國立成功大學

114學年度碩士班招生考試試題

編　號：120

系　所：電機工程學系

科　目：電子材料概論

日　期：0210

節　次：第 2 節

注　意：1.不可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

(1) Single choice question (75 %)

1. Which of the following is considered an intrinsic semiconductor?
   A) Silicon (Si)
   B) Gold (Au)
   C) Copper (Cu)
   D) Aluminum (Al)

2. What does the term "bandgap" in a semiconductor refer to?
   A) The gap between two conductors
   B) The energy difference between the valence and conduction bands
   C) The physical spacing between atoms in a crystal
   D) The energy required to form an ion

3. Which material has the highest electrical conductivity?
   A) Silicon
   B) Graphene
   C) Germanium
   D) Diamond

4. What type of bond is predominant in semiconductor materials like silicon?
   A) Ionic bond
   B) Metallic bond
   C) Covalent bond
   D) Hydrogen bond

5. What is the primary function of a dielectric material in a capacitor?
   A) To conduct electricity
   B) To store electrical energy
   C) To block electron flow
   D) To reduce energy dissipation

6. What property distinguishes ferroelectric materials?
   A) High thermal conductivity
   B) Permanent electric polarization
   C) High magnetic susceptibility
   D) Low dielectric constant

7. In which of the following applications is piezoelectric material used?
   A) Solar panels
   B) Sensors and actuators

C) Transistors
D) Capacitors

8. Which phenomenon explains the operation of light-emitting diodes (LEDs)?
A) Photovoltaic effect
B) Electroluminescence
C) Thermionic emission
D) Hall effect

9. What is the typical coordination number for atoms in a cubic close-packed structure?
A) 4
B) 6
C) 8
D) 12

10. What is the Miller index of a plane parallel to the x-axis in a crystal?
A) (100)
B) (010)
C) (001)
D) (111)

11. What happens to the electrical conductivity of an intrinsic semiconductor as temperature increases?
A) It decreases
B) It remains constant
C) It increases
D) It oscillates

12. Which of the following best describes the density of states (DOS) in a two-dimensional electron gas?
A) Linear dependence on energy
B) Constant across energy levels
C) Quadratic dependence on energy
D) Inversely proportional to energy

13. Which mechanism primarily governs the electrical breakdown of a dielectric material under high electric fields?
A) Thermionic emission
B) Quantum tunneling
C) Avalanche breakdown
D) Piezoelectric effect

14. What determines the effective mass of charge carriers in a semiconductor?
    A) Crystal lattice symmetry
    B) Density of states
    C) Curvature of the energy band
    D) Doping concentration

15. In a superconductor, what causes the resistance to drop to zero?
    A) High carrier density
    B) Formation of Cooper pairs
    C) Complete elimination of phonons
    D) Reduction in electron scattering

16. Which phenomenon is utilized in quantum well lasers?
    A) Carrier recombination in a confined structure
    B) Carrier scattering at a heterojunction
    C) Field induced carrier tunneling
    D) Ballistic electron transport

17. What is the primary limitation of Shockley Queisser efficiency for solar cells?
    A) Auger recombination losses
    B) Nonradiative recombination
    C) Thermalization of excess energy of hot carriers
    D) Incomplete light absorption

18. Which transport mechanism dominates in heavily doped semiconductors?
    A) Drift due to electric fields
    B) Diffusion due to concentration gradients
    C) Tunneling through the potential barrier
    D) Ballistic transport

19. In an MOSFET, what is the primary function of the gate oxide layer?
    A) To provide a conductive channel
    B) To block electron-hole recombination
    C) To modulate the conductivity of the channel
    D) To act as a thermal insulator

20. What is the primary function of spin-orbit coupling in topological insulators?
    A) Enhancing carrier mobility
    B) Breaking time-reversal symmetry

C) Inducing nontrivial band topology
D) Suppressing phonon scattering

21. In thermoelectric materials, what parameter quantifies the conversion efficiency of heat to electricity?
A) Seebeck coefficient
B) Electrical conductivity
C) Thermal conductivity
D) Figure of merit (ZT)

22. Which property of a material is most critical for achieving high breakdown strength in power electronics?
A) Low dielectric constant
B) High bandgap energy
C) High carrier density
D) Low defect density

23. What is the primary advantage of using IIIV semiconductors for high-frequency applications?
A) High electron mobility
B) Low production cost
C) High thermal stability
D) Wide availability of materials

24. Which phenomenon is responsible for the photoconductivity of semiconductors?
A) Photon-induced carrier generation
B) Phonon scattering
C) Carrier trapping at defects
D) Quantum tunneling

25. In quantum dots, the optical properties are primarily determined by:
A) Material composition
B) Exciton binding energy
C) Particle size and shape
D) Surface roughness

(2) Short answer question (25%)

1. Please compare the differences between capacitor and battery (5%)
2. List 5 types of Bravais lattices and describe the relationship between their edges and angles. (5%)
3. Explain Schottky contact and Ohmic contact. (5%)
4. From thermodynamic points of view, explain the formation of critical nuclei during solidification. (5%)
5. List possible strengthen mechanism for materials such as metals and ceramics. (5%)