Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

SEVENTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION
NOV/DEC 2016
SUBJECT: Material Science for Micro and Nano Technologies (ECE - 443)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A. Indicate and prove two highly packed crystal structures. Explain the defects in solids in terms of symmetry.

1B. Calculate the number of atoms in a 1.4 nm diameter Pt nano particle using total number of unit cells present. Consider FCC unit cell with lattice constant a= 0.391 nm.

1C. Calculate thermal energy for the temperatures. T = 300K, 77K, and 4.2K. Comment on the result. Advise at what temperatures experiments are best performed and Why?

(4+3+3)

2A. GaAs has a Zink blend structure with a lattice constant a= 0.56nm and ϵ = 12.8. Given that electron and hole effective masses are $m_e = 0.067\ m_o$ and $m_h = 0.2\ m_o$. Calculate bulk excition Bohr radios and individual Bohr radii for electron and hole. Comment on the result. Find the number of unit cells contained within lowest exciton orbit. Indicate GaAs nano particle dimensions in which strong confinement is possible.

2B. Estimate the energies for quantum nos. 1, 2 and 3 for an electron in GaAs quantum wells of width 10 nm and 4 nm and infinite potential height. Assume the mass is $0.067\ m_o$. Repeat the calculation for heavy hole $m_{hh} = 0.5\ m_o$. Comment on the result.

(5+5)

3A. Derive time independent Schrodinger equation. Define the Eigen function and Eigen value.

3B. Describe 2D and 1D sub bands for electrons in low dimensional systems with neat diagrams.

(5+5)

4A. Answer All of the following

i) The wave equation for electric field of EM wave is ----------

ii) Average value of a particular positional coordinate, z is given by ----------

iii) The lowest value of energy of a particle confined in a parabolic quantum well is -------

iv) The energy level spacing of metallic nano-particles is --------

v) The Hamiltonian for a particle in motion in a potential field is ------

4B. List important properties of the quantum mechanical wave function.

4C. Describe the growth modes of hetero-epitaxial thin film.

(5+2+3)

5A. Describe how the melting point depends on the nano-particle size of the gold.

5B. What is a plasmon? How plasmons can be excited in metallic nano structures

5C. Describe a technique to prepare high purity and quality Si single crystals

(2+4+4)

6A. Describe construction and working of Scanning tunnelling microscopy (STM) and how it can be utilised to characterise the occupied and unoccupied energy states around Fermi energy.

6B. Describe three techniques of for the growth of Carbon nano tubes.

(6+4)