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** 

## Instructions to candidates

- Answer **ANY FIVE** full questions.
  - Missing data may be suitably assumed.
    - 1A. Indicate and explain with mathematical formulation why some crystal structures are said to be close packed structures?
      - 1B. Calculate the number of atoms in 1.4 nm diameter Pt, using bulk density  $\rho$ = 21.5 grams / cm<sup>3</sup>.
      - 1C. List properties of quantum mechanical wave function

(4+3+3)

MAX. MARKS: 50

- 2A. Derive an expression and calculate binding energy of lowest orbit of GaAs and InAs. Given that: For GaAs  $- m_e = 0.067 m_o$  and  $m_h = 0.45 m_o$  and  $\epsilon = 12.4$  and for InAs :  $m_e = 0.02 m_o$  and  $m_h = 0.4 m_o$  and  $\epsilon = 14.5$ . Comment on the result.
- 2B. Calculate thermal voltage at  $300^{\circ}$  K,  $150^{\circ}$  K and  $1.5^{\circ}$  K. and comment on the result
- 2C. Calculate Rydberg constant.

(6+2+2)

(3+7)

- 3A. Explain the types of materials in terms of symmetry rules.
- 3B. Obtain the wave function and also energy of first three quantised energy levels for a particle confined in a quantum well of infinite potential walls.
- 4A Explain SNOM modes of operation with proper diagrams.
- 4B. Answer all of the following:
  - i) The solution for Schrodinger equation for a particle confined in all three dimensions in terms of energy ------ and wave function -----.
  - ii) The energy levels are quantised while the particle is moving in classically --- region and the wave function is exponentially decay while the particle is moving in classically ---- region.
  - iii) The dispersion relation for an electromagnetic wave travelling in a medium ------.
- 4C. Describe the growth modes of hetero-epitaxial thin film.

(5+3+2)

- 5A. Explain construction and modes of operation of AFM. Explain how scanning tunnelling spectroscopy can be utilised for determining local density of states.
- 5B. Explain how colour of a metal nanoparticles is differing from that of bulk material.

(6+4)

- 6A. Explain the thin film growth modes in hetero-epitaxial process.
- 6B. Explain steps involved in photolithography technique.
- 6C. Explain briefly two techniques to prepare carbon nanotubes.

(4+3+3)

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