SEVENTH SEMESTER B.TECH DEGREE EXAMINATION

13.701 NANOELECTRONICS (2013 SCHEME)

MODEL QUESTION PAPER

Time: 3 Hours Max. Marks: 100

PART – A

Answer all questions. Each question carries 2 marks.

1. Define any two characteristic lengths associated with nanoelectronic devices.
2. Quantum dots are considered as artificial atoms. Justify.
3. Draw the energy Vs wave vector diagram for a parabolic quantum well and list the features.
4. A dosage of $10^{11}cm^{-2}$ is achieved while irradiating a sample of area $100cm^2$ in an ion implantation equipment for a period of 60 seconds. Calculate the ion current.
5. Explain TEOS technique of SiO2 deposition.
6. List the merits of AFM over STM.
7. Explain the different types of multiple quantum well.
8. Suppose a metallic quantum dot, of shape similar to a flat circular disk of radius R parallel to an infinite metal plane, at a distance L from the plane. Show that in order to observe single electron effects at room temperature, the radius of the dot should be of the order of a few nanometers. Take as value of ε_r the relative dielectric constant of silicon.
9. MODFETs are High Electron Mobility Transistors. Justify.
10. Explain the working of a RTD.

PART – B

Answer any one full question from each module

MODULE -I

11. (a) Derive the expression for density of states function of a 2D semiconductor nano structure.
    (b) What is the probability that a particle be found between 0.49 and 0.51 L in a 1D box of length L for n=1.
12. (a) Show that current in a quantum wire is proportional to group velocity and density of states.
    (b) Compare and contrast the features of square, triangular and parabolic quantum wells.

MODULE -II

13. (a) With simple schematic diagram, explain the principle of molecular beam epitaxy for fabricating nano layers.
    (b) DC sputtering cannot be used for the coating of non-conducting materials. Justify.
14. (a) Explain the different emission and interaction processes between electron beam and the sample.

(b) Illustrate the working principle of Atomic Force Microscope.

MODULE – III

15. (a) List and explain the major electron scattering mechanisms in parallel transport.
    (b) Explain Aharonov- Bohm effect.

16. (a) Explain Kronig–Penney model of a super lattice. What is meant by Zone folding?
    (b) Explain Integer Quantum Hall Effect.

MODULE - IV

17. Explain the concept of coulomb blockade. Derive the conditions to be fulfilled to observe single electron effect? Explain the principle of operation of a quantum dot based single electron transistor.
18. (a) Draw the schematic representation of the conduction band of a resonant tunnel diode for (i) no voltage applied (ii) increasing applied voltages. Explain its I-V characteristics.
    (b) Illustrate the working of a quantum well laser.