Reg. No.															

B.Tech. DEGREE EXAMINATION, NOVEMBER 2019
First / Second Semester

18PYB103J – PHYSICS: SEMICONDUCTOR PHYSICS
(For the candidates admitted during the academic year 2018-2019 onwards)

Note:
(i) **Part - A** should be answered in OMR sheet within first 45 minutes and OMR sheet should be handed over to hall invigilator at the end of 45th minute.
(ii) **Part - B** and **Part - C** should be answered in answer booklet.

Time: Three Hours Max. Marks: 100

PART – A (20 × 1 = 20 Marks)
Answer **ALL** Questions

1. The motion of electron in an periodic potential is explained by
   (A) Drude model (B) Lorentz model
   (C) Drude – Lorentz model (D) Kronig Penny Model

2. What type of material is obtained, when an intrinsic semiconductor is doped with trivalent impurity?
   (A) Extrinsic semiconductor (B) Insulator
   (C) N – type semiconductor (D) P – type semiconductor

3. Most commonly used semiconductor material is _____.
   (A) Silicon (B) Copper
   (C) Mixture of silicon and copper (D) Arsenic

4. Energy band gap size for insulators is in the range of _____eV.
   (A) 1 – 2 (B) 2 – 3
   (C) 3 – 4 (D) >4

5. A hole in a semiconductor is defined as _____.
   (A) A free electron (B) The incomplete part of an electron pair bond
   (C) A free proton (D) A free neutron

6. The P-region has a greater concentration of _____ as compared to the n-region in a P-N junction.
   (A) Holes (B) Electrons
   (C) Both holes and electrons (D) Phonons

7. A P-type semiconductor material is doped with _____ impurities whereas N-type semiconductor material is doped with _____ impurities.
   (A) Acceptor, donor (B) Acceptor, acceptor
   (C) Doner, donor (D) Donor, acceptor

8. The forward bias current in a typical Schottky barrier is due to what physical mechanism?
   (A) Drift (B) Diffusion
   (C) Recombination (D) Thermionic emission

9. The absorption of photons in a photodiode is dependent on
(A) Absorption co-efficient (α_0) (B) Properties of material
(C) Charge carrier at junction (D) Amount of light

10. The semiconductor material, for which the lowest energy absorption takes place is
(A) GaAs (B) Silicon
(C) Gash (D) Germanium

11. Optical processes directly involves _____ absorption and emission.
(A) Electron (B) Proton
(C) Photon (D) Neutron

12. _____ statistics can be applied to identical indistinguishable particles of half spin.
(A) Bose-Einstein (B) Fermi-Dirac
(C) Maxwell-Boltzmann (D) Bose-Dirac

13. In Four probe technique, the outer two probes are used to apply _____ and inner two probes are used to measure _____.
(A) Voltage, current (B) Temperature, voltage
(C) Current, voltage (D) Voltage, Temperature

14. In linear four probe method, the tip of probe diameter is usually _____ than the probe spacing.
(A) Larger (B) Cooler
(C) Heater (D) Smaller

15. C-V measurements are capable of yielding information about the _____ and concentration of charge carriers.
(A) Drift potential (B) Diffusion potential
(C) Bonding (D) Crystal structure

16. C-V technique uses a metal-semiconductor junction (Schottky barrier) or a p-n junction or a MOSFET to create a _____.
(A) Depletion region (B) Hole generation
(C) Electron – Hole pairs (D) Electron generation.

17. An example for O-D material is _____.
(A) Nanowire (B) Nanorod
(C) Nanosheet (D) Nanoparticle

18. An ideal monochromator should have an _____ narrow effective bandwidth.
(A) Small (B) Infinite
(C) Finite (D) Zero

19. _____ spectroscopy can be used to determine the concentration of the absorbs in a solution.
(A) UV-Vis (B) IR
(C) Microwave (D) Gamma

20. The physical parameter that is probed in AFM resulting from different interactions is _____.
(A) Charge (B) Force
(C) Potential (D) Current

PART – B (5 × 4 = 20 Marks)
Answer ANY FIVE Questions

21. Explain indirect band gap materials with the help of E-K diagram.
22. Explain nonequilibrium properties of carriers.
23. Write a note on drift current.
24. Write a short note on organic light emitting diodes.
25. Explain optical absorption and recombination process.
26. Explain the working of two point probe technique.
27. Write a note on applications of carbon nanotubes.

PART – C (5 × 12 = 60 Marks)
Answer ALL Questions

28.a.i. Define Density of states. Derive an expression for density of states of a semiconducting material. (9 Marks)
ii. Write any two success and failures of classical free electron theory. (3 Marks)

(OR)

b.i. What is effective mass? Derive an expression for effective mass of an electron. (10 Marks)
ii. Find the temperatures at which there is 1% probability of a state with energy 0.5 eV above Fermi energy. (2 Marks)

29.a.i. Define extrinsic semiconductor. Derive an expression for Fermi energy in N-type semiconductor. Explain the variation of Fermi level with temperature. (8 Marks)
ii. Define P-N junction. Explain the biasing concepts in P-N junction. (4 Marks)

(OR)

b.i. What is Light emitting Diode? Describe the principle, construction and working of a LED (10 Marks)
ii. Write any two advantages and disadvantages of LED. (2 Marks)

30.a. Explain the absorption and emission process with necessary theory and derive the relation between Einstein's co-efficients.

(OR)

b. Derive an expression for joint density of states and also density of states of photons.

31.a. Describe linear and Vander Pauw's four point probe technique for electrical measurements

(OR)

b. Describe the principle, construction and working of Deep level Transition spectroscopy. (8 Mar
ii. Write a note on I-V characteristics of a junction diode. (4 Mar

32.a.i. Describe the fabrication of Carbon Nanotubes by Physical vapour Deposition (PV technique. (8 Mar
ii. Write a short note on powder XRD technique. (4 Ma

(OR)

b. With a neat sketch, explain the working concept, source and utilization of scanning elec microscope.

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b.i. What is a Light Emitting diode (LED)? Describe the principle, construction and working of LED. (8 Marks)

ii. Write a note on diffusion and drift current. (4 Marks)

30. a. Explain the absorption and emissions processes with necessary theory and hence derive the relation between Einsteins coefficients.

(OR)

b.i. Describe the theory of Drudes model and hence derive the expression for electrical conductivity. (10 Marks)

ii. Mention any two applications of photovoltaic effect. (2 Marks)

31. a. Describe the Linear and Vander Pauw Four Point Probe technique for electrical measurements.

(OR)

b. What are the fundamental laws of absorption? Describe the principle, construction and working of UV Visible Spectrophotometer.

32. a.i. What are Carbon nanotubes (CNT)? Mention the properties of CNTs. (4 Marks)

ii ii. Describe the fabrication of CNT's by Physical Vapor Deposition (PVD). (8 Marks)

(OR)

b.i. Describe the principle, construction and working of Scanning Electron Microscope (SEM). (8 Marks)

ii. Write a note on Heterojunctions. (4 Marks)

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Note:
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Time: Three Hours Max. Marks: 100

PART – A (20 × 1 = 20 Marks)
Answer ALL Questions

1. The average distance travelled by an electron between two successive collisions in the presence of applied field is called _____
(A) Collision time (B) Mean free path
(C) Wave number (D) Drift velocity

2. The band gap is called _____, if the crystal momentum of electrons and holes is the same in both the conduction band and the valence band; an electron can directly emit a photon.
(A) Direct (B) Indirect
(C) Crystalline (D) Noncrystalline

3. _____ is the state at which the probability of electron occupation is ½ at any temperature above 0K.
(A) Valence level (B) Fermi level
(C) Conduction level (D) Density of states

4. When an electron in a periodic potential is accelerated relative to the lattice in an electric field or magnetic field, then the mass of the electron is called the _____
(A) Rest mass (B) Effective mass
(C) Zero mass (D) Accelerated mass

5. _____ is a PN Junction, which is forward biased?
(A) Light Emitting diode (B) Zener diode
(C) Rectifier (D) Transistor

6. When light impinges upon a semiconductor to create electron – hole pairs, some of the carriers are collected at the contact which leads to _____
(A) gain (B) photocurrent
(C) amplification (D) biasing

7. Which type of material is obtained when intrinsic semiconductor is doped with pentavalent impurity?
(A) N-type semiconductor (B) Extrinsic semiconductor
(C) P-type semiconductor (D) Insulator

8. _____ is the process of radiative recombination of electron-hole pairs created by electron bombardment.
(A) Photoluminescence (B) Cathodoluminescence
(C) Electroluminescence (D) Anodoluminescence

9. The spectral region, where the material changes from being relatively transparent to strongly absorbing is known as _____
(A) Absorption edge (B) Conduction edge
(C) Valence edge (D) Annihilation edge

10. According to Drudes theory, the velocities of electrons are assumed to have _____ velocity given by kinetic theory of gases.
(A) Root mean square (B) Drift
(C) Instantaneous (D) Uniform

11. _____ is the creation of voltage and electric current in a material upon exposure to light and is a physical and chemical phenomenon.
(A) Acousto- optics (B) Photovoltaics
(C) Electrolysis (D) Electrophoresis

12. In stimulated emission, the states at which the life time of atoms is extended is _____
(A) Metastable state (B) Stable state
(C) Basic state (D) Excited state

13. For determining the resistivity of a semiconductor, the diameter of contacts between the probe and the semiconductor should be _____ the gap between the probes.
(A) Smaller than (B) Greater than
(C) Equal to (D) Double

14. _____ is a technique for characterizing semiconductor materials and devices, where the applied voltage is varied, and the capacitance is measured and plotted as a function of voltage.
(A) Capactive - voltage profiling (B) Current profiling
(C) Voltage profiling (D) Baising

15. A _____ is a method of determining quickly whether a semiconductor sample is n (negative) type or p (positive) type.
(A) Electrolysis (B) Hot point probe
(C) Rectification (D) Hydrogenation

16. _____ law states that, when a beam of monochromatic light passes through an absorbing medium, the rate of decrease in intensity with the thickness of the medium, is proportional to the intensity of light.
(A) Lambert's (B) Beer's
(C) Photoelectric (D) Snell's

17. Nanoparticles are special mainly because of their _____
(A) Surface area (B) Surface charge
(C) Volume (D) Force

18. In a quantum wire, the material size is reduced _____
(A) In three directions (B) In two directions
(C) In one direction (D) Infinitely

19. In CVD chamber, the precursors are introduced to the reaction chamber in the _____ state.
(A) Liquid (B) Solid
(C) Semisolid (D) Gaseous

20. The physical parameter that is probed in AFM resulting from different interactions is _____
(A) Charge (B) Force
(C) Potential (D) Field

PART – B (5 × 4 = 20 Marks)
Answer ANY FIVE Questions

21. Write a note on Energy bands in solids.

22. Describe the nonequilibrium properties of carriers.

23. What is a PN Junction? Explain the biasing concept in PN Junction.

24. Write a note on organic light emitting diodes.

25. Describe the optical absorption and recombination process.

26. Write a note on I-V characteristics of a diode.

27. Describe the powder method of X-ray diffraction.

PART – C (5 × 12 = 60 Marks)
Answer ALL Questions

28.a.i. What is Density of states? Derive an expression for density of states for a semiconducting material. (10 Marks)

ii. The Fermi level for potassium is 1.9 eV. Calculate the velocity of the electron at the Fermi level. (2 Marks)

(OR)

b. Describe the behavior of electron in a periodic potential and hence explain the Kronig Penny Model in detail with the cases.

29.a.i. What is an extrinsic semiconductor? Describe the variation of Fermi level with carrier concentration and temperature in an N-Type semiconductor. (8 Marks)

ii. Determine the position of the Fermi Level in an instrinsic semiconductor from the centre of forbidden gap at room temperature, if the effective mass of an electron is equal to twice the effective mass of hole. (4 Marks)

(OR)