Marks Scored:

KATHMANDU UNIVERSITY
End semester Examination
August, 2018

Level : B. Sc. | Course : PHYS 314
Year : III | Semester : II
Exam Roll No. : | Time: 30 mins . | F. M. : 20
Registration No.: | Date AUG 19 2018

SECTION "A"
[20 Q × 1 = 20 marks]

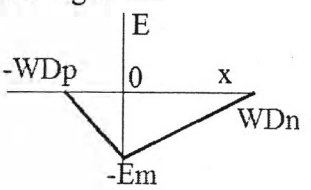
1. The Miller indices <hkl> represents _____ .
[a] x-y plane along h, k, l directions
[b] family of plane that cuts 1/h. 1. K. and 1/l along x-, y- and z- axis.
[c] a plane that intercepts negative x-, y-, and z- axes
[d] a full set of equivalent directions.

2. Valence band of _____ crystal structure such as GaAs consists of four subbands
[a] diamond [b] zincblende [c] NaCl [d] Wurzite

3. If energy band equation of electron is $E(k) = a + b\,k + c\,k^2$, the effective mass will be _____.
[a] $\frac{2c}{\hbar^2}$ [b] $\frac{\hbar^2}{c}$ [c] m* c [d] c m_0

4. Diffusion length is the length approximately after _____ time of diffusion.
[a] 1/e [b] e [c] ln(2) [d] log(2)

5. If the electric field vs position of a *p-n* junction diode, which of the following is the correct doping?
[a] arbitrary [b] linear
[c] abrupt [d] diffused



6. Diffusion capacitance appears when the junction is _____ .
[a] forward biased [b] reverse biased [c] breakdown [d] neutral

7. In metal semiconductor junction the Fermi level on the metal side _____
[a] deviates downwards [b] does not deviate at all
[c] goes outside the bandgap [d] deviates upwards

8. A typical critical thickness from lattice mismatch of 2% of a_e = 5Å is _____ Å
[a] 100 [b] 10 [c] 5 [d] 20

9. The base current in transistor is the _____ current.
[a] difference of emitter and collector [c] same as collector
[c] sum of emitter and collector [d] product of gate and collector

10. Negative differential resistance in TED is mainly due to _____ .
[a] degenerate doping [b] very thin depletion layer
[c] valleys in conduction bands [d] double potential barrier

Fill in the blanks with appropriate words.

11. The three major current transport processes at the metal semiconductor interface are _____, _____, and _____.

12. Semiconductor with _____ in the lowest minimum of the conduction bans such as *n*-type GaAs, A^*/A is equal to m^*/m_0.

13. Metal-semiconductor contact with negligible junction resistance relative to total resistance of the semiconductor device is _____ contact.

14. At _____ common-emitter short-circuit current gain h_{fe} is unity.

15. Microwave transistors are _____ amplifiers.

16. If the gate voltage in MOSFET is zero with respect to drain and I_D is maximum then the MOSFET is called _____ type.

17. Negative differential resistance is observed by *real-space transfer* in _____ semiconductor junctions.

18. Three current components of static current voltage characteristic of tunnel diodes are _____, _____, and _____ .

19. Two semiconductors _____, _____are the best candidate for building thyristor.

20. The formula of differential mobility is _____.

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F. M. : 55

SECTION "B"
[5Q × 4 = 20 marks]

Answer *ALL* the questions. Symbols have their usual meanings.

1. Find the concentration of carriers after 1.0 μ sec if the carrier life time is 0.5 μ sec, generation rate is 10^{10} sec^{-1} and equilibrium concentration is 10^5 cm^{-3}.

   OR

   Show that for intrinsic semiconductor the Fermi level is at the middle of bandgap.

2. Derive the expression for depletion layer capacitance of linearly graded *p-n* junction diode.

3. Explain and illustrate the band alignments of three different heterojunctions.

4. Distinguish between thermal and Zeener breakdown mechanisms.

5. What are the origins of negative differential resistance?

   OR

   Calculate the Fermi level of boron doped silicon with an impurity concentration of 10^{15} cm^{-3} at 300K. (take $n_i = 9.65 \times 10^9$ cm^{-3})

SECTION "C"
[5Q × 7 = 35 marks]

6. Draw and label the schematic diagrams of density of states, Fermi-Dirac distribution and carrier concentrations of (i) intrinsic, (ii) *p*-type and (iii) *n*-type semiconductors.

   OR

   What is the height of barrier in Gold-Si interface in silicon when the applied field is 10^7 V/cm? Given: dielectric constant = 12, $x_m = 5$ nm.

7. Explain the small signal operation of bipolar transistor using two-port network.

8. Derive the formula for drift velocity of in TED as a function of applied field.

9. Describe working principle and I-V curve of typical thyristor. What do you mean by controlled rectification?

10. Draw the different band diagrams and corresponding current markers of tunnel diode at (a) thermal equilibrium, (b) forward bias at peak current, (c) forward current near valley current, (d) forward current at diffusion current and (e) reverse bias.

    OR

    Describe the different methods to determine height of Schottky barrier.