MODEL ANSWER
WINTER– 18 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 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.	Answer	Marking Scheme
Q.1		**Attempt any FIVE:**	**10- Total Marks**
	a)	**Define resistivity. State its unit.**	**2M**
	Ans:	Resistivity can be defined as the resistance of a conducting material per unit length with unit area of cross section. Its unit is ohm/meter	
	b)	**State any four dielectric materials.**	**2M**
	Ans:	Ceramics, distilled water, paper, mica, polyethylene, and glass. Metal oxides	
	c)	**State the classification of magnetic material.**	**2M**
	Ans:	Magnetic materials are classified into different categories based on their magnetic parameters. And also on the basis of effect of temperature and magnetic field on the magnetic properties So, all materials are classified broadly into the following three categories 1. Ferrimagnetic Materials 2. Antiferromagnetic Materials 3. Ferromagnetic Materials 4. Paramagnetic Materials 5. Diamagnetic Materials	

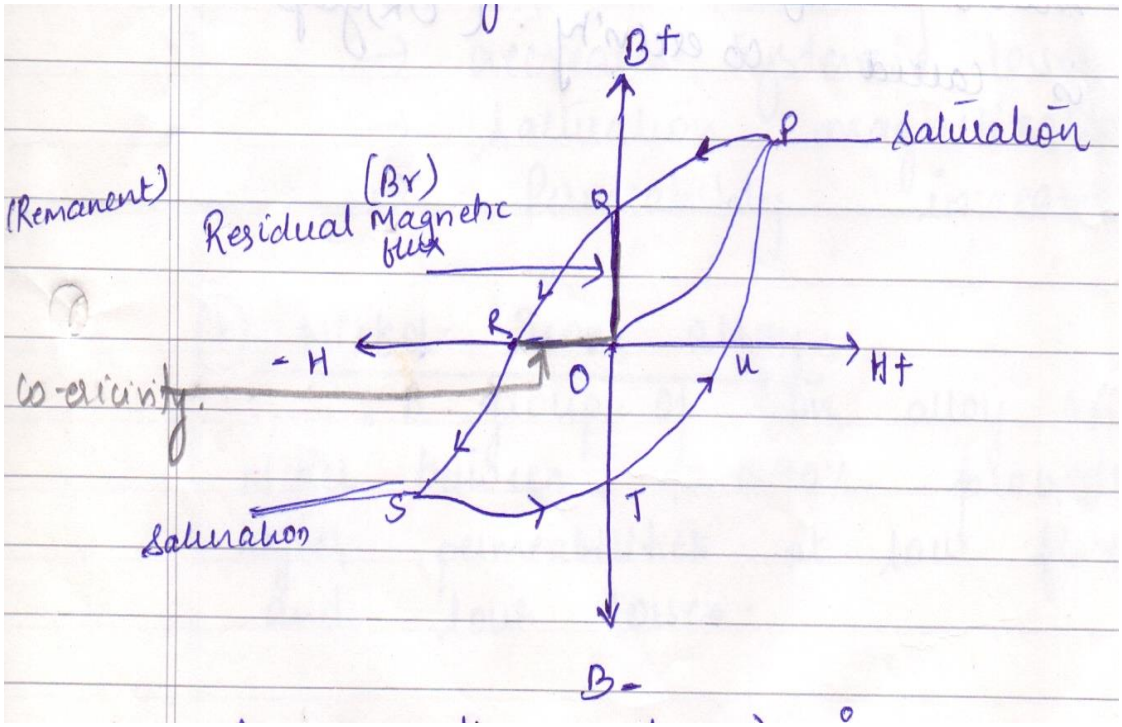
	d)	**Define intrinsic and extrinsic semiconductor**.	**2 M**
	Ans:	**Intrinsic Semiconductor** is a pure form of the semiconductor as there is no addition of impurity takes place. An example of intrinsic semiconductors is Silicon (Si) and Germanium (Ge). **Extrinsic Semiconductor** is obtained, when a small quantity of Tetravalent or Pentavalent impurity like Arsenic (As), Aluminum (Al), Phosphorus (P), Galium (Ga), Indium (In), Antimony (Sb) etc. is added in pure semiconductor, an .	**1M each**
	e)	**Define Thermionic emission**.	**2M**
	Ans:	The process by which free electrons are emitted from the surface of a metal when external heat energy is applied is called thermionic emission. Thermionic emission occurs in metals that are heated to a very high temperature. In other words, thermionic emission occurs, when large amount of external energy in the form of heat is supplied to the free electrons in the metals.	
	f)	**State the impurities for obtaining p-type and n-type semiconductor from intrinsic semi conductor. (2 each)**	**2M**
	Ans:	Crystals of Silicon and Germanium are doped using two types of dopants: 1. The impurities for obtaining n-type semiconductor from intrinsic semiconductor are pentavalent impurity; like Arsenic (As), Antimony (Sb), Phosphorous (P), etc. 2. The impurities for obtaining p-type semiconductor from intrinsic semiconductor are trivalent impurity; like Indium (In), Boron (B), Aluminum (Al), etc.	**1M each**
	g)	**Give the material composition for obtaining RED and yellow colour LED.**	**2M**
	Ans:	For RED colour materials are: (**Any one)** Aluminum gallium arsenide (AlGaAs) Gallium arsenide phosphide (GaAsP) Aluminum gallium indium phosphide (AlGaInP) Gallium phosphide (GaP) For yellow colour materials are: **(Any one)** Gallium arsenide phosphide (GaAsP) Aluminium gallium indium phosphide (AlGaInP) Gallium phosphide (GaP)	**1M each**
Q 2		**Attempt any THREE :**	**12- Total Marks**
	a)	**Describe super conductivity. State its applications**.	**4M**
	Ans:	• Superconductivity is a phenomenon of exactly zero electrical resistance. • Superconductivity is a quantum mechanical phenomenon. It is characterized by the Meissner effect	**Describe - 2M**

		• The electrical resistance of a metallic conductor decreases gradually as temperature is lowered. • In a superconductor, the resistance drops abruptly to zero when the material is cooled below its critical temperature. **Applications:-** Some of the technological applications of superconductivity includes: • The production of sensitive magnetometers based on SQUIDs (superconducting quantum interference devices) • Fast digital circuits • Powerful superconducting electromagnets used in maglev trains, magnetic resonance imaging (MRI) and Nuclear magnetic resonance(NMR) machines, magnetic confinement fusion reactors (e.g. tokamaks), and the beam-steering and focusing magnets used in particle accelerators • Low-loss power cables • RF and microwave filters (e.g., for mobile phone base stations, as well as military ultra-sensitive/selective receivers) • Fast fault current limiters • High sensitivity particle detectors, including the transition edge sensor, the superconducting bolometer, the superconducting tunnel junction detector, the kinetic inductance detector, and the superconducting nano wire single-photon detector • Railgun and Coilgun magnets • Electric motors and generators	**Any 2 applications** **1M each**
b)	**Describe the concept of piezo electricity and state its applications**.		**4M**
Ans:	**Concept of piezoelectricity:-** The phenomenon in which production of polarization, takes place when mechanical stress is applied. Piezo electricity 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:-** Piezoelectric transducers are common in ultrasonic applications, such as intrusion detectors and alarms. Piezoelectric devices are employed at AF (audio frequencies) as pickups, microphones, earphones, beepers, and buzzers. In wireless applications, piezoelectricity makes it possible to use crystals and ceramics		**Concept - 2M** **Any 2 applications** **2M**

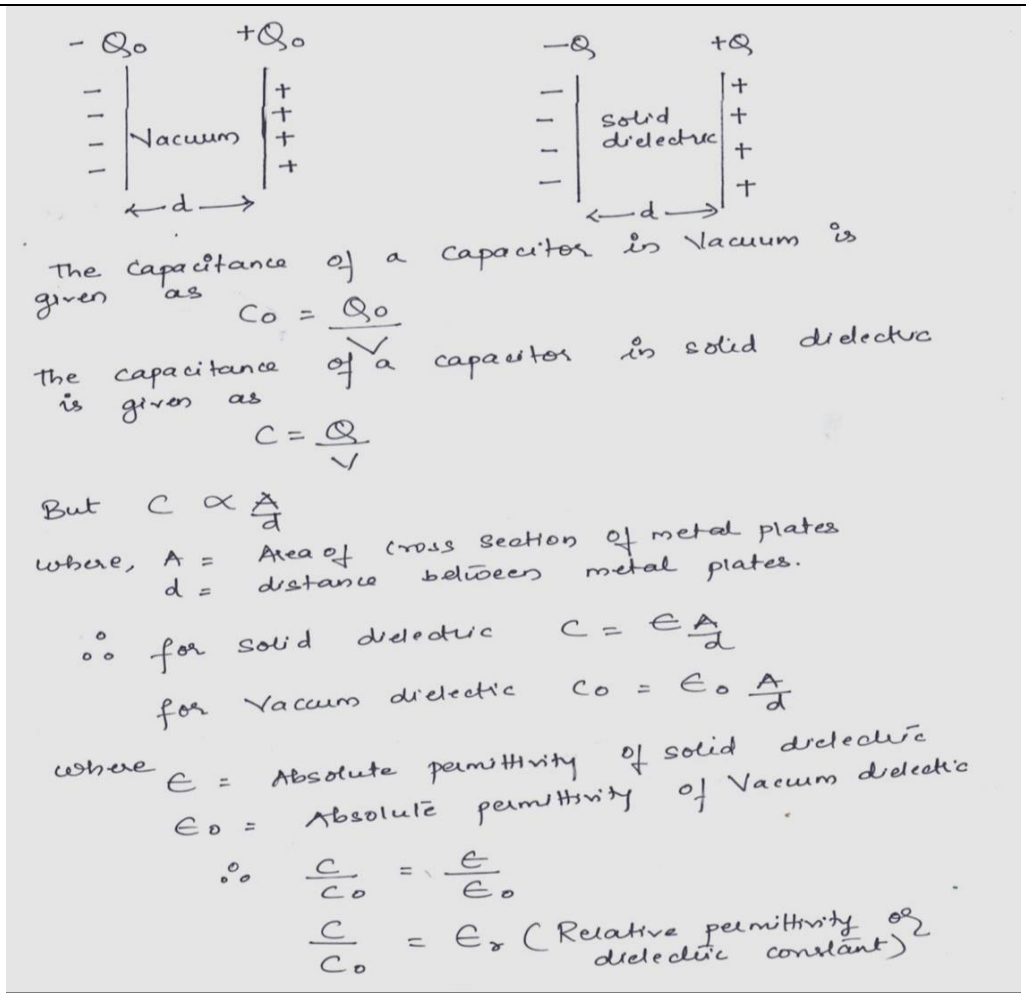
		as oscillators that generate predictable and stable signals at RF (radio frequencies)	
	c)	**State the requirements of good insulating material.**	**4M**
	Ans:	Requirement of good insulating material are i)Electrical ii)Mechanical iii)Thermal iv)Chemical **i)** Electrical requirement: A good insulating 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.	**1 Mark** **1 Mark** **1 Mark** **1 Mark**
	d)	**Describe the effects of temperature on conductivity of metals**.	**4M**
	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.	**2M each**
Q.3		**Attempt any THREE :**	**12- Total Marks**
	a)	**State the materials used for fabrication of photo diode along with its Justification.**	**4M**
	Ans:	<table><tr><th>Material</th><th>Electromagnetic spectrum wavelength range (nm)</th></tr><tr><td>Silicon</td><td>190–1100</td></tr></table>	**4M**

Germanium	400–1700	
Indium gallium arsenide	800–2600	
Lead(II) sulfide	<1000–3500	
Mercury cadmium telluride	400–14000	

b)	**Describe the process of photo emission. State the application of photo emission in electronic components**	**4M**
Ans:	Process of Photoemission:when light of appropriate frequency and intensity is incident upon a surface of certain materials,the energy of light is given to electrons to leave the surface of metal this phenomenon is known as photoemission.(2M) Application of photo emission in electronic components:photoemission are used in photo cathode which are widely used in automation and for remote control of industrial process. Photoemissive cells or photo tubes are used in door openers,counters, position and temperature control and colour analysis (1M)	**(1M)**
c)	**Describe the principle of thermoelectric. State thermoelectric materials.**	**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 Thermoelctric 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.	

d)	**Draw and explain hysteresis loop in magnetic material.**	**4M**
Ans:		**2Marks**
	The phenomenon of magnetisation and demagnitisation of ferromagnetic material is known as hysterisis. It is observed that as the electric field increases magnetic filed(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 hystersis. As magnetic field (H) increases, the magnetic flux density (B) too increaes, but B stop increasing and reaches saturation. The curve OP is saturation curve when it decreases the curve doesnot 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 fleld (N) reaches zero H=0, that means B should be zero but B≠0, that means material does not get demagnatised there is some residual magnetism i.e. OQ (graph is Remanent flux density Br. When H is increased in reverse direction B also increases in reverse direction and again get saturated.	**2Marks**

		The magnetic flux density (B) becomes zero when reverse magnetic force is applied that is called coercitivity (OR) graph.	
Q.4	**A)**	**Attempt any THREE :**	**12- Total Marks**
	a)	**Write one application for the give dielectric material.** (i) Polyvinyl Carbide (PVC) (ii) Glass (iii) Mica (iv) Cotton and Silk	**4M**
	Ans:	(i) Polyvinyl Carbide (PVC):it is used in insulation of wires and cables in domestic wiring as well as in aircraft and factory wiring (any one) (ii) Glass: 1) Alkaline glasses are used for optical and electrical applications. 2) Pyrex glasses are used for oven proof utensils. (any one) iii) Mica It is used in circuits, capacitors, parts of sockets, plugs, bushing in transformer etc. (any one) iv) cotton and silk :cotton and silk impregnated with wax or varnishes are used in windings of magnet coils and small medium sized mechanics (any one) ***NOTE: ANY RELEVANT APPLICATIONS SHOULD BE GIVEN MARKS***	**(1M)**
	b)	**Explain the materials used in wearable antennas with their properties**	**4M**
	Ans:	1. The Substrate: The fabric textile material to be used should have more dielectric permittivity. o Low dielectric constant o Nominal thickness value. o Low moisture content of fabric. Eg. 100% pure cotton / polyamide space fabric. 2. Conducting material having low and stable electrical resistance, flexible in nature eg.: Copper, Nickel	**2M** **2M**
	c)	**Describe dielectric strength and dielectric constant with respect to dielectric materials**	**4M**
	Ans:	Dielectric strength is the ability of a dielectric material of specified thickness to withstand high voltages without breaking down	**1 mark**



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 $C = \epsilon \frac{A}{d}$

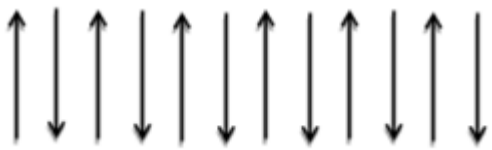
for Vacuum dielectric $C_0 = \epsilon_0 \frac{A}{d}$

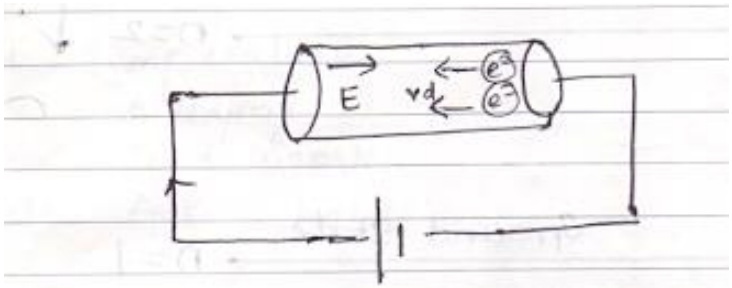
where ϵ = Absolute permittivity of solid dielectric
ϵ_0 = Absolute permittivity of Vacuum dielectric

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

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

3mark

	d)	**Explain the concept of anti-Ferro magnetism and state its significance.**	**4M**
	Ans:	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)	**2M**
		Eg.: Cobalt oxide, Nickel oxide, Chromium.	
			**1 M**
		Arrangement of dipole moment	**1M**

	e)	**Define Electron mobility. State its significance in electronic components.**	
	Ans:	It is defined as drift velocity acquired per unit strength of the electric field applied across the conductor.  $V_d = \frac{e\ E\ c}{m_e}$ Where, Vd = drift velocity e = charge of electron E = Electric field strength m_e = mass of electron c = Average relaxation time. $\frac{Vd}{E} = \frac{e\ c}{m_e}$ V_d/E is refered as election mobility. Unit of election mobility is $m^2 v^{-1} s^{-1}$	**1M** **1M** **2M**
Q.5		**Attempt any TWO :**	**12- Total Marks**
	a)	**State the different modes of electron emission in metal. Explain any two modes of emission**.	**6M**
	Ans:	**Different modes of electron emission in metal –** 1. Thermionic emission 2. Photo electric emission. 3. Field emission. 4. Secondary emission.	**2 Marks**

Mode of Emission ANY 2 (2M EACH)

Mode of Emission ANY 2 (2M EACH)

1. **Thermionic emission.**
   Concept: The electron emission from a metal surface, which occurs by supplying the thermal energy to the metal is called as thermionic emission.

   At room temperature, the free electrons of a metal do not possess sufficient energy to cause electron emission.

   As the temperature of a metal is increased, the electrons acquired energy more than the work function (Ø) due to which electrons gets accelerated and is emitted from surface of metal.

   Material : Tungsten, thorlated Tungsten, metallic oxides of barium and tungsten.
   Application: It is used in Vacuum tubes, cathode Ray tube (CRT), Camera tube, Picture tube in TV.

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.
   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

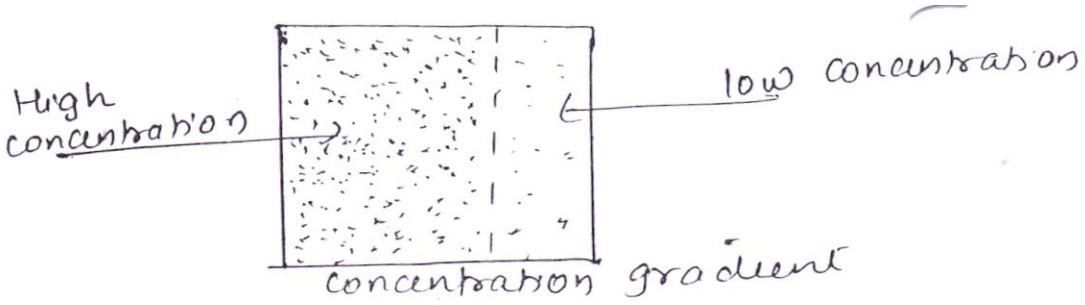
   Applications: It is used in Photo multiplier tubes, photo tube, Photo voltaic cell, Solar cells.

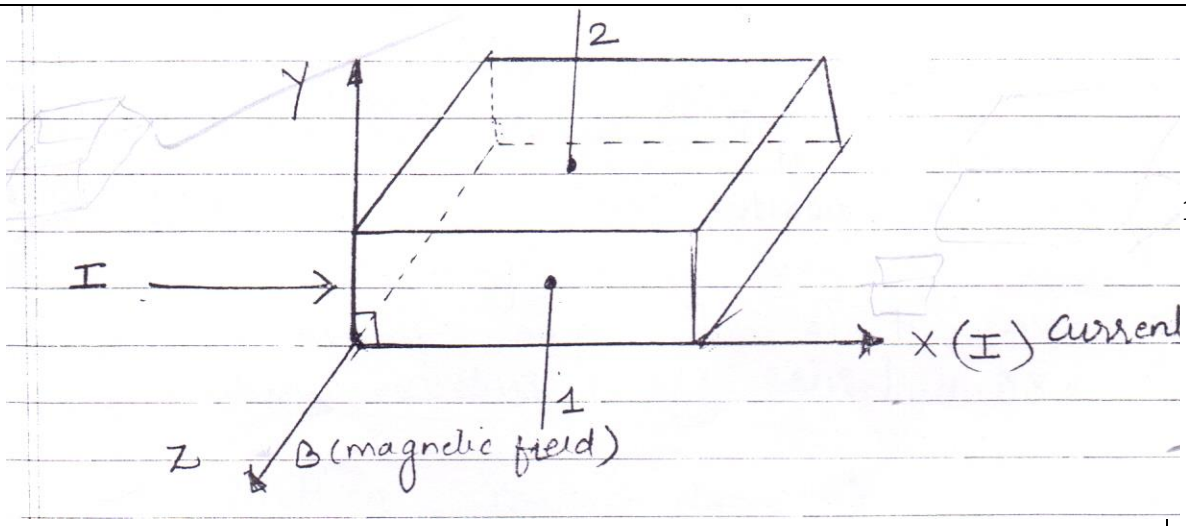
3. **Field emission.**
   Concept: The electron emission from the surface of a metal which occurs due to application of strong electric field is high field emission.
   A strong electric field is applied at the surface of a metal, which pulls the electron out of the metal surface. The stronger the electric field, higher the electron emission.

   Material: Silicon, amorphous or diamond like carbon, Carbon nanowalls or wide band gap semiconductor.

   Applications: Electronic information display, Microwave generation, X-ray generation, Space vehicle neutralization.

		4. **Secondary emission**. Concept: 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 posphide (GaP) Application: Electron multiplier tubes, Special amplifying tubes, Computer memory tubes.	
	b)	**Define magnetic permeability. State and explain the factors affecting permeability of magnetic materials**	**6M**
	Ans:	**Permeability** : The capability of the magnetic material to conduct the magnetic flux is known as permeability. Permeability and hysteresis loss are inversely related to each other. **Factors affecting permeability and hysteresis loss are** o 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. o 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** **2 M** **2 M**
	c)	**Describe the concept of Ferro electricity. Explain the application of Ferro electric material**	**4M**
	Ans:	The ferroelectric material has an electric dipole moment and it is spontaneously polarized. They have high dielectric constant which is nonlinear because it is dependent on the intensity of electric field. They also exhibit hysteresis loop. When the temperature increases above curie point, the ferroelectric material loses their ferroelectric properties.	**3M**

		Materials: Rochelle salt, Barium Titanate. Application: It is used in condensers to concentrate considerable quantities of electric energy within a small space.	**1M**
Q.6		**Attempt any TWO :**	**12- Total Marks**
	a)	**(i) Explain the process of diffusion in semiconductor material.** **(ii) Explain Hall effect.**	**6M**
	Ans:	(i) Diffusion: In a semi conductor bar a concentration gradient exist when either number of electrons or holes is greater in one region of a semi conductor 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.  **(ii)** 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	**2 Marks** **1 Mark** **2 Marks**

			**1 Mark**
	b)	**Explain magnetostriction property. Explain generation of ultrasonic using magnetostriction**	**6M**
	Ans:	When a ferromagnetic material is magnetized then the material exhibit small change in its dimensions, this phenomenon is called magnetostriction effect. Iron crystal expands when magnetized in easy direction and contracts when magnetized in hard direction. Magnetic permeability is dependent on the magnetostriction effect the magnetostriction effect should be minimized in order to obtain high value of permeability. Magnetostriction property is used in generation of following ultrasonic waves 1.ultrasonic signaling 2.ultrasonic cleaning 3.ultrasonic soldering 4.ultrasonic drilling.	**4 M** **2M**
	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: o It is used for deposition of thin film layers, Substrate can be plastic, glass or ceramic. o 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	**(1Mark each)**

		resistors and capacitors. 2. Metals: o The fabrication of the passive part of integrated silicon and thin film circuits involves use of different metals. o The metals usually act as capacitor plate, as heat dissipater as a mechanical support. 3. Capacitance Material: o They should have high dielectric constant, pin-hole free continuous layer, ability to withstand thermal stress, o Commonly used capacitance material are SiO, ZnS, SiO2. 4. Junction coating: o The junction protected by using resins as coating material are called junction coating. o 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: o It is process of filling a complete electronic device with Gelatinous compound for resistance of shock and vibrations, exclusion of moisture and corrosive agents o Silicon fluids dielectric gels and flexible potting resins are some of the potting materials 6. Packaging: o A suitable enclosure or packaging is needed for ensure safety of solid state devices. o Metal cans and sealed glass containers satisfy the extreme requirements of space and military users. **(Any relevant points should be given marks)**	