F.Y. Diploma : Sem. II

Applied Physics

[CD/CM/CO/CW/DE/ED/EE/EI/EJ/EN/EP/ET/EV/EX/IC/IE/IF/IS/IU/MU]

Time : 2 Hrs.] Prelim Question Paper Solution **[Marks : 50**

Q.1 Attempt any NINE of the following : [18]

Q.1(a) Define : [2]

(i) Electric current (ii) 1Ω

(A) (i) **Electric Current:** The rate of flow of electric charge is called electric current.

(ii) **1Ω:** If a potential difference of 1 volt applied across a conductor and it produces a current of 1 ampere through it, then the resistance of conductor is said to be one ohm.

Q.1 (b)State the working principle of Wheatstone's network. [2]

(A) Statement: In the balanced condition of Wheatstone's network, current flows through the rest of the circuit but does not flow through the galvanometer.

Q.1(c) Calculate the potential drop across a potentiometer wire of length 200 cm so as to have potential gradient of 10^{-3} V/m. [2]

(A) Given : L= 200 cm = 2m

P.G = 10-3 V/m

Potential drop = ?

We have,

Potential drop = P.G x length of wire(L)

$= 10^{-3} \times 2$

Potential drop $= 2 \times 10^{-3}$ V

Q.1(d) A capacitor of capacitance 5 μF is connected to a supply of 10V. Calculate the charge on the capacitor. [2]

(A) Given: $C = 5\mu f = 5 \times 10^{-6}$

V = 10 V

Q=?

We have $C = Q / V$

$Q = C \times V$

$Q = 5 \times 10^{-6} \times 10$

$Q = 50 \times 10^{-6}$ C **OR**

Q = 50 μC

Q.1(e) State the values or range of values of energy band gap for conductors, semiconductors and insulators. [2]

(A) Value of Energy Band gap

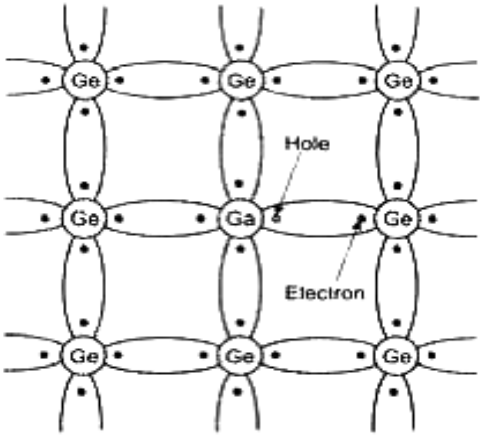
Conductor : No energy gap

Semiconductor : Approximately 1eV

Insulator : Greater than 5.5 eV

Q.1(f) Explain the p-type semiconductor. **[2]**

(A)



1) Trivalent impurity is added to a pure semiconductor it is called P-type semiconductor.
2) Some trivalent impurities are gallium , indium ,boron, aluminium etc. These impurities provide large number of holes.threrefore they are called acceptor impurities.
3) Above diagram is of p-type of semiconductor .Consider a pure Germanium crystal, it has four valance electrons which forms covalent bonds.
4) When gallium is added out of four electrons of Ge only three forms the covalent bonds with creating one hole as shown above.
5) The current in it is predominantly by holes(positive charge)So they are called as majority carriers and electrons are called minority charge carriers.

Q.1(g) Define : (i) Threshold frequency (ii) Work function **[2]**

(A) **Threshold frequency:** The minimum frequency of incident radiation at which emission of photoelectrons starts is called Threshold frequency.

Work function: The amount of energy required to detach the electron from metal surface is called work function.

Q.1(h) State Einstein's photoelectric equation with the meaning of all the symbols involved. **[2]**

(A) $K.E = h (v - v_0)$

$1/2mv^2 = h(v - v_0)$

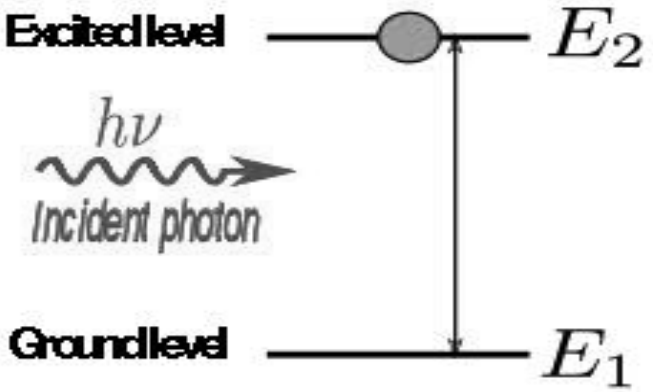
Where, K.E = Kinetic energy of ejected electrons.

v = Frequency of photon.

v_0 = Threshold Frequency.

Q.1(i) Explain the term "Stimulated Absorption" in lasers. **[2]**

(A) When the photon of energy (E=hv) is incident on an atom then the atom get excited i.e Moves from lower energy state to higher energy state is called as stimulated absorption



Q.1(j) State any two engineering applications of X-Rays. **[2]**

(A)
1) X- rays are used to detect the cracks in the body of aero plane or motor car
2) X- rays are used to detect the manufacturing defects in rubber tyres or tennis ball in quality control
3) X - rays are used to detect flaws or cracks in metal jobs.
4) X- rays are used to distinguish real diamond from duplicate one
5) X- rays are used to detect smuggling gold at airport and docks (ship) yard.
6) X-rays are used to detect cracks in the wall
7) X- ray radiography is used to check the quality of welded joints.

Q.1(k) Classify nanomaterials according to their dimensions. **[2]**

(A)
1) Nano material of zero dimension : Nanoclusters
2) Nano material of one dimension : Carbon nanotube (CNT), nanofiber etc.

Q.1(l) State any two engineering applications of nanomaterials. **[2]**

(A) Applications of nano-material in engineering field.
1. Data storage system Semiconductor material in the form of film can be deposited on substrate to form the chip.
2. Use of nanomaterial in energy sector The conventional energy sources like coal, fuel are depleting day by day, thus use of alternative energy source is inevitable.
3. Application in automobiles- High mechanical strength material but light in weight can be produced by using nanotechnology. Nano painting materials can be used to get uniform layer of coating on the vehicle body.

Q.2 Attempt any FOUR of the following : **[16]**

Q.2(a) Calculate the resistance of wire of length 50 cm and cross section area of 0.02×10^{-6} m^2. **[4]**
(Given – specific resistance of the wire = 3.5×10^{-7} Ω-m)

(A) Given :

$L = 50cm = 0.5m$

$A = 0.02 \times 10^{-6}\ m^2$

$\rho = 3.5 \times 10^{-7} \Omega m$

$$\rho = \frac{(R \times A)}{L}$$

$$R = \frac{(L \times \rho)}{a}$$

$$R = \frac{\left(0.5 \times 3.5 \times 10^{-7}\right)}{0.02 \times 10^{-6}}$$

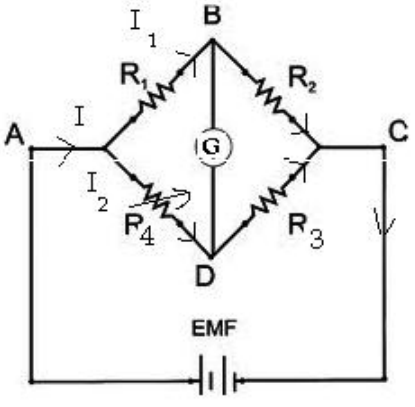
$R = 8.75\ \Omega$

Q.2(b) State and explain the balancing condition of Wheatstone's network. **[4]**

(A) The balancing condition Wheatstone's network is given as follows.

$$\frac{R_1}{R_2} = \frac{R_4}{R_3}$$

In this network R_1, R_2, R_3 are kept constant and R_4 is so adjusted that galvanometer shows zero deflection. When galvanometer shows zero deflection, network is said to be balanced.
Network is balanced means points B and D are at equal potential. This is possible if,
(P.D. across AB) = (P.D. across AD) and
(P.D. across BC) = (P.D. across DC)



Using Ohm's law,

$I_1R_1 = I_2R_4$ ...(1)

$I_1R_2 = I_2R_3$ ...(2)

Dividing equation (1) by (2) we get

$$\frac{I_1R_1}{I_1R_2} = \frac{I_2R_4}{I_2R_3}$$

$$\frac{R_1}{R_2} = \frac{R_4}{R_3}$$

This is of the balancing condition Wheatstone's network.

Q.2(c) (i) State and explain the principle of potentiometer. **[4]**

(ii) Give any two uses of potentiometer.

(A) (i) Principle of Potentiometer

The fall of potential is directly proportional to the length of conducting wire.

$V \propto L$

OR

The potential difference between two points of conductive wire is directly proportional to the length/distance between the two points.

ii) Uses of potentiometer.

a) To determine internal resistance of cell.

b) Compare EMF of two cells.

c) Measure P.D. between two points in the circuit.

Q.2(d) Define:(i) P-N junction diode (ii) Depletion layer **[4]**

(iii) Forward bias (iv) Reverse bias of P-N junction diode

(A) **i) P-N junction diode:** It is a semiconductor device in which half of its region is P-type and other half is N-type.

ii) Depletion layer: The region where free electrons and free holes are absent is called depletion layer.

iii) Forward bias: If the positive terminal of external battery is connected to p – side and negative terminal is connected to n-side of p-n junction diode, it is said to be forward bias.

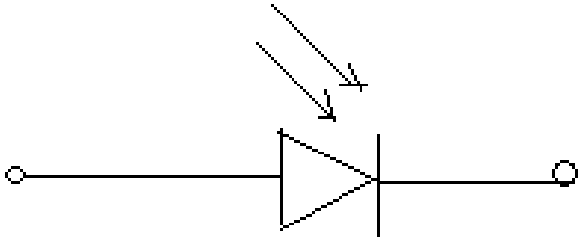
iv) Reverse bias of P-N junction diode: If the positive terminal of external battery is connected to n – side and negative terminal is connected to p-side of p-n junction diode, it is said to be reverse bias.

OR

Any other relevant definition may consider.

Q.2(e) Draw the symbol and state the principle of photodiode. State its any two applications. **[4]**

(A) Symbol of Photodiode



Principle of the photodiode: When light is incident on suitably arranged semiconductor diode, then it produces current in the circuit.

Light energy → Electrical energy

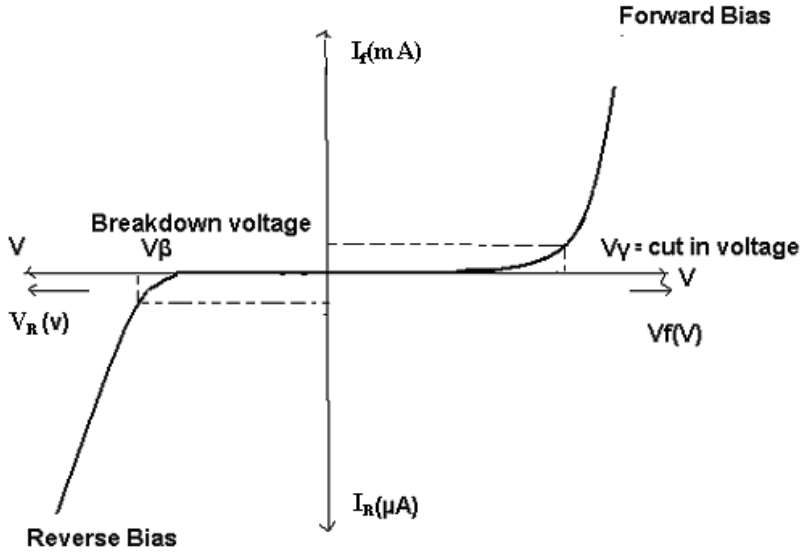
Application of photodiode

1. It is used as light sensor in remote controlled television set.
2. It is used as light sensor in remote controlled air conditioner
3. It is used as object counter to count object, cards etc.
4. It is used as smoke detector.
5. It is used as encoder.
6. It is used as position sensor.

Note: Any relevant applications can be given credit.

Q.2(f) Plot and explain the I-V characteristics of a p-n junction diode. [4]

(A)



Forward Bias Characteristic:

If external voltage is increased from zero onwards , initially the forward voltage is increased and values of currents are recorded and the graph is plotted as shown above.

Initially for increase in voltage there is no corresponding increase in current. Above barrier potential current increases rapidly and diode starts conducting current.

Reverse Bias Characteristics:

As the reverse biased voltage is increased , at critical voltage VBR the reverse current through the diode increases sharply. The corresponding voltage is called breakdown voltage

Q.3 Attempt any FOUR of the following : [16]

Q.3(a) Three condensers are connected in series across 220V supply. If the voltage drops across the condensers are 50V, 60V and 110V respectively and the charge on each condenser is 6μF, calculate the capacitance of each condenser and hence the effective capacitance of the combination. [4]

(A) Given

V_1 = 50V; V_2= 60V; V_3 = 110V and Q = 6 μ

We have , $C = Q / V$

$C_1 = Q/V_1 = 6/50 = 0.12$ μF

$C_2 = Q/V_2 = 6/60 = 0.1$ μ

$C_3 = Q /V_3 = 6/110 = 0.0545$ μ

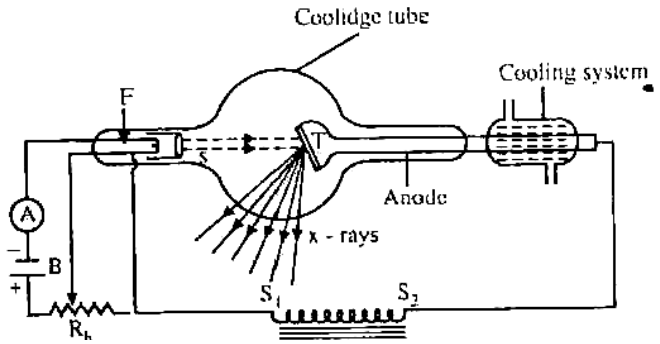
These three condenser are connected in series therefore their effective capacitance of the combination is C_s given by

$1/Cs = 1/C_1 + 1/C_2 + 1/C_3$

= 1/0.12 + 1/0.1 + 1/0.0545
= 8.33 + 10 + 18.34
$1/Cs$ = 36.67
Cs = 0.0272 μ

Q.3(b) Explain the production of X-rays using Coolidge tube with a neat labeled diagram. [4]

(A)



T – Target
F – Metal filament
S – Cylinder
A – Ammeter
B – Battery
R_h – Rheostat
P_1 P_2 – Primary of transformer
S_1, S_2 – Seconday of transformer

Principle:
When fast moving electrons are suddenly stopped then X- rays are produced.

Working:
When the cathode is heated by electric current it produced electron due to thermionic emissions. The beam of electron is then focused on the anode (target). The electrons from cathode are accelerated by applying of high voltage between cathode & anode using step up transformer. When these fast moving electrons are suddenly stopped by tungsten anode, they lose their kinetic energy and x rays are produced from the target. Some amount of Kinetic energy is converted to large amount of heat.
By controlling the filament current, the thermionic emission of electron hence intensity of X- rays can be controlled.

Q.3(c) Differentiate between spontaneous and stimulated emission of light with diagram. [4]

(A)

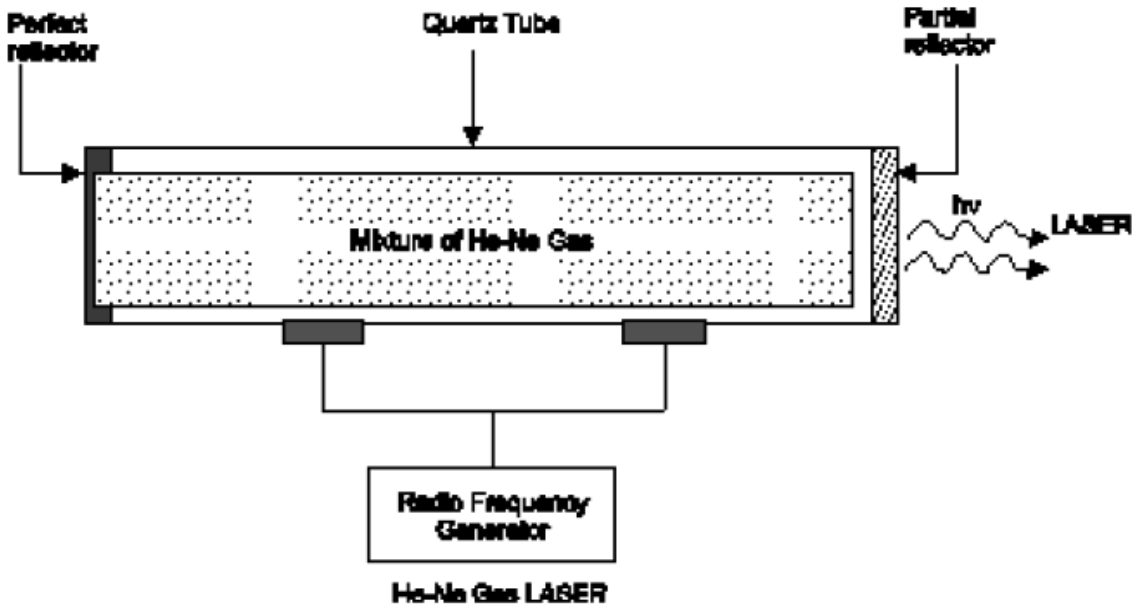
Spontaneous emission	**Stimulated emission**
Excited atoms comes to ground state on its own accord.	Excited atoms comes to ground state after interaction with incident photon.
Radiations are in random direction , phase and wavelength.	Radiations are coherent, monochromatic and in same direction.
Independent of outside circumstances.	Dependent of outside circumstances.
No metastable state exist.	Metastable state exist.
Number of photons emitted are less.	Number of photons emitted are more.

Q.3(d) State any four engineering applications of laser. [4]

(A) i) Lasers are used for engraving and embossing of printing plates
For example- number plate, name plate etc.,
ii) Lasers are used in cutting, drilling and welding metals.
iii) Lasers are used in holography.
iv) Lasers are used in computer printers.
v) Lasers are used for 3D, Laser scanners.
vi) Lasers are used in controlled heat treatment.
vii) Lasers are used for data transfer through optical fiber from one Computer to other.
viii) Lasers are used to find flaws or defect in material.

Q.3(e) With neat labelled diagram, explain the working of He-Ne laser. **[4]**

(A)



He-Ne Gas LASER

Working:

(1) When electric discharge is produced in the tube, He and Ne gas atoms are excited. Some excited levels of helium are close to some excited levels of neon. Therefore these excited helium atoms collide with excited atoms of neon and transfer the energy to neon atoms.

(2) The actual lasing action is done by neon atoms. The neon atoms with extra energy from helium atom are forced to jump in ground state by emitting a photon. This produces the LASER light. The newly emitted photon triggers the next neon atom and increases the radiations.

(3) Thus coherent, monochromatic, unidirectional LASER is produced by He-Ne gas LASER The energy level diagram of He-Ne LASER is shown below.

Q.3(f) Write the names of any four physical methods of synthesis of nanoparticles. **[4]**

(A) There are two main types of physical methods.

I) Mechanical method

II) Vapour deposition method

In Mechanical method :

A) High Energy Ball Milling method.

B) Melt mixing method :

In Vapour deposition method:

A) Physical vapour deposition

B) Sputtering

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