MODEL ANSWER

SUMMER– 19 EXAMINATION

Subject Title: Electronic Engineering Materials **Subject Code: 22217**

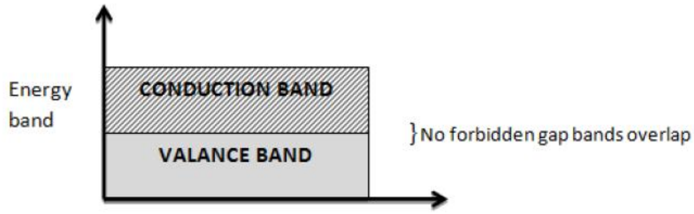
Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for anyequivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

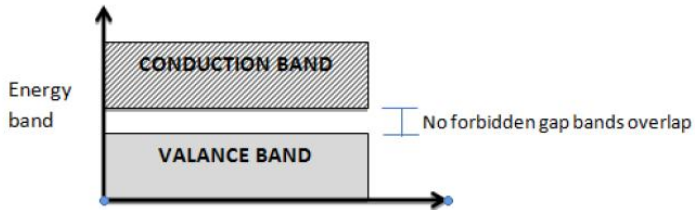
Q. No.	Sub Q.N.	Answer	Marking Scheme
Q.1		**Attempt any Five :**	**10 M**
	a)	**Define Superconductivity.**	**2M**
	Ans:	Superconductivity is a phenomenon of exactly zero electrical resistance. **OR** The property of zero electrical resistance in some substances at very low absolute temperatures called superconductivity.	**2M**
	b)	**Give any two properties of polymers.**	**2M**

	Ans:	**Properties of polymers:-** **1.** It can be molded. **2.** It has ability to soften and even melt.	**Each 1M**
	c)	**Give the classification of magnetic materials.**	**2M**
	Ans:	**The magnetic behavior of materials can be classified into the following five major groups:** **1.** Diamagnetism **2.** Paramagnetism **3.** Ferromagnetism **4.** Ferrimagnetism **5.** Antiferromagnetism	**Any 4 Each ½ M**
	d)	**Define intrinsic and extrinsic semiconductor.**	**2M**
	Ans:	**Intrinsic Semiconductor:-** It is pure semi-conducting material and no impurity atoms are added to it. In the intrinsic semiconductor, number of free electrons in the conduction band and the number of holes in valence band is exactly equal and very small indeed. **Extrinsic Semiconductor:-** It is prepared by doping a small quantity of impurity atoms to the pure semi conducting material. In the extrinsic Semiconductor, number of free electrons and holes is never equal. There is excess of electrons in n-type semi-conductors and excess of holes in p-type semi-conductors.	**1M** **1M**
	e)	**List any two applications of thermionic emission.**	**2M**
	Ans:	**1.** The components which are made by the process of thermionic emission are used in the electronic devices such as cathode ray tube, radio etc. **2.** Thermionic emission are used in a variety of applications, including high-frequency vacuum transistors for electronics, electron guns for scientific instrumentation, power electronics, x-ray generation, and energy converters from high-temperature sources and solar energy.	**1M** **1M**
	f)	**Draw energy level diagram of conductor and insulator.**	**2M**
	Ans:	**Diagram:**	**Each 1M**

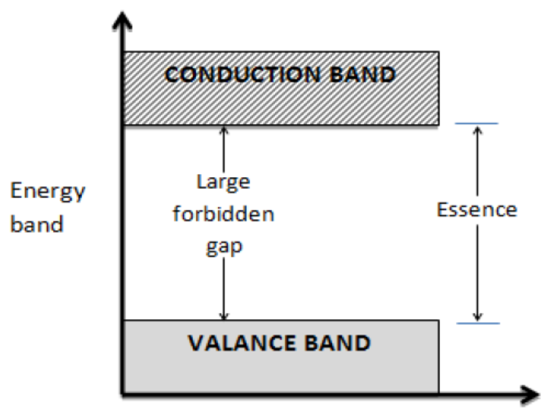
(i) Energy band diagram of conducting material



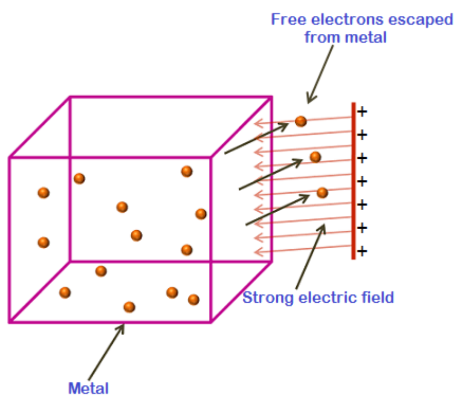
OR

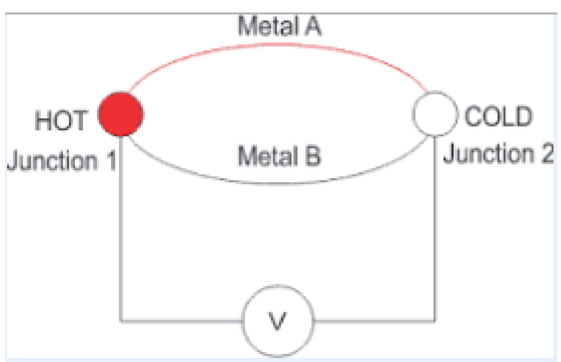


(ii) Energy band diagram of insulating material



	g)	**State any four applications of micrometers.**	**2M**
	Ans:	• It is used to measure the teeth of gears accurately. • This instrument is used to check round work pieces accurately • It is also used to check wall thickness of the pipes • It is used to check depth or height of the work piece • It is used to measure groves keyways etc • It is used to check inside bore of the work piece accurately • It is used in telescopes or microscopes to measure the apparent diameter of celestial bodies or microscopic objects.	**(Any 4) Each ½ M**
Q 2		**Attempt any Three :**	**12M**
	a)	**Explain the concept of field emission and give its two applications.**	**4M**
	Ans:	**Concept of field Emission:-**	**2M**

		• Electric field electron emission is the process by which free electrons are emitted from the metal surface when strong electric field is applied. • Electric field electron emission is also called as electron field emission, field electron emission and field emission. Electric field electron emission occurs not only in metals, but also in liquids. • Field electron emission occurs in metals that are placed at very strong electric field. In other words, field electron emission occurs when large amount of energy in the form of electric field is applied to the free electrons in the metals.  **Applications:-** 1. Field emission displays. 2. Microwave power amplifiers 3. Parallel e-beam lithography tools 4. Electron guns for electron microscopes.	**Any 2 Appln. 1M each**
	b)	**Explain the requirements of good insulating material.**	**4M**
	Ans:	**Requirement of good insulating material are:** **i) Electrical** **ii) Mechanical** **iii) Thermal** **iv) Chemical** **(i) Electrical requirement:** A good insulating material should have high resistivity and low leakage current. It should have high dielectric strength and small dielectric loss. **(ii) Mechanical requirement:** A good insulating material should have sufficient mechanical strength to withstand vibrations. **(iii) Thermal requirement:** A good insulating material should have small thermal expansion to avoid damages, It should be non-ignitable and self-extinguishable. **(iv) Chemical requirement:** A good insulating material should be resistant to oils, gas, fumes acids and alkalies. It should not absorb water as water reduces insulation resistance and dielectric strength.	**(Any 4)** **1M each**

	c)	**Explain the concept of piezo-electricity and give its two applications.**	**4M**
	Ans:	**Concept of piezoelectricity:-** • The phenomenon in which production of polarization, takes place when mechanical stress is applied. • Piezoelectricity is a special property of certain material which provides us with a means of converting mechanical energy into electrical energy and vice versa. • Rochelle salt, Quartz and Barium titanate are few piezo materials. **Applications:-** 1. Piezoelectric transducers are common in ultrasonic applications, such as intrusion detectors and alarms. 2.Piezoelectric devices are employed at AF (audio frequencies) as pickups, microphones, earphones, beepers, and buzzers. 3.In wireless applications, piezoelectricity makes it possible to use crystals and ceramics as oscillators that generate predictable and stable signals at RF (radio frequencies)	**2M** **1M each**
	d)	**Explain seekback effect and give its two applications.**	**4M**
	Ans:	**(Diagram & Explanation = 2M, Any 2 Applications = 1M each)** **Diagram:**  **Explanation:-** Thermoelectric effect also called as seeback effect. **Principle:** When two dissimilar metals are connected with each other at their ends a thermocouple junction is formed. This thermocouple junction formed between them when kept at different temperatures, An EMF is generated this EMF is known as Thermoelectric emf. This thermoelectric emf will force a continuous current this current is known as thermoelectric current and the whole phenomenon is called as thermoelectric effect or Seeback effect	

		Applications:- 1. Measurement of the temperature difference between two objects. 2. Used in the thermoelectric generator, these functions like a heat engine. 3. Used in power plants for converting waste heat into additional power (a form of energy recycling). 4. In automobiles as automotive thermoelectric generators (ATGs) for increasing fuel efficiency. 5. Space probes often use radioisotope thermoelectric generators with the same mechanism but using radioisotopes to generate the required heat difference.	
Q.3		**Attempt any three:**	**12M**
	a)	**Explain types of impurity added in a semiconductor with one example each.**	**4M**
	Ans:	There are two types of impurities added in a intrinsic semiconductor which are as follows 1.Donor Impurity 2.Acceptor Impurity <u>1.Donor Impurity –</u> • These are pentavalent which means they have five valence electron. • Four valence electron out of five elctrons are utilized to form four covalent bond with Silicon or Germanium. • Fifth valence electron thus enter the conduction band very easily,thus this impurity are also called as donor impurity while doping is called as donor doping. • It is used to manufacture N-type semiconductor • Eg:Arsenic,Phosphorus,Antimony <u>2.Acceptor Impurity</u> • These are Trivalent which means they have three valence electron. • All the three elctrons are utilized to form three covalent bond with Silicon or Germanium. • Thus fourth covalent bond remains incompelete resulting in a vacancy called as hole.this hole act as a positive charge carrier,thus this impurity are also called as Acceptor impurity while doping is called as Acceptor doping. • It is used to manufacture P-type semiconductor • Eg:Boron,Gallium,Indium	**2M** **2M**
	b)	**Give various photoemissive materials and suggest relevant combination of material for LED to emit Yellow and Green colour.**	**4M**

	Ans:	Various photoemmisive materials are as follows • Zinc • Potassium • Lead sulphate • Sodium • Cadmium sulphide **Relevant combination of material for LED to emit Yellow colour** 1. Gallium Phosphide(GaP) 2. Aluminum Gallium Indium Phosphide 3. Gallium Arsenide Phosphide **Relevant combination of material for LED to emit Green colour** 1. Gallium Phosphide(GaP) 2. Aluminum Gallium Indium Phosphide 3. Aluminum Gallium Phosphide	**2M** **(Any2)** **½ M EACH** **½ M EACH**
	c)	**State and explain various factors affecting the resistivity of electrical materials.**	**4M**
	Ans:	**(Note: stating the factor =1M, explanation of any three factors=3M)** **Various factor affecting the resistivity of electrical materials are** **1. Temperature** **2. Alloying** **3. Cold work** **4. Age hardening** **1. Temperature:** As the temperature increases the resistivity of material increases hence conductivity decreases. **2. Alloying:** Addition of another metal to a pure metal will increase the resistivity considerably hence decrease conductivity. **3. Cold work:** Mechanical distortion taking place in metal increases resistivity of a metal because the localized strains interface with electron movement. **4. Age hardening:** The age hardness increases resistivity of an alloy.	
	d)	**Explain the concept of anti-ferromagnetism.**	**4M**
	Ans:	**(Explanation=2M, Example=1M, Diagram=1M)**	

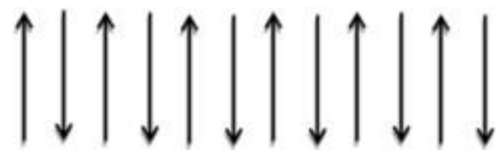
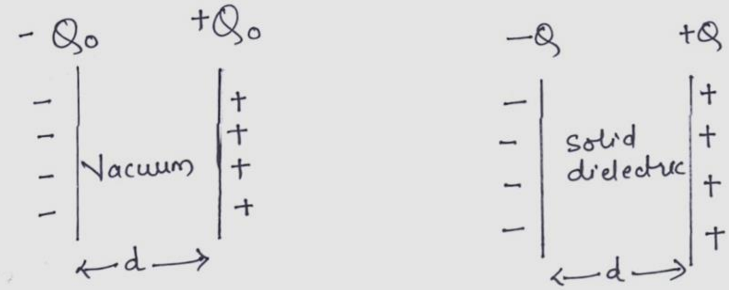
		• When the neighboring magnetic moments are aligned anti-parallel. This phenomenon is called anti ferromagnetism. • This phenomenon occurs below a certain temperature known as Neel temp (TN) • **Example:** Cobalt oxide, Nickel oxide, Chromium. **Diagram:**  **Arrangement of dipole moment**	
Q.4	**A)**	**Attempt any THREE :**	**12 M**
	a)	**Suggest the relevant materials used in flexible and wearable antenna.**	**4M**
	Ans:	1. **The Substrate:** • The fabric textile material to be used should have more dielectric permittivity. • Low dielectric constant. • Nominal thickness value. • Low moisture content of fabric. • **Example:** 100% pure cotton / polyamide space fabric. 2. Conducting material having low and stable electrical resistance, flexible in nature • **Example:** Copper, Nickel	**2M** **2M**
	b)	**Explain the effect of a dielectric on the behaviour of a capacitor.**	**4M**
	Ans:	• The function of a capacitor is to store charge. its capacity to store charge is measured in terms of capacitance (C) • The presence of dielectric material between the two conducting material in capacitor helps the capacitor to store charge or else the circuit gets completed and current starts flowing. • When electric field is applied across the dielectric material ,the electrons of atoms are acted upon by the electric field and are displaced in a direction opposite to that of electric field this results in separation of positive and negative charges hence dipoles are created in the dielectric material and said to be polarized	**2M**

Diagram: **2M**



The capacitance of a capacitor in Vacuum is given as

$$C_0 = \frac{Q_0}{V}$$

the capacitance of a capacitor in solid dielectric is given as

$$C = \frac{Q}{V}$$

But $C \propto \frac{A}{d}$

where, A = Area of cross section of metal plates
d = distance between metal plates.

$\therefore$ for solid dielectric $C = \epsilon \frac{A}{d}$

for Vacum dielectic $C_0 = \epsilon_0 \frac{A}{d}$

where ϵ = Absolute permittivity of solid dielectric
ϵ_0 = Absolute permittivity of Vacum dielectic

$$\therefore \frac{C}{C_0} = \frac{\epsilon}{\epsilon_0}$$

$$\frac{C}{C_0} = \epsilon_r \text{ (Relative permittivity or dielectric constant)}$$

	c)	**Explain various factors that affecting the permeability.**	**4M**
	Ans:	**Factors that affecting the permeability are as follows:** 1. Physical condition of sample 2. Chemical purity of sample	**1M**

		Factors affecting permeability and hysteresis loss are: **1. Physical condition of sample:** • The crystals of a ferromagnetic material when cold worked experience deformation as a result of which the material have very poor magnetic properties due to the internal strains on domains greater magnetic field is required to give definite magnetization. • The permeability decreases and hysteresis loss is increased. **2. Chemical purity of the sample:** • The main impurities in the magnetic materials used are C, S, O and N, impurities affect the geometric pattern of the crystals and are harmful to the magnetic property.	**2M** **1M**
	d)	**Explain the effect of temperature on the electrical conductivity of metal.**	**4M**
	Ans:	**Effect of temperature on the electrical conductivity of metal are as follows:** • Electrical conductivity of a metal decreases with the increase in temperature of metal, as the resistivity increases. • The increase in the resistivity is due to hindrance in mean free path. • As the temperature increases vibrations are also increased, as the result greater amount of thermal energy is converted to mechanical energy. • The mean free path for movement of free electron is blocked increasing the resistivity thus the electrical conductivity decreases.	**1M each point**
	e)	**Describe the breakdown in solid dielectric materials.**	**4M**
	Ans:	**(Note: consider any two types of breakdown 2M for each breakdown)** • In solids there are three types of breakdown: **1.** Electro thermal break down **2**. Purely electrical breakdown **3.** Electro-mechanical breakdown **1. Electrothermal break down:** • It is due to heat produced by dielectric loss • Large thickness of dielectric ,high temperature od dielectric materials,high applied voltage are responsible for electrothermal breakdown. **2. Purely electrical breakdown:**	

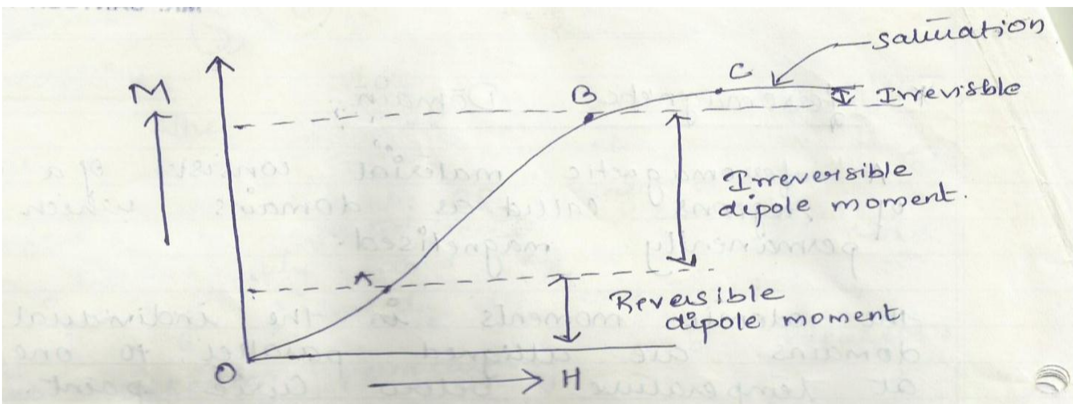
		• This takes place due to collision ionization specially in crystalline solid dielectric • The free electron in crystal gets accelerated due to strong applied field, which further liberate more electron • Small thickness of dielectric, moderate temperature and low frequency favor electrical breakdown. **3.Electro-mechanical breakdown:** • This generally takes place when the surrounding air has high temperature and humidity. • Due to high temperature and humidity the insulation resistance decreases.	
Q.5		**Solve any TWO :**	**12 M**
	a)	**Suggest suitable material for (i) Secondary emission (ii) Photoelectric emission and explain any one emission process. Give one application of each.**	**6M**
	Ans:	**1.Secondary emission**: When a solid surface is bombarded by electrons of adequately high energy, secondary electrons are emitted from the solid surface. The electrons being bombarded are called primary electrons the number of secondary electrons will depend on the energy of primary electrons. **Materials:** Magnesium oxide (MgO), Lead Oxide (PbO), Gallium phosphide (GaP) **Application:** Electron multiplier tubes, Special amplifying tubes, Computer memory Tube. **2.Photo electric emission:** The electron emission from the metal surface, when illuminated by light is called photo electric emission. When a beam of light is made to strike the surface of metal due to which the electron are emitted from its surface. **Material:** Sodium, Potassium, Caesium, Rubidium **Applications:** It is used in Photo multiplier tubes, photo tube, Photo voltaic cell, Solar tubes.	**Mode of Emission ANY 1 (2M)** **Material For each emission (1M)** **Application For each emission (1M)**
	b)	**State one application for the given dielectric material:** **(i) Mica** **(ii) Rubber** **(iii) Cotton** **(iv) Wood** **(v) Polythene**	**6M**

		(vi) Bakelite	
	Ans:	**(NOTE: ANY RELEVANT APPLICATIONS SHOULD BE GIVEN MARKS)** **i) Mica:** 1. It is used in radio circuits, capacitor, radio tubes, segment insulation etc. 2. It is used in high voltage machines, traction motors, switches, plugs, fuse, holder, parts of sockets etc. **ii) Rubber:** 1. It is used in flexible wires, jack cards and installation wires 2. It is used in manufacturing tubes, tyres etc. **iii) Cotton:** 1) It is used to Manufactured tubes, tyres. 2) It is used to make Flexible wires and installation wires 3) cotton impregnated with wax or varnishes are used in windings of magnet coils and small medium sized mechanics. **iv) Wood:** 1)Woods are used for building the fencing and simple decoration for artificial gardening inside a home or on roofs. 2) It is used for terminal blocks, wedges for armature windings, operating rods . **v) Polythene:** 1) It is used for making insulators for cables and radio frequency generators 2) It is used to produce yarns, cloths and films. 3)The synthetic resins are popular in the electrical installations. **vi) Bakelite:** 1)It is used to manufactured lamp holders ,terminal blocks ,instrument cases, small ponds ,switch covers etc.	**1M Each**
	c)	**Draw and explain the typical magnetization curve for a ferromagnetic material. State the application of ferromagnetic materials.**	

Ans:

2M

Diagram:



Explanation:

2M

The above graph is a magnetization curve for a ferromagnetic material. It is magnatization (M) against field strength(H)

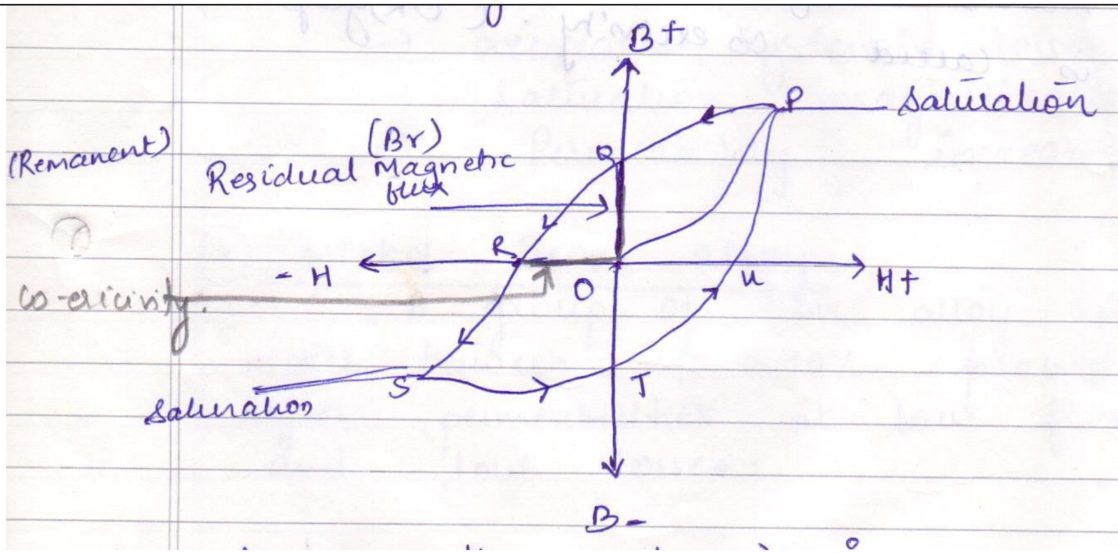
Magnatization curve is divided into 3 region.

- Region O TO A –the value of H is small, the doman wall moment is mostly reversible.
- Region A TO B-the wall of H are higher , the domain wall moment continues to take place and its irrevisible.
- Region B TO C- in this region the ferromagnetic material is magnetised the dipole moments are aligned in the direction of magnetic field.
- Above point C it is saturation.

OR

Diagram:

2M



Explanation: 2M

By plotting values of flux density, (B) against the field strength, (H) we can produce a set of **curves** called **Magnetization Curves**, Magnetic Hysteresis **Curves** or more commonly B-H **Curves.** The phenomenon of magnetization and demagnetization of ferromagnetic material is known as hysteresis.

It is observed that as the electric field increases magnetic field(H) increases and therefore magnetic flux density (B) also increases, but when it decreases, B does not decreases at the same rate at which it was increased.

The magnetic material does not get demagnetised it retains some magnetisation this is hysteresis. As magnetic field (H) increases, the magnetic flux density (B) too increase, but B stop increasing and reaches saturation. The curve OP is saturation curve when it decreases the curve does not follow the path, it follows different path PQ. That means rate of decrease of B is not same as rate of increase of B.

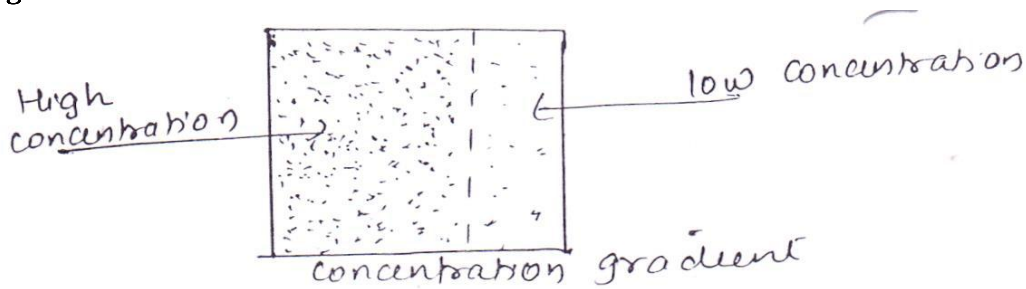
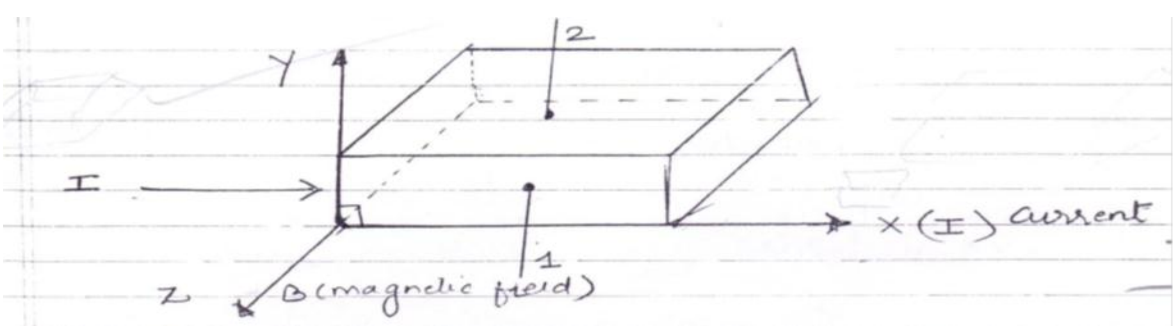
When magnetic field (N) reaches zero H=0, that means B should be zero but $B \neq 0$, that means material does not get demagnetized there is some residual magnetism i.e. OQ (graph is Remnant flux density Br.

When H is increased in reverse direction B also increases in reverse direction and again get S The magnetic flux density (B) becomes zero when reverse magnetic force is applied that is called coercitivity (OR) graph saturated.

Application of ferromagnetic material:

1) It is used as a preferable choice for aviation instrumentation, electronic tubes, electromagnetic valve, magnetic separator and electromagnetic shielding**.**

	Q.6	**Attempt any TWO:**	**12M**

	a)	**Explain the following in brief:** **(i) Diffusion** **(ii) Hall effect** **(iii) Thermal conductivity**	**6M**
	Ans:	**<u>Diffusion</u>**: In a semiconductor bar a concentration gradient exist when either number of electrons or holes is greater in one region of a semiconductor as compared to other region. When such concentration gradient exist, the carriers (electrons/holes) move from the region of higher concentration to lower concentration this process is called as diffusion. **Diagram:**  **<u>Hall Effect</u>**: If a piece of metal or semiconductor carrying current "I" is placed in a transverse magnetic field „B" then an electric field „E" is induced in the direction Perpendicular to both I and B. Hall effect is used to determine whether a semiconductor is N type or P type, and to find carrier concentration. **Diagram:** 	**1M** **1M** **1M** **1M**

		Thermal conductivity:- Thermal conductivity (often denoted k, λ, or κ) is the property of a material to conduct heat. It is evaluated primarily in terms of the Fourier's Law for heat conduction. In general, thermal conductivity is a tensor property, expressing the anisotropy of the property. Heat transfer occurs at a lower rate in materials of low thermal conductivity than in materials of high thermal conductivity. Correspondingly, materials of high thermal conductivity are widely used in heat sink applications and materials of low thermal conductivity are used as thermal insulation. The thermal conductivity of a material may depend on temperature.	**2M**
	b)	**Explain the properties of magnetic materials with examples:** **(i) Permanent magnetic dipole** **(ii) Para magnetism** **(iii) Diamagnetism**	**6M**
	Ans:	**Permanent magnetic dipole:** Whenever a charged particle has an angular momentum, it will contribute to the permanent dipole moment. These occur when two atoms in a molecule have substantially different electronegativity: One atom attracts electrons more than another, becoming more negative, while the other atom becomes more positive. A molecule with a permanent dipole moment is called a polar molecule. **Para magnetism:** Para magnetism is a form of magnetism whereby certain materials are weakly attracted by an externally applied magnetic field, and form internal, induced magnetic fields in the direction of the applied magnetic field. Paramagnetic materials include most chemical elements and some compounds; they have a relative magnetic permeability slightly greater than 1 (i.e., a small positive magnetic susceptibility) and hence are attracted to magnetic fields. Para magnetism is due to the presence of unpaired electrons in the material, so all atoms with incompletely filled atomic orbitals are paramagnetic. Due to their spin, unpaired electrons have a magnetic dipole moment and act like tiny magnets. An external magnetic field causes the electrons' spins to align parallel to the field, causing a net attraction. Paramagnetic materials include aluminum, oxygen, titanium, and iron oxide (FeO). **Diamagnetism:** Diamagnetic materials are repelled by a magnetic field; an applied magnetic field creates an induced magnetic field in them in the opposite direction, causing a repulsive force. The magnetic permeability of diamagnetic materials is less than $\mu 0$, the permeability of	**2M** **2M** **2M**

		vacuum. In most materials diamagnetism is a weak effect which can only be detected by sensitive laboratory instruments, but a superconductor acts as a strong diamagnetic because it repels a magnetic field entirely from its interior. Diamagnetic materials, like water, or water-based materials, have a relative magnetic permeability that is less than or equal to 1. Diamagnetic material includes copper, water ,wood etc,	
	c)	**Explain the following materials used for fabrication of semiconductors:** **(i) Substrate** **(ii) Capacitance materials** **(iii) Metals**	**6M**
	Ans:	**Fabrication of semiconductor devices like transistors diode, solar cell etc. we have to make use of following types of materials,** **i) Substrate:** It is used for deposition of thin film layers, Substrate can be plastic, glass or ceramic. Plastic substrate are used only for thin film solar cells, Glass or Ceramic are high temperature substrates. They are used for deposition of metals for resistors and capacitors. **ii) Capacitance Material:** They should have high dielectric constant, pin-hole free continuous layer, ability to withstand thermal stress, Commonly used capacitance material are SiO, ZnS, SiO2. **iii) Metals:** The fabrication of the passive part of integrated silicon and thin film circuits involves use of different metals. The metals usually act as capacitor plate, as heat dissipater as a mechanical support.	**Each 2M**