WINTER-19 EXAMINATION

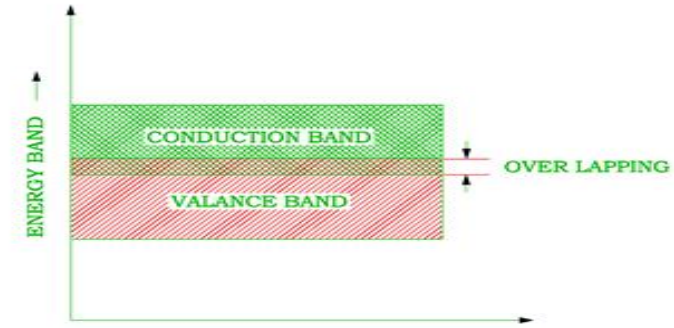
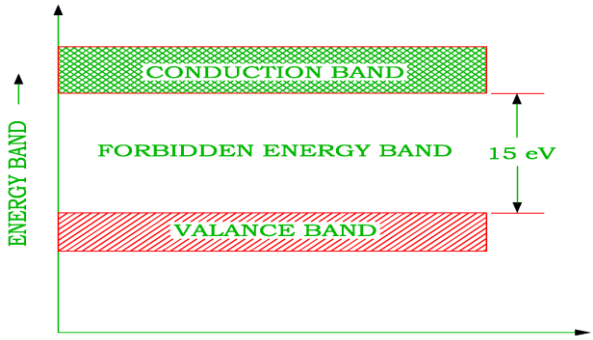
Subject Name: Electronic Engineering Materials **Subject Code:** 22217

Model Answer

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in themodel answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may tryto assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given moreImportance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in thefigure. 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 constantvalues 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 judgement 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.	Answers	Marking Scheme
1	**(A)**	**Attempt any FIVE of the following:**	**10- Total Marks**
	(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)	**List any two examples of ferroelectric materials.**	**2M**
	Ans:	1)Rochelle salt 2) Barium Titanate.	**1M each**
	(c)	**Give 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)	**Draw energy level diagram of conductor and insulator.**	**2M**
	Ans:	1)Energy level diagram for conductor:  FIG A : ENERGY BAND DIAGRAM FOR CONDUCTOR 2)Energy band diagram for insulator:  FIG C : ENERGY BAND DIAGRAM FOR INSULATOR	**1M each**

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	e)	**List any two applications of photoelectric emission.**	**2M**
	Ans:	1)It is used in Photo multiplier tubes,. 2) It is used in photo tube. 3)It is also used in Photo voltaic cell, Solar cells.	**1M each**
	f)	**List any two trivalent and pentavalent impurity materials.**	**2M**
	Ans:	Pentavalent impurity; like Arsenic (As), Antimony (Sb), Phosphorous (P), etc Trivalent impurity; like Indium (In), Boron (B), Aluminum (Al), etc..	**1M each**
	g)	**Give any two applications of micro-relays.**	**2M**
	Ans:	**Relays** are used in a wide variety of **applications** throughout industry, such as in telephone exchanges, digital computers and automation systems. They are also used in electrical fuel pump.	**1M each**
Q. No.	Sub Q. N.	Answers	Marking Scheme
2		**Attempt any THREE of the following:**	**12- Total Marks**
	a)	**Explain how energy levels are formed in a materials.**	**4M**
	Ans:	There are three types of energy levels(bands)in metals 1)**Valence band:** The range of energies formed by valence electrons are known as valence band.valence electrons are electrons which are present in the outermost shell of an atom. 2)**Conduction Band:** The range of energies formed by conducting electrons are known as conduction band. Conducting electrons are valence electrons which are free to move. **3)Forbidden Energy Gap:** The gap between valence band and conduction band is known as forbidden energy gap.	**1M each**

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	b)	**Explain the concept of piezo-electricity and state its any one application.**	**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** **2M**
	c)	**Explain the properties of dielectric materials.**	**4M**
	Ans:	1)**Dielectric constant**.-A dielectric characteristic of a material is determined by its dielectric constant. It is a measure of polarization of the dielectrics. 2) **Dielectric strength**- Dielectric strength is the ability of a dielectric material of specified thickness to withstand high voltages without breaking down. **3) DIPOLE MOMENT :** The product of the magnitude of the charge (q) and distance between two charges (d) is called as dipole moment. **4) POLARIZATION** : The process of producing electric dipoles inside the dielectric by the application of an external electrical field is called polarization in dielectric **5) PERMITTIVITY.:** The permittivity represents the dielectric property of a medium. It indicates easily polarizable nature of material. Its unit is farad/metre	**Any 2**

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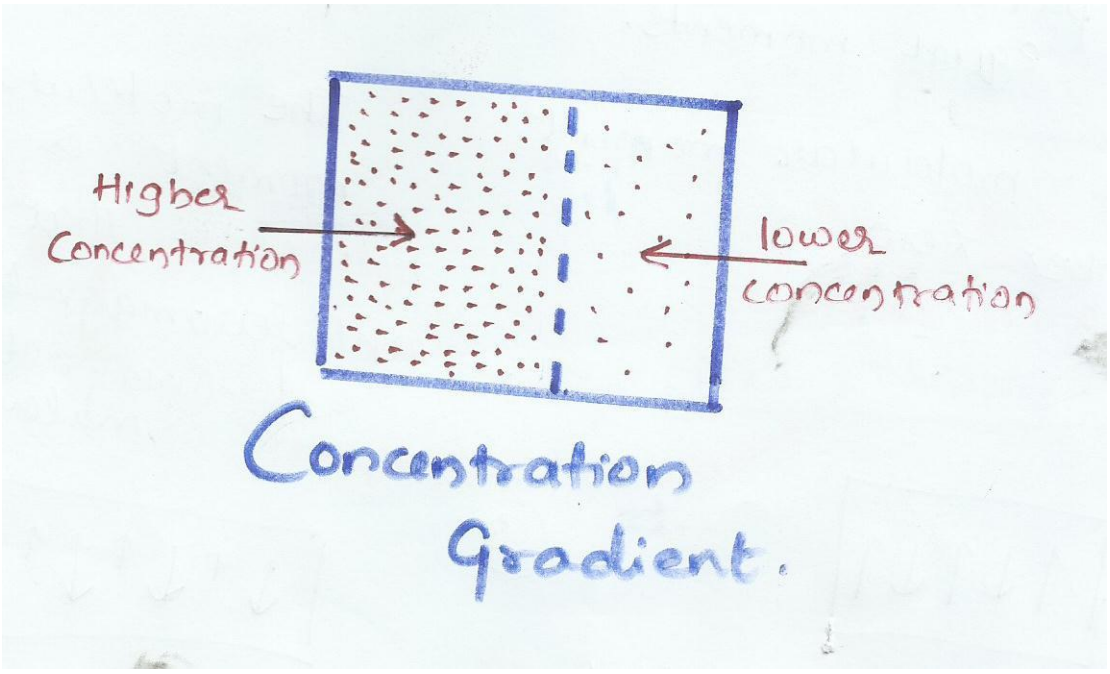
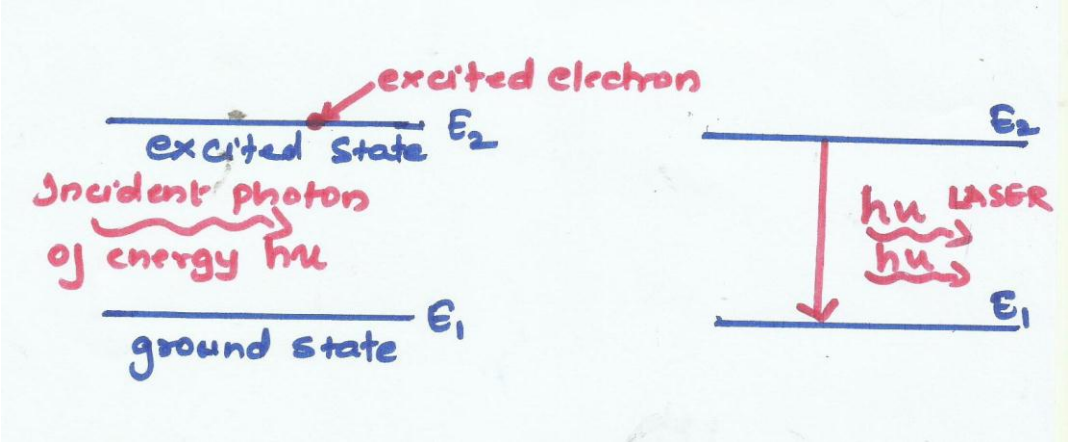
	d)	**Explain the concept of thermoelectric effect and give any two materials for thermocouples.**	**4M**
	Ans:	Thermoelectric effect also called as seeback effect. **Principle**:When two disimilar metals are connected with each other at their ends a thermocouple junction is formed.this thermocouple junction 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 continous current this current is known as thermoelectric current and the whole phenomenon is called as thermoelectric effect or Seeback effect. The most commonly used thermoelctric material as a rhermocouple are **(any one)** 1)copper-constantan 2)iron –constantan 3)chromel –constantan	**2M** **1M each**

Q. No.	Sub Q. N.	Answers	Marking Scheme
3		**Attempt any THREE of the following :**	**12- Total Marks**
	a)	**Explain the process of photoelectric emission.**	**4M**
	Ans:	**Process of photoelectric 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. • The number of electrons emitted from the metal surface depends upon the intensity and frequency of incident light. • Higher the intensity and frequency of light higher is the emission. These emitted electrons are called photo electrons. **Material**: Sodium, Potassium, Cesium, Rubidium **Applications**: It is used in Photo multiplier tubes, photo tube, Photo voltaic cell, Solar cells.	**(3M)** **(1M)**

	b)	**Explain diffusion (current) in a semiconductor.**	**4M**
	Ans:	• When some voltage is applied to a semiconductor bar ,the holes move towards the negative terminal and electron move towards positive terminal,this movement of holes and electron constitute electric current which is known as drift current. • Even in absence of applied voltage flow of electric current in semiconductor is possible provided concentration gradient exist. • A concentration gradient exists when either number of electron or holes is greater in one region of a semiconductor as compared to other region. • When concentration gradient exist ,the carriers (either electron/holes) move from the region of higher concentration to lower concentration this process is called as diffusion and the electric current produced due to diffusion is known as diffusion current. • Diagram:  	**(3M)** **(1M)**
	c)	**Explain the principle of stimulated emission and radiation in LASER.**	**4M**
	Ans:	**Principle of stimulated emission:** • When a photon of energy hμ is incident on an atom (electron), then the electron gets excited and moves from lower energy level E1 to higher energy level E2. • After completion of life time, the excited electron comes to lower energy level	**(3M)**

emitting a photon this is known as spontaneous emission.

- But when before completing the life time of excited electron ,if the electron is triggered due to an action of incident photon.
- The interaction between excited electron and incident photon can trigger the excited electron to make a transition to ground state.
- This transition generates another photon which is identical to incident photon.



(1M)

This process of forced emission of photons due to incident photon is called as stimulated emission and radiation.

d) Differentiate between anti-ferromagnetism and ferrimagnetisms. **4M**

Ans: **(1M EACH)**

Sr.no	Anti-ferromagnetism	Ferrimagnetism
1	When the neighbouring magnetic moments are aligned anti-parallel this phenomenon is called anti-ferromagnetism	When the neighboring magnetic moments are aligned anti-parallel of unequal moments this phenomenon is called ferrimagnetism

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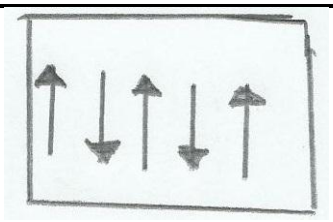
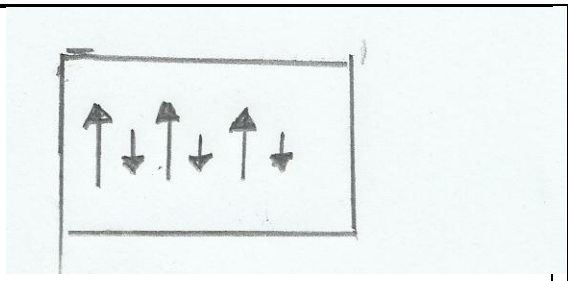
		2			
		3	The molecular moment will be zero	The molecular moment is in between that of anti-ferromagnetic and ferromagnetic material	
		4	Examples of anti-ferromagnetic material are manganin, ferric chloride,chromium,nickel oxide,cobalt oxide,ferrous oxide.	Examples of anti-ferromagnetic material are ferrite, magnetic garnets,magnetite	

Q. No.	Sub Q. N.	Answers	Marking Scheme
4		**Attempt any THREE of the following :**	**12- Total Marks**
	(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 characteristics of good insulating materials.**	**4M**

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	Ans:	characteristics of good insulating material are: i) Electrical **ii)** ii) Mechanical **iii)** iii) Thermal **iv)** iv) Chemical (i) Electrical characteristics: A good insulating material has high resistivity and low leakage current. It has high dielectric strength and small dielectric loss. **(ii)** Mechanical characteristics: A good insulating material should have sufficient mechanical strength to withstand vibrations. **(iii)** Thermal characteristics: A good insulating material should have small thermal expansion to avoid damages, It should be non-ignitable and self-extinguishable **(iv)** Chemical characteristics: 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	**1M each**
	(c)	**Explain the concept of magnetostriction effect and state its application.**	**4M**
	Ans:	**Concept of magnetstriction effect**: • When a ferromagnetic material is magnetized then the material exhibit small change in its dimensions, this phenomenon is called magnetostriction effect. • Magnetic permeability is dependent on the magnetostriction effect, the magnetostriction effect should be minimized in order to obtain high value of permeability <u>For example in case of iron</u>: Iron crystal expands when magnetized in easy direction and contracts when magnetized in hard direction. **Application :(Any one)**	**(2M)** **(1M)** **(1M)**

		Magnetostriction property is used in generation of following ultrasonic waves 1.ultrasonic signaling 2.ultrasonic cleaning 3.ultrasonic soldering 4.ultrasonic drilling	
	(d)	**Suggest any one suitable material and any one application for:** **(i) Thermionic emission** **(ii) Secondary emission**	**4M**
	Ans:	**Material for thermionic emission (ANY ONE)** Tungsten, throated Tungsten, metallic oxides of barium and tungsten. **Application: (ANY ONE)** It is used in Vacuum tubes, cathode Ray tube (CRT), Camera tube, Picture tube in TV **Material for Secondary emission (ANY ONE)** Magnesium oxide (MgO), Lead Oxide (PbO), Gallium phosphide (GaP) **Application: (ANY ONE)** Electron multiplier tubes, Special amplifying tubes, Computer memory Tube	**(1M)** **(1M)** **(1M)** **(1M)**
	(e)	**Write one application for the given dielectric materials:** **(i) Mica** **(ii) Bakelite** **(iii) Rubber** **(iv) Polythene**	**4M**
	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) Bakelite 1) It is used to manufacture lamp holders, terminal blocks, instrument cases, small ponds, switch covers etc. iii) Rubber: 1. It is used in flexible wires, jack cards and installation wires 2. It is used in manufacturing tubes, tyres etc. iv)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.	**(1M)** **(1M)** **(1M)** **(1M)**
Q. No.	Sub Q. N.	Answers	Marking Scheme
5.		**Attempt any TWO of the following:**	**12- Total Marks**
	a)	**Explain the effect of temperature on conductivity of metals.**	**6M**
	Ans:	• For metallic conductors, the resistance of all pure materials increases linearly with temperature over a limited range of temperature hence conductivity decreases. • For metallic conductors, the resistance of all pure materials decreases linearly with temperature over a limited range of temperature hence conductivity increases. • As the temperature increases, the ions inside the metal acquire energy and starts oscillating about their mean positions. These vibrating ions collide with the moving electrons. Hence resistance increases with increasing temperature.	**2 M each**
	b)	**On the basis of given properties, identify the magnetic materials** **(i) Permanent magnetic dipole** **(ii) Diamagnetism**	**6M**

		(iii) Paramagnetism **(iv) Ferromagnetism**	
	Ans:	**(i)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. **(ii)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 μ0, the permeability of 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, **(iii)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). **(iv)Ferromagnetism:**Ferromagnetism is the form of magnetization which independent of any external field.Even if the external magnetic field(H) is zero,the magnetization (M) may have a finite value**. E**ach ferromagnetic material has a characteristic temperature above which its properties are quite different from those below that temperature. This temperature is called the ferromagnetic curie temperature or the transition temperature(Tf). Ferromagnetic materials are iron.steel,nickel,cobalt,gold,cadmium ,silicon iron etc.	**2M** **2M** **2M**

	c)	**Write one property for the given dielectric material.** **(i) Ceramic** **(ii) Porcelain** **(iii) Poly Vinyl Chloride(PVC)** **(iv) Cotton** **(v) Silk** **(vi) Glass**	**6M**
	Ans:	i)Ceramic: • It has resistance to heat. • It has low thermal expansion. • It has good electrical properties. • It has a clay product. ii) porcelain: • It has good plasticity. • It has good moulding property. • It prevents cracking during firing. • It reduces the firing temperature. iii) Poly Vinyl Chloride(PVC): • It has high mechanical strength. • It has very high resistivity. • It has higher flexibility. • It is resistance to oils, liquids, gas, fumes chemical etc. iv) Cotton: • It is hygroscopic materials. • It has low electric strength. • It has low mechanical strength. v) Silk: • It has electric strength. • It is more flexible. • It takes up less space. • It is less hygroscopic. vi)Glass: • It is a thermoplastic inorganic material. • It is flexible & forms a thread, tape etc. • It has high refractive index. • It has very high density.	**1 M each**

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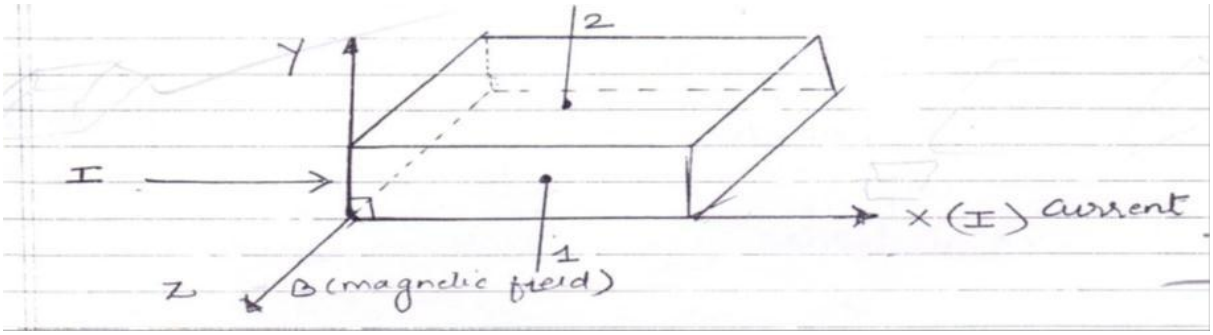
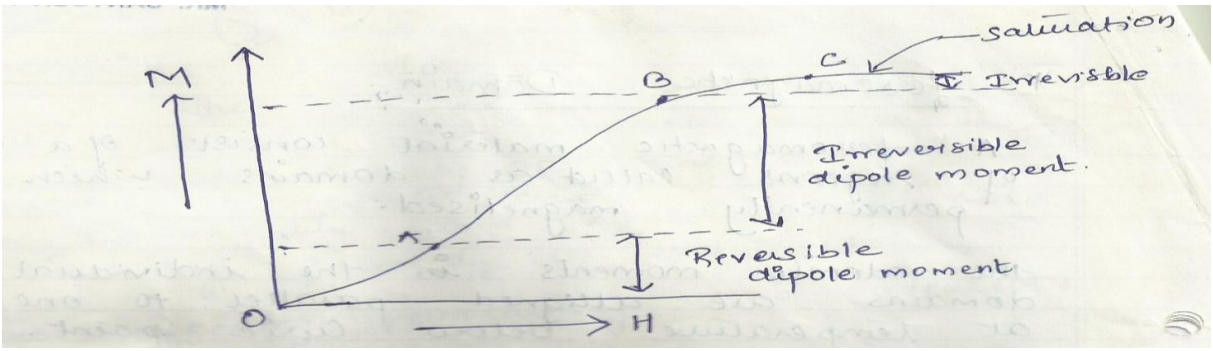
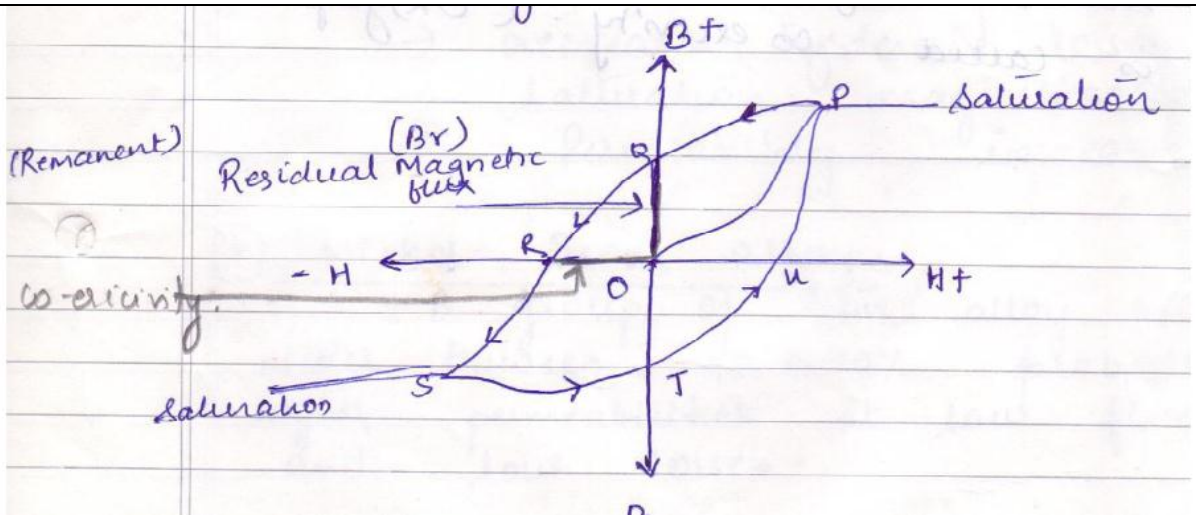
6.		**Attempt any TWO of the following :**	**12- Total Marks**
	a)	**Describe Hall effect and state its applications.**	**6M**
	Ans:	Hall Effect: If a piece of metal or semiconductor carrying current "I" is placed in a transverse magnetic field „B" then an electric field „E" is induced in the direction 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  APPLICATIONS OF HALL EFFECT: i)Used for power measurement. ii)Used to sense magnetic field. iii)Used to measure mobility of electrons.	**2M for explanation,2M for diagram, 2 M applications**

		iv)Used to measure concentration of electrons & holes. v)Used for fuel label indicator. vi)Use of determine whether semiconductor is N -type or P-type.	
	b)	**Describe the magnetization curve.**	**6M**
	Ans:	 Explanation: The above graph is a magnetization curve for a ferromagnetic material. It is magnetization (M) against field strength(H) Magnetization curve is divided into 3 regions. • Region O TO A –the value of H is small, the domain 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 irreversible. • 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**	**3M** **3M**



Explanation:
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 decrease 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≠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.

	c)	**State any four materials used in fabrication of semiconductor device and describe its need.**	**6M**
	Ans:	For fabrication of semiconductor devices like transistors diode, solar cell etc. we have to make use of following types of materials **1.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. **2.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. 3.**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. 4. **Junction coating:** -The junction protected by using resins as coating material are called junction coating. - The material generally used are high purity silicon resin and silicon modified polyester resin, because of the satisfactory performance and long life. 5. **Device potting:** -It is process of filling a complete electronic device with Gelatinous compound for resistance of shock and vibrations, exclusion of moisture and corrosive agent's -Silicon fluids dielectric gels and flexible potting resins are some of the potting materials 6. **Packaging**: - A suitable enclosure or packaging is needed for ensure safety of solid state devices. - Metal cans and sealed glass containers satisfy the extreme requirements of space and military users. **(Any relevant points should be given marks)**	**2 MARKS FOR MATERIALS &** **4 MARKS FOR NEED**

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