Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY

SEVENTH SEMESTER B.TECH. (E & C) DEGREE END SEMESTER EXAMINATION DECEMBER 2018/ JANUARY 2019 SUBJECT: NANOTECHNOLOGY (ECE - 4029)

TIME: 3 HOURS

MAX. MARKS: 50

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.
- 1A. Explain the fabrication steps of OTFT.

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(A constituent unit of MAHE, Manipal)

- 1B. Explain Vapour-Liquid-Solid (VLS) growth mechanisms of ZnO nanorod with neat diagram.
- Calculate (i) the volume and (ii) the mass of one million unit cells of body-centered cubic iron. The atomic radius of iron is 1.241 A°. Given density=7.87 g/cm³.

(4+3+3)

2A. In a powder diffraction experiment using incident copper (Cu) K α radiation gave the following set of reflections expressed as θ : 19.20°; 22.25°; 32.43°; 38.95°; 40.9°; 49.2°; 55.6°.

(i) Determine the crystal structure. (ii) Calculate the lattice constant, a (iii) Assume that the crystal is a pure metal and on the basis of the hard-sphere approximation calculate the atomic radius. (iv) Calculate the density of this element which has an atomic weight of 66.6 g/mol.

- 2B. Explain the CVD mechanisms of graphene growth with neat diagram.
- 2C. Explain the principle of LED.

(4+3+3)

- 3A. Sketch the following within a cubic unit cell. (i) [12 3] (ii) [1 1 0] (iii) (011) (iv) (4 2 1).
- 3B. List the 3 major difference between the Ballistic and Scattering transport.
- 3C. Consider the silicon substrate on which titanium nanowire has been fabricated. In between the total titanium nanowire, a barrier of dimension less than 10 nm has been fabricated as shown in Figure 3C. Explain the fabrication technique used to get the final structure.



Figure 3C

(4+3+3)

- 4A. Assume that $\psi 1(x, t)$ and $\psi 2(x, t)$ are solutions of the one-dimensional time-dependent Schrodinger's wave equation. (i) Show that $\psi 1 + \psi 2$ is a solution. (ii) Is $\psi 1^* \psi 2$ a Solution of the Schrodinger's equation in general? Why or why not?
- 4B. Derive the Density of states relation for Quantum wire.
- 4C. Explain the operation of the TEM with neat diagram.

(4+3+3)

- 5A. An electron in free space is described by a plane wave given by $\psi(x, t) = A \exp(j(kx \cdot \omega t))$. If $k = 1.5 \times 10^9 / m$ and $\omega = 1.5 \times 10^{13}$ rad/s, determine the (i) phase velocity and wavelength of the plane wave, and the (ii) momentum and kinetic energy (in eV) of the electron.
- 5B. List the difference between direct and indirect semiconductor.
- 5C. i. When the size of the material decreases, the band gap energy
 - ii. The relationship between the crystal size and color
 - (a) Smaller crystal size , Shorter wavelength
 - (b) Larger crystal size, Shorter wavelength
 - (c) Smaller crystal size, Longer wavelength
 - (d) Larger crystal size, Longer wavelength
 - iii. Quantum effects mainly occurs for

(4+3+3)