AJAY KUMAR GARG ENGINEERING COLLEGE, GHAZAIABAD

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Model Solution Sessional Test-2

Course: B. Tech
Session: 2017-18
Subject: EEEM
Max. Marks: 50

Semester: III
Section: EN-1, 2
Sub. Code: REE- 301
Time: 2 hour

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SECTION – A

Ques 1: Define the term Remanence and Susceptibility related to magnetic materials?

Solution: Remanence:

It is defined as the magnetic flux density which still persists in magnetic material even when the magnetising force is completely removed. It is expressed in wb/m2.

Susceptibility:

It is denoted by letter χ. and is defined as the ratio of intensity of magnetisation (I) to magnetising force (H). In other words $\chi = \frac{I}{H}$.

Ques 2: Discuss the effect of ageing on magnetic materials?

Solution: Ageing of a permanent magnet is the process of normal or accelerated change, under continued normal or specified artifical conditions, in the strength of the magnetic field maintained.

Ageing can be of following types

1.> Metallurgical

2.> Magnetic.

Magnets that have been metallurgical aged cannot be restored while magnets with magnetic ageing can be restored to their original strength by remagnetisation.

Ques 3: Explain the transport phenomenon of mobile charge carriers in a semi conductor?

Solution: As per the free electron model of an atom, the valence electrons are not attached to individual atoms but are free to move about in all dirn. among the atoms. These e^- are called conduction electrons. The free electrons move at random in all dirn when no external field is applied. However when an external field is applied to the metal the free e^- motion becomes directed.

So in case of intrinsic semi conductor the flow of current is due to movement of e^- and holes in opposite dirn. while in extrinsic semi conductor the flow of current depends on the majority charge carrier.

Ques 4: What is Feebly Magnetic Materials.

Solution: Feebly magnetic materials are not in themselves useful as electromagnet cores, they may be important in such designs to provide structural members which are "non magnetic". They are often employed to reduce eddy current heating and to reduce energy losses of such parts as rotor - coil binding wire, shafts, bolt, filters and pole - supports castings.

Ques 5: Distinguish between Drift and Diffusion Current?

Solution: Drift Current:

Drift current is the electric current or movement of charge carriers, which is due to the applied electric field, often stated as electromotive force.

Diffusion Current:

Diffusion current is a current in a semiconductor caused by the diffusion of charge carriers (holes and/or electrons). Diffusion current occurs even though there isn't an electric field applied to the semi conductor.

It does not have E as one of its parameters.

while diffusion current depends on the value of electric field applied to the semi conductor.

Section - B

Ques 6. Explain the following

Solution : (i) Ferromagnetism:

Some compounds have unequal magnetic moments although their atoms are anti ferro magnetically coupled. The magnetude of magnetic moment is more in one dirn than in the other. This behaviour of a material is called ferri magnetism.

Garnets and ferrites show this behaviour. Ferrites are the ceramic materials possessing following properties.

1> Very high electrical resistivities.

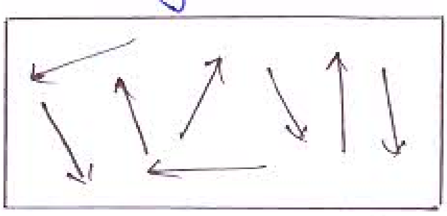
2> Low power loss at high freq.

3> Suitable for both temporary as well as permanent magnets.

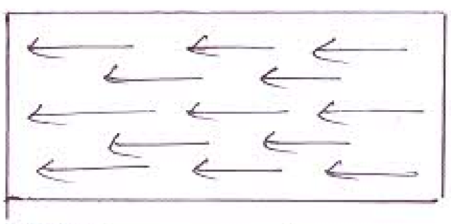
4> Conductivity behaviour like those of semiconductors.

(ii) Paramagnetism:

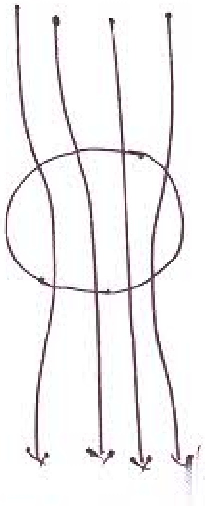
Atoms and ions possessing odd number of e^- give rise to residual permanent magnetic moment. If some inner orbits are in complete in an atom having an even number of e^-, the solid may behave as paramagnetic. These randomly oriented magnetic moments as a whole have negligible net magnetic moment in the solid. When a magnetic field is applied on them, the random magnetic moments align them selves in direction of the field. This results in a feeble magnetization, and is referred as paramagnetism.



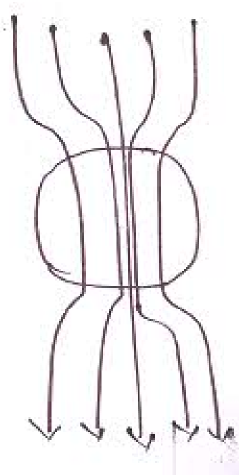
(a) Paramagnetic



(b) Ferro magnetic



(c) Paramagnetic

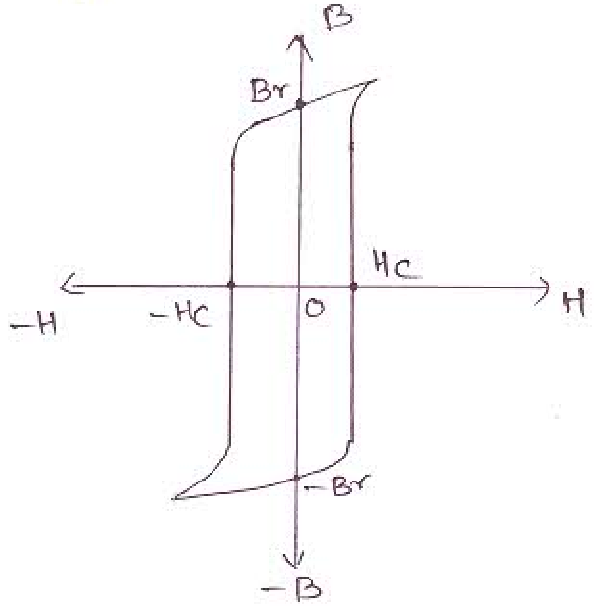


(d) Ferromagnetic

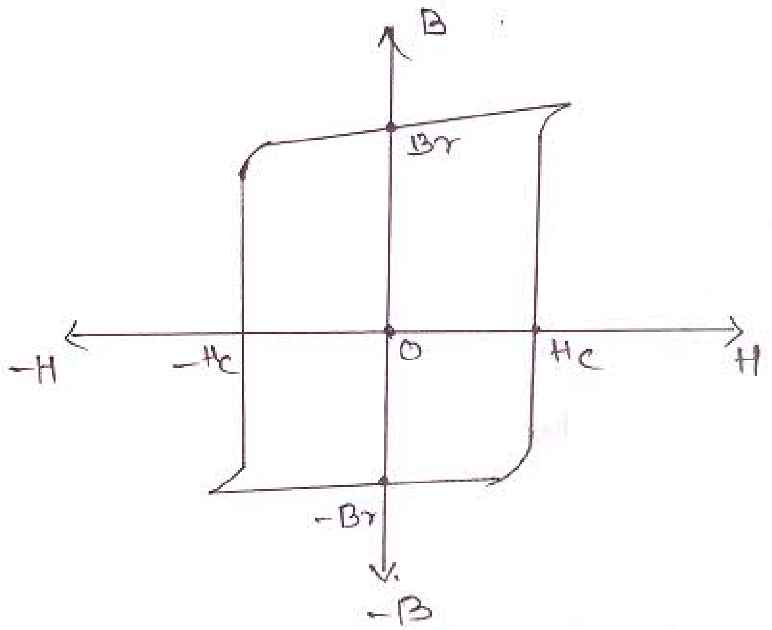
Ques 7: Differentiate between Hard and Soft magnetic materials along with the magnetization characteristics.

Solution: Soft Magnetic Material:

These materials are also known as permeable magnetic materials as they possess high permeability. The B-H curve of a soft magnetic material is shown in fig. Due to very low coercive force, the hysteresis loop gives small area under the B-H curve. Due to smaller area of hysteresis loop, the power losses in such materials are low, and they can be used as magnets at high frequencies.



(a) Soft Magnetic Material



(b) Hard Magnetic Material

Hard Magnetic Materials:

Hard or permanent magnetic materials have an ability to retain magnetic field. They are characterized by large coercive force, and sufficient permeability. Therefore, area below their B-H curves is large, and is typically as shown in fig. Material of fig is a better hard magnetic material due to it's larger hatched area than that of fig. They are used to make permanent magnetic poles for alternators and motors.

Example: High carbon steel, Alnico, Cunife and Cunico etc.

Ques8: Calculate the current produced in a Germanium Plate, of area 1 cm² and of thickness 0.3mm when a potential difference of 2V is applied across faces. Given, concentration of free electron in Germanium is $2\times10^{19}/m^3$ and mobilities of electrons and holes are $0.36\ m^2/V\text{-}s$ and $0.17\ m^2/V\text{-}s$ respectively.

Solution:

$A = 1cm^2 = 10^{-4}m^2$

$d = 0.3mm = 0.3\times10^{-3}m$

$V = 2$ volts

$\mu_e = 0.36 m^2/V\text{-sec}$

$\mu_h = 0.17\ m^2/V\text{-sec}$

$n_I = 2\times10^{19}\ /m^3$

$J = I/A \Rightarrow I = J\times A.$

$= ne(\mu_e+\mu_h)\cdot V/d \cdot \times A$

$$I = \frac{2\times10^{19}\times1.6\times10^{-19}\ (0.36+0.17)\times10^{-4}\times2}{0.3\times10^{-3}}$$

$I = 1.13$ Amp

Ques9: Discuss the process of manufacturing of IC from Ingot along with elaborative diagram.

Solution: The manufacturing of IC consists of following steps. The steps includes 8-20 patterned layers created into the substrate to form the complete integrated ckt. The electrically active region are created due to this layering in and on the surface wafer.

Step 1: Wafer production

The first step in wafer production. The wafer is a round slice of semiconductor material such as silicon. Silicon is preferred due to its characteristics. It is the base or substrate for entire chip. first purified polycrystalline silicon is created from the sand. Then it heated to produce molten liquid. A small piece of solid silicon is dipped on the molten liquid.

Then the solid silicon (seed) is slowly pulled from the melt. The liquid cools to form single crystal ingot. A thin round wafer of silicon is cut using wafer dicer.

Step 2: Masking:

To protect some area of wafer when working on another area, a process called photolithography is used. The process of photolithography includes masking with a photographic mask and photo etching. A photoresist film is applied on the wafer. The wafer is alligned to a mask using photo aligner.

Step 3: Etching:

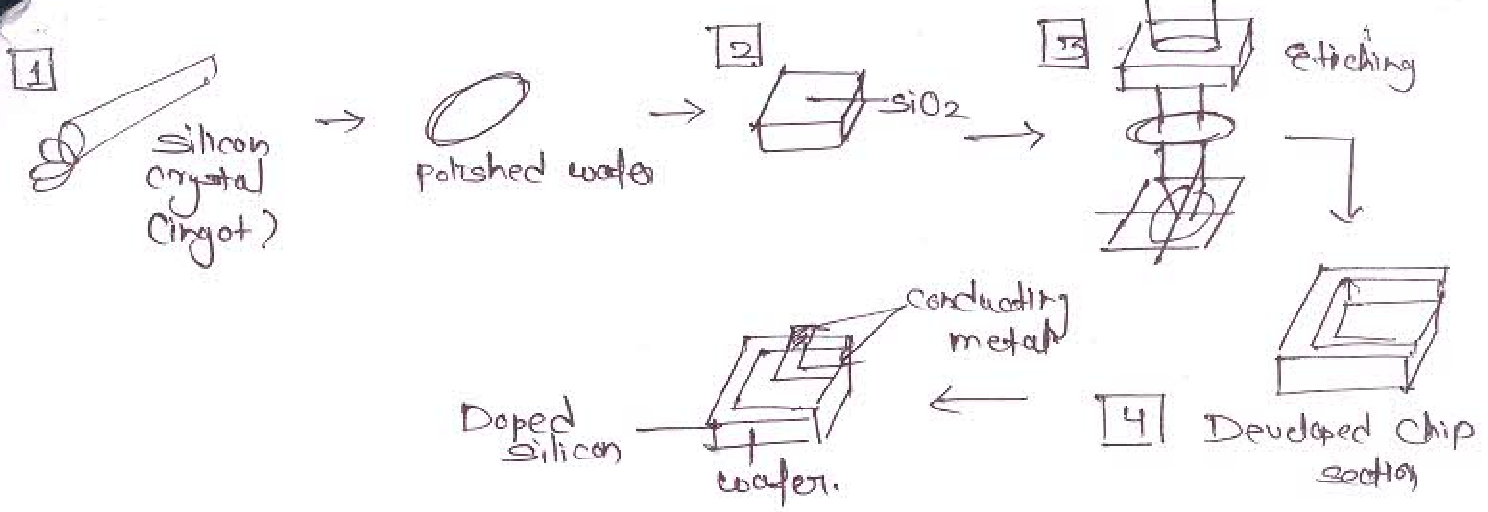
It removes material selectively from the surface of wafer to create patterns. The pattern is defined by etching mask. The parts of material are protected by this etching mask. Either wet or dry etching can be used to remove the unmasked material. To perform etching in all direction at same time isotropic etching will be used.

Step 4: Doping:

To alter the electrical character of silicon, atom with one less electron than silicon such as boron and atom with one electron greater than silicon such as phosphorous are introduced into the area. The p-type (boron) or N-type (phosphorus) are created to reflect their conducting characteristics.

Step 5: Metallization:

It is used to create contact with silicon and to make interconnection on chip. A thin layer of aluminium is deposited over the whole wafer. Aluminium is selected becoz it is a good conductor, has good mechanical bond with silicon forms low resistance contact and it can be applied and pattern with single deposition and etching process.



Ques 10: Define the term magnetostriction and discuss the types of magnetostriction.

Solution: When a ferromagnetic material is magnetised small changes in dimensions occur, the effect being known as 'magnetostriction'. The magnetostriction may be of the following three types.

1. Longitudinal Magnetostriction:

It is the change in length in the direction of magnetisation. This change may be increase or decrease in length.

2. Transverse Magnetostriction:

It is the change in dimension, perpendicular to magnetisation direction.

3. Volume Magnetostriction:

It is the change in volume resulting from the above two effects.

Formula is given by, $\lambda = \frac{\delta l}{l}$.

δl = extension (or contraction) of a specimen l in the dir^n of an applied field of strength H when the field strength is raised from zero to a value causing technical saturation.

Section-C

Q.11 Derive the relation between Relative Permeability and susceptibility. A magnetic field of 2400 A/m is applied to a material having a susceptibility of 1500. Determine (i) the relative permeability (ii) Intensity of Magnetization (iii) Magnetic field Intensity

Solⁿ:- Consider a solenoid having length 'l', Area of cross section 'A', No of turns 'N' and current through solenoid 'I'.

If the solid is placed in vacuum the flux density

$$B_0 = \mu_0 H \quad \text{—(i)}$$

and

$$H = \frac{NI}{l} \quad \text{—(ii)}$$

If vacuum is replaced by a homogeneous magnetic medium the flux density will increase to

$$B = \mu_0 \mu_r H \quad \text{—(iii)}$$

thus there will be an increase in the flux density of

$$B - B_0 = \mu_0 (\mu_r - 1) H = \mu_0 H' \quad \text{—(iv)}$$

So increase in B can be though of due to an increase in H by H' rather than due to change in medium. If I' is ~~[illegible]~~ Correspondingly increase in current then.

$$H' = \frac{NI'}{l} = \frac{NI'A}{l \cdot A} \quad \text{— (IV)}$$

and we know that $\boxed{M = \frac{NI'A}{V}}$

so $H' = M = (\mu_r - 1)H$

$$\boxed{\frac{M}{H} = \mu_r - 1 = \chi} \quad \text{— (VI)}$$

from equation — (IV)

$$B = B_0 + \mu_0 H'$$

$$B = B_0 + \mu_0 (\mu_r - 1)H$$

$$\boxed{B = \mu_0 H + \mu_0 M}$$

$$\boxed{B = \mu_0 (H + M)}$$

from equation (VI) $\boxed{\mu_r = 1 + \chi}$

Given $\chi = 1500$

(a) $\mu_r = 1 + \chi = 1 + 1500 = \boxed{1501}$

(b) $\chi = \frac{M}{H} \Rightarrow M = \chi \times H = 1500 \times 2400$

$$\boxed{M = 3.6 \times 10^6 \text{ A/m}}$$

(c) $B = \mu_0 \mu_r H = 4\pi \times 10^{-7} \times 1501 \times 2400$

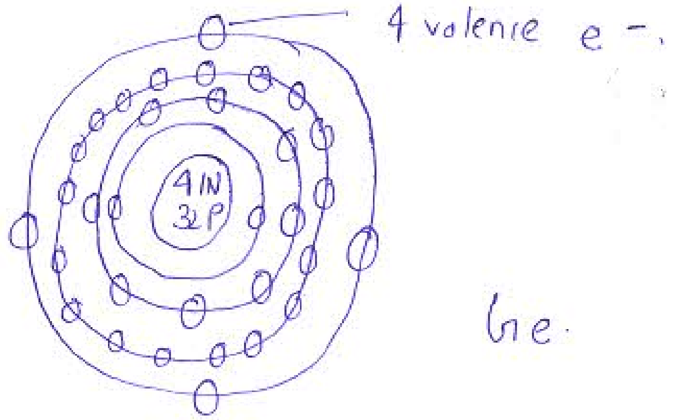
$$\boxed{B = 4.52 \text{ T}}$$

Q.12 Write short notes on the following
(i) Atomic structure of Intrinsic and Extrinsic semiconductors
(ii) Application of Semiconductors
(iii) Thermistors

Sol^n -: Atomic structure of Intrinsic and Extrinsic Semiconductors
(i)

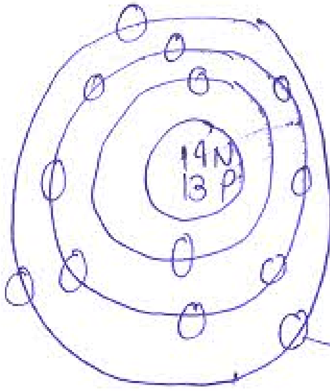
Conductivity depends on the number of electrons in the valence orbit. If atoms having less than 4 e^- they are good conductors and having equal to 4 valence e^- they are semiconductors.

A pure semiconductor is called Intrinsic Semiconductor. Here no free electrons are available since all the covalent bonds are complete.



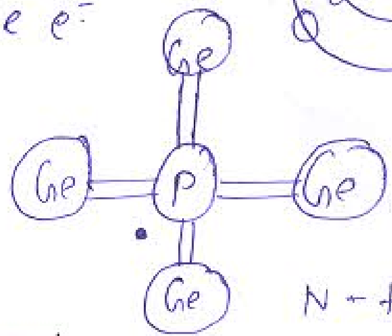
Ge.

If small amount of certain metallic impurity is added it attains current conducting properties.
Pentavalents atoms having 5 e^- called donor atoms.
Trivalents atoms having 3 e^- called acceptor atoms

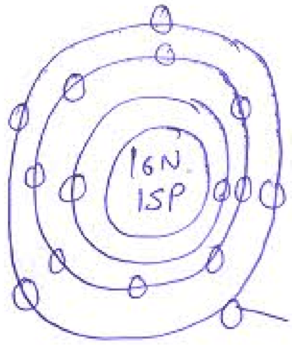


3 volence e^-

Aluminium.



N - type semiconductor



5 volence e^-

Phosphorus

(II) Application of Semi Conductors :-

(i) Semiconductor are used for Heating appliances.

(ii) Power amplifiers in radio System.

(iii) Photo Conductive and Photo voltaic Cells are prepared by light sensitive Semiconductor material.

(iv) Semiconductor are used as non-linear resistors.

(v) Semiconductors are used for making diodes and other switches, used for Power electronic devices.

(vi) Used for Remote Control System.

(vii) Used for Memory elements of Computers.

(iii) Thermistors :-

A thermistor is a type of resistor whose resistance is dependent on temperature. Thermistors are widely used as inrush current limiter, temperature sensors, self resetting over current protectors, and self regulating heating elements.

With negative temperature coefficient (NTC), resistance decreases as temperature increases.

With Positive temperature coefficient (PTC), resistance increases as temperature increases.