective Schrödinger equation in the class $E < V_0$ and $E > V_0$.

b) Describe the Tunneling Effect of the Quantum potential well. 10 + 4

4. a) Describe the Physical structure, Energy Bank Diagram with potential distribution, I-V characteristics and Q-V characteristics of HEMT with suitable diagram.

b) Consider a *n*-type GaAs/$Al_{0·3}Ga_{0·7}As$ HEMT at 300 K with the following parameters :

Schottky barrier height $\Phi_{B0} = 0 \cdot 9\,\text{V}$, Space layer thickness $d_0 = 50\,\text{Å}$, barrier layer doping $N_D = 2 \times 10^{18}\,\text{cm}^{-3}$, conduction band discontinuity $\Delta E_C = 0 \cdot 24\,\text{eV}$.

Calculate the barrier thickness d at which the HEMT channel starts to turn on at a gate bias of $V_G = 0 \cdot 5\,\text{V}$.

Calculate the Sheet charge density at $V_G = 0 \cdot 7\,\text{V}$. 8 + 6

5. a) Describe Physical structure, Potential distribution I-V Characteristics and Tunneling Characteristics of an RTD.

b) Describe the Molecular Beam Epitaxy (MBE) with proper Schematic Diagram of useful apparatus. 6 + 8

6. a) State and explain MOS scaling laws.

b) Explain the effects of short channel in MOSFET. 6 + 8

7. a) How do the emitter and base be designed in a bipolar transistor for optimum gain ?

b) Explain the concept of 2-DEG. 10 + 4

8. a) Compare SiGe HBT and CMOS.

b) Compare HBT and HEMT.

c) Write down the operation of MESFET with diagram and mention its advantages. 3 + 3 + 8

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