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# SARDAR PATEL UNIVERSITY

## M. Sc. (Electronics) FIRST SEMESTER EXAMINATION

(Under CBCS)

PS01CELE01: SEMICONDUCTOR SCIENCE AND DEVICES

Date/Day : 30-11-2012( Friday)
Time: 10.30AM to 01.30PM

Total Number of Questions: [06]
Total Marks: [70]

**Q1 Choose the correct/nearest answer (statement) for the following *ALL* Multiple Choice Questions (Statements).** 8x1=[08]

(1) The magnitude of wave vector is given in terms of its wavelength as
- (i) $k=2\pi/\lambda$
- (ii) $k=2/\pi\lambda$
- (iii) $k=\lambda/2\pi$
- (iv) $k=2\pi\lambda$

(2) In indirect band gap materials, the momentum for electron transition is normally provided by
- (i) photons
- (ii) protons
- (iii) phonons
- (iv) neutrons

(3) When the binding energy of an electron approaches infinity, we get
- (i) continuous energy spectrum
- (ii) line spectrum of energy
- (iii) tunneling phenomena
- (iv) none of the above

(4) A semiconductor has a Fermi Level located at 1.25eV at 0K. If the conduction band edge is at 1.50eV, then the energy location of the valence band edge is at
- (i) 0.25eV
- (ii) 2.25eV
- (iii) 1.0eV
- (iv) 2.75eV

(5) Gunn effect is useful for designing
- (i) audio amplifiers
- (ii) high power rectifiers
- (iii) microcontrollers
- (iv) microwave oscillators

(6) In an ideal Metal-Insulator-N type Semiconductor structure, if the applied voltage is smaller than zero (V<0), it leads to
- (i) accumulation
- (ii) depletion
- (iii) inversion
- (iv) rectification

(7) For band gap absorption in semiconductors, the energy of light quanta should be

(i) greater than or equal to the width of the band gap
(ii) smaller than the width of the band gap
(iii) square root of the value of width of the band gap
(iv) square of the value of width of band gap

(8) Which of the following is a *'passive type'* of display device?

(i) LED
(ii) LASER
(iii) UJT
(iv) LCD

**Q2 Give short answers to *any* <u>*SEVEN*</u> of the following.** **7x2=[14]**

(1) Draw the curve showing electron energy as a function of wave vector of free electrons.
(2) What are the drawbacks of free electron theory?
(3) What are the applications of Hall effect?
(4) What is Debye length and on what factors does it depend?
(5) What do you understand by *'light'* and *'heavy'* holes?
(6) Draw the Mott-Davis energy model for an amorphous semiconductor and show the extended states, localized tail states and localized defect states
(7) Give the basic classification of interface traps and oxide charges for a practical Si-$SiO_2$ MOS diode.
(8) Draw the electrical equivalent circuit of a typical PN junction based solar cell.
(9) What are *'activators'* and *'co- activators'* in luminescence?

**Q3(a)** Develop a free electron expression for the electrical conductivity of a material. **6**

**Q3(b)** With the necessary diagrams, explain the concept of reduced zone vector representation. **6**

**<u>OR</u>**

**Q3(b)** Develop the following equation for a one dimensional periodic lattice with symbols having their usual meanings **6**

$$(P \sin \propto a)/\propto a + \cos \propto a = \cos ka$$

**Q4(a)** Deduce an expression for Hall constant ($R_H$) for an **N**-type semiconductor. **6**

**Q4(b)** Obtain an expression for the effective mass of an electron in an energy band. **6**

**<u>OR</u>**

**Q4(b)** Show that the Fermi energy for **N**-type semiconductor is given by **6**

$$E_F = E_{Fi} - kT \ln(N_A/n_i)$$

(With the symbols having their usual meanings)

**Q5(a)** Derive an expression for the density of states, as a function of energy, for the conduction band of a semiconductor. **6**

**Q5(b)** What do you understand by ohmic and rectifying contacts? Explain the formation of a rectifying contact between a Metal and an **N**-type Semiconductor. **6**

**OR**

**Q5(b)** Explain the term 'inversion', for an ideal MIS diode considering a **P**-type semiconductor. Drawing the energy band diagram at the surface of the **P**-type semiconductor, show that the surface charge is given by **6**

$$Q_s = \pm \frac{\sqrt{2}\varepsilon_s kT}{qL_D} F\left[\beta\psi_s, \frac{n_{po}}{p_{po}}\right]$$

(With the symbols having their usual meanings)

**Q6(a)** What is 'intrinsic photoeffect' in semiconductors? Develop an expression for the responsivity of a semiconducting photoresistor under an incident light. **6**

**Q6(b)** With the necessary band diagram and current-voltage characteristics, explain the photoelectric phenomena in a PN Junction. **6**

**OR**

**Q6(b)** With the necessary diagrams explain the construction and working features of a typical **AC** powder electroluminescent display device. **6**

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