TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE 502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg
$h = 6.626 \times 10^{-34}$ Js
Permittivity of Silicon, $\varepsilon = \varepsilon_r \varepsilon_o = 11.9 \times 8.85 \times 10^{-12}$ F/m
$n_i = 1.45 \times 10^{10}$ cm^{-3} for silicon
$\mu_h = 450$ cm^2/V.s (at 300 K)

$1 \text{ eV} = 1.6 \times 10^{-19}$ J
$k = 1.38 \times 10^{-23}$ J/K
$\mu_e = 1350$ cm^2/V.s (at 300 K)
$N_A = 6.022 \times 10^{23}$ / mol

1. a) Prove that the energy of a particle confined in an infinite potential well is quantized. Find also the expression for normalized wave function and draw graph for Ψ and $|\psi|^2$. [8]

   b) Evaluate the probability that an energy state 3KT above the Fermi level will be occupied by an electron. [4]

2. a) What do you understand by infinite effective mass? Derive the expression for effective mass of electron and show that it can be positive as well as negative, explain with the help of E-k diagram. [8]

   b) Calculate the Fermi energy at 0 K for copper. Given its density as 8.96 g/cc and atomic mass as 63.5 g/mol. [4]

3. a) Define electric dipole moment and local electric field. Derive the Clausius-Mossotti equation for electronic polarization, relating polarizability with permittivity. [8]

   b) What is loss tangent? Show that power loss in a dielectric material per unit volume is the function of frequency of the applied field and loss tangent. [6]

4. a) How does a superconductor expel magnetic field? Differentiate between type I and type II superconductors. [8]

   b) Explain demagnetization of magnetic materials with the help of magnetic domain formation. What is deperming method of demagnetization? [8]

   c) Classify different type magnetic materials and explain any two of them. [6]

5. a) Differentiate between non-degenerate and degenerate semiconductor. [4]

   b) An n-type silicon wafer is uniformly doped with 10^{17} antimoney per cm^3. Where will the Fermi level compared to its intrinsic Fermi level? Where will the Fermi level be shifted if the sample is further doped with 2×10^{16} atoms per cm^3? [8]

   c) A heavily doped N-side with donor concentration of 10^{17} cm^{-3} and P-side with acceptor concentration of 10^{16} cm^{-3} are connected. Find [8]

   (i) Built in potential (V_o)

   (ii) Depletion width (W_o, Wn and W_p)

   (iii) Electric field at metallurgical junction (E_o)

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE 502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ *Values of commonly used constants are given below:*

Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg | **$1\ eV = 1.6 \times 10^{-19}$ J**

$h = 6.626 \times 10^{-34}$ Js | **$k = 1.38 \times 10^{-23}$ J/K**

Permittivity of Silicon, $\varepsilon = \varepsilon_r\ \varepsilon_o = 11.9 \times 8.85 \times 10^{-12}$ F/m | **$\mu_e = 1350\ cm^2/V.s$ (at 300 K)**

$n_i = 1.45 \times 10^{10}\ cm^{-3}$ for silicon | **$N_A = 6.022 \times 10^{23}$ / mol**

$\mu_h = 450\ cm^2/V.s$ (at 300 K)

1. a) Starting from the suitable equation, prove that energy of an electron in infinite potential well of width L is quantized and also derive the wave function for that electron. [8]

   b) A transmitter type vacuum tube operated at 1500°C has a cylindrical Thorium coated Tungsten cathode which is 5 cm long with diameter of 1.5 mm. Determine the saturation current of vacuum tube if the cathode has emission coefficient constant of $3 \times 10^4\ Am^{-2}K^{-2}$ and work function of 2.6 eV. [4]

   c) If electric conductivity of potassium is 1.39×10^5 Sm/cm, calculate the drift mobility of electron at room temperature. Molar mass and density of potassium are 39.5 and 0.91 gm/cc. [4]

2. a) Explain how energy bands are formed in solids taking the example of N number of Lithium atoms for the explanation. [6]

   b) Define local field inside a solids and hence derive the Clausis-Massoti Equation for the solids. [6]

   c) Graphically explain frequency dependency of polarizability. [5]

3. a) What is a magnetic domain? Explain the behavior of magnetic domains in presence of external field. [8]

   b) How strong magnetic fields effect the superconductor? Derive the relation of critical current in superconductor with necessary diagram. [8]

4. a) Given that the density of states related effective masses of electrons and holes in Si are approximately $1.08m_e$ and $0.60m_e$ respectively and the electron and hole drift mobilities at room temperature are 1350 and 450 $cm^2V^{-1}S^{-1}$ respectively. Calculate the intrinsic concentration and intrinsic resistivity of Si. The energy band gap for Si is 1.10eV. (T = 300K) [6]

   b) Explain the diffusion process in semiconductor and derive the Einstein relation for diffusion process. [8]

5. a) Calculate the resistance of pure silicone cubic crystal of 8 cm^3 at room temperature. What will be the resistance of the cube when it is doped with 1 arsenic in 5×10^9 Si atom? Take atomic concentration of Si is $5 \times 10^{22}\ cm^{-3}$. [6]

   b) Explain how does temperature affects the formation of carrier concentration in semiconductor. [6]

   c) What is fermi energy? Explain its importance in semiconductor. [5]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Kartik

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE 502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ *Values of commonly used constants are given below:*

Mass of electron, $m_e = 9.1\times10^{-31}$ kg
$h = 6.626\times10^{-34}$ Js
Permittivity of Silicon, $\varepsilon = \varepsilon_r\,\varepsilon_o = 11.9\times8.85\times10^{-12}$ F/m
$n_i = 1.45\times10^{10}$ cm^{-3} for silicon
$\mu_h = 450$ cm^2/V.s (at 300 K)
1 eV $= 1.6\times10^{-19}$ J
$k = 1.38\times10^{-23}$ J/K
$\mu_e = 1350$ cm^2/V.s (at 300 K)
$N_A = 6.022\times10^{23}$ / mol

1. a) Differentiate between classical and quantum mechanics with examples. [4]
   b) Define Degenerate state and Fermi energy. Derive an expression showing the relationship between density of states and energy. [8]
   c) A vacuum tube with a cylindrical Thorium coated Tungsten cathode is 5 cm long and 3 mm in diameter. Estimate the saturation current if the tube is operated at 1400°C. Given, the Emission constant is 3 Acm^{-2}K^{-2} and work function for Thorium coated Tungsten is 2.6 eV. [4]
2. a) What is linear combination of atomic orbitals (LCAO)? With the help of LCAO, justify that the "Formation of H_2 molecule is energetically stable". [8]
   b) What is effective mass? Show that the effective mass is same as mass of electron in vacuum. [4]
   c) Differentiate between a normal conductor and a superconductor. [4]
3. a) What are the different limiting factors for a superconductor to remain in its superconducting state? Write some applications where superconductors are used. [4]
   b) What are the different types of polarization mechanisms? Explain briefly about each of them. [8]
   c) How does thermal and electromechanical breakdown process lead to dielectric breakdown in solid dielectrics? [4]
4. a) Define magnetic dipole moment and atomic magnetic moment. Differentiate between ferromagnetic material and ferrimegnetic material. [2+4]
   b) Justify that, "magnetization of a magnetic material occurs due to the growth of magnetic domains along the direction of applied field". [4]
   c) In an n-type semiconductor, the Fermi level lies 0.5eV below the conduction band at 300 K, if the temperature is increased to 310 K, find the new position of Fermi level. [6]
5. a) In doped semiconductors, show that the carrier concentration and drift mobility both are highly dependent on temperature with necessary diagrams. [6]
   b) Find the resistance of a cubic pure silicon crystal. Find the resistance when the Si-crystal is doped with one Arsenic atom in 10^9 Silicon atoms. If the sample is further doped with 10^{14} Boron atoms what will be the new resistance? [6]
   c) Differentiate between direct and indirect band gap semiconductors with examples. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE 502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ *Values of commonly used constants are given below:*

Mass of electron, $m_e = 9.1\times10^{-31}$ kg
$h = 6.626\times10^{-34}$ Js
Permittivity of Silicon, $\varepsilon = \varepsilon_r\,\varepsilon_o = 11.9\times8.85\times10^{-12}$ F/m
$n_i = 1.45\times10^{10}$ cm^{-3} for silicon
$\mu_h = 450$ cm^2/V.s (at 300 K)
1 eV $= 1.6\times10^{-19}$ J
$k = 1.38\times10^{-23}$ J/K
$\mu_e = 1350$ cm^2/V.s (at 300 K)
$N_A = 6.022\times10^{23}$ / mol

1. a) What is Thermionic emission and work function? Derive the Richardson's expression for the thermionic emission for Schottky effect. [8]
   b) Calculate the Fermi energy level in copper at 0K, if its density is 8.96 gm.cm^{-3} and atomic weight is 63.5 gm.mol^{-1}. What will be its new Fermi energy at 15°C? [4]
   c) "The effective mass of electron in Gold is 1.1 times the mass of electron". Justify. [4]
2. a) Define lattice and basis of a crystal structure. Draw the face entered cubic (FCC) unit cell and find the body diagonal and parking density. [2+6]
   b) What is Meissner effect? Explain the difference between type I and type II superconductors. [2+6]
3. a) What are different types of polarization in dielectric medium? How do electronic polarization differ from orientational polarization? [4+4]
   b) How can you demagnetize a magnetic material? Explain with the help of its B-H curve. What type of magnetic material would you chose for electronic storage of digital data? Justify. [4+4]
4. a) Derive the relation for built in potential and depletion layer of a p-n junction. [4+4]
   b) Given that the density of states related effective masses of electrons and holes in Si are approximately $1.08m_e$ and $0.60m_e$ respectively, and the electron and hole drift mobilities at room temperature are 1350 and 450 cm^{2}V^{-1}S^{-1} respectively. Calculate the intrinsic concentration and intrinsic resistivity of Si. The energy band gap for Silicon is 1.10eV, T = 300K [8]
5. a) In a pure germanium of 50g, 5μg of Arsenic is thoroughly mixed in molten form. The density of germanium is 5.46 gcm^{-3} and atomic weight of Arsenic is 74.92 gmol^{-1}. Find the total resistance of a wire of such n-type material having length of 1cm and cross-sectional area of 2.25×10^{-4}cm^2. Take mobility of electrons in germanium = 3600 cm^{2}V^{-1}s^{-1}. [8]
   b) What are degenerate and non-degenerate semiconductors? Explain. [4]
   c) What is minority charge suppression in extrinsic semiconductor? [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE 502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ *Values of commonly used constants are given below:*

Mass of electron, $m_e = 9.1\times10^{-31}$ kg
$h = 6.626\times10^{-34}$ Js
Permittivity of Silicon, $\varepsilon = \varepsilon_r\,\varepsilon_o = 11.9\times8.85\times10^{-12}$ F/m
$n_i = 1.45\times10^{10}$ cm^{-3} for silicon
$\mu_h = 450$ cm^2/V.s (at 300 K)
1 eV $= 1.6\times10^{-19}$ J
$k = 1.38\times10^{-23}$ J/K
$\mu_e = 1350$ cm^2/V.s (at 300 K)
$N_A = 6.022\times10^{23}$ / mol

1. a) Explain the significance of operators in quantum mechanics. How do you calculate the expected energy value of a particle represented by $\psi(x,t)$ confined at a boundary of 0 to L? [4+4]
   b) Explain the thermionic emission in metal. Using image charge method, derive an expression of emission current density for Schottky effect. [2+6]
2. a) Calculate the lattice constant, face diagonal, body diagonal and packing density of body centered cubic (BCC) crystal unit cell. [4]
   b) Drift mobility of conduction electron is 43 cm^{2}V^{-1}s^{-1} and mean speed is 1.2×10^6ms^{-1}. Calculate the mean free path of electrons between collisions. [4]
   c) How does a superconductor expel all the magnetic lines of force at T<Tc? [4]
   d) How does Meissner effect help to differentiate superconductor as type-I and type-II? Explain in brief. [4]
3. a) Explain how? [4×2]
      (i) If the spacing between parallel plates of a capacitor is less, the dielectric breakdown will occur soon.
      (ii) Average dipole moment in dipolar polarization depends on temperature.
   b) Distinguish between ferromagnetic and anti-ferromagnetic materials. Give an example for each class of material. [4+1]
   c) Explain about the applications of soft magnetic materials. [3]
4. a) The density of states related effective masses of electrons and holes in silicon are approximately $1.08m_e$ and $0.6m_e$ respectively. The electron and hole drift mobilities at room temperature are 1350 and 450 cm^{2}V^{-1}s^{-1} respectively. Calculate intrinsic concentration and intrinsic resistivity of silicon at T = 300K. The energy band gap for silicon is 1.1eV. [8]
   b) Explain how does the band bends in semiconductor. [4]
   c) Describe the Direct and indirect recombination process between an electron and hole in semiconductor with necessary diagrams. [4]
5. a) What is PN junction? Derive the relation for built in potential and depletion layer of a PN junction. [8]
   b) Find the resistance of p-n junction Germanium diode if temperature is 27°C and $I_o = 1\mu A$ for an applied forward bias of 0.2 Volt. [4]
   c) Explain the importance of Fermi energy level in semiconductor. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE 502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

Mass of electron, $m_e = 9.1*10^{-31}$ kg;
$h = 6.624*10^{-34}$ JS;
$\varepsilon_o\varepsilon_r = 11.9*8.85*10^{-12}$ F/m for Si
$\mu_e = 1350$ cm^2/v.s. at 300 K
$e=1.6*10^{-19}$ c
$1ev=1.6*10^{-19}$ J;
$K=1.38*10^{-23}$ J/K;
$n_i=1.45*10^{10}$ /cm^3 for Si)
$\mu_h = 450$ cm^2/v.s. at 300 K
$N_A = 6.022*10^{23}$ /mol

1. a) What is tunneling in quantum mechanics? Explain with necessary mathematical expression, the nature of wave function in different regions in case of tunneling. [8]
   b) Calculate the Fermi energy level at absolute zero for the copper having electron concentration of 8.43×10^{28}m^{-3}. [4]
   c) X-rays of wavelength 0.9 A° fall on a metal plate having work function of 2 eV. Find the wavelength associated with emitted photoelectrons. [4]
2. a) Drift mobility of conduction electron is 43 cm^2/V.s and mean speed is 1.2×10^6 m/s. Calculate mean free path of electrons between collisions. [4]
   b) What is Meisner effect? Explain the difference between type I and type II super conductors. [2+6]
   c) For silver with E_{F0}=5.5ev and ∅=4.5 ev, calculate the toal number of status per unit volume and compare this with atomic concentration of silver. Density and atomic mass of silver are 10.5 g/cm^3 and 107.9 g/mol respectively. [4]
3. a) Define magnetic domain and domain walls in magnetic materials. Explain in brief about losses that would occur in magnetic materials. [2+4+2]
   b) Define local field in relation to polarization. Derive the Clausius-Massoti Equation for ionic polarization, relating polarizability with the permittivity. [8]
4. a) An n-type silicon wafer is uniformly doped with 10^{16} antimony atoms per cm^3. Where will be the Fermi level compared to its intrinsic Fermi level? [6]
   b) Explain the diffusion process in semiconductor and derive the Einstein relation for diffusion process. [10]
5. a) Define p-type semiconductor. Derive an expression for minority carrier suppression and hence prove that the conductivity in p-type semiconductor is mainly due to the hole. [8]
   b) If it is desired to raise Fermi level to 0.7 eV above the intrinsic Fermi level at room temperature, what type of dopant is to be used? Also determine its doping level if the used intrinsic semiconductor is silicon. [4]
   c) An n-type semiconductor doped with 10^{16} cm^{-3} phosphorus atoms has been doped with 10^{17}cm^{-3} boron atoms. Calculate the electron and hole concentrations in the semiconductor. [4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Chaitra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE 502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ *Values of commonly used constants are given below:*

Mass of electron, $m_e = 9.1*10^{-31}$ kg; *1ev=$1.6*10^{-19}$ J;*
$h = 6.624*10^{-34}$ JS; *$K=1.38*10^{-23}$ J/K;*
$\varepsilon_o\varepsilon_r = 11.9*8.85*10^{-12}$ F/m for Si *$n_i=1.45*10^{10}$ /cm^3 for Si)*
$\mu_e = 1350$ cm^2/v.s. at 300 K *$\mu_h = 450$ cm^2/v.s. at 300 K*
$e=1.6*10^{-19}$ c *$N_A = 6.022*10^{23}$ /mol*

1. a) Starting from the suitable equation, prove that the energy of an electron that is confined in an infinite potential well of width L is quantized. [8]

   b) An electron is confined to an infinite potential well of size 0.1nm. Calculate the ground energy of the electron and radian frequency. How can this electron be put to the third energy level? [4]

2. a) Derive Einstein's relation between mobility and diffusion co-efficient. Also define the terms electron mobility, conductivity and resistivity. [5+3]

   b) Explain the concept of effective mass in crystal with necessary mathematical expression. [6]

3. a) Define polarization. Derive the Clausius-Massoti equation showing the relation between relative permittivity and electronic polarizability. [8]

   b) Describe how thermal breakdown and electromechanical breakdown results in dielectric breakdown in solids. [4]

   c) Classify the magnetic material based on magnetization and explain each of them briefly. [8]

4. a) Explain how strong magnetic field effects superconductor. [4]

   b) Describe the phenomenon of generation of electrons and holes, and conduction in semiconductor. Also derive equation for conductivity. [6]

   c) How band bending occurs in semiconductors? Derive Einstein relationship. [10]

5. a) A pn junction semiconductor has resistivity of 5Ω cm. If mobility of holes is 450 cm^2/Vs, and electron mobility is three times the mobility of holes at room temperature, find

      i) Built in potential
      ii) Depletion width that lies in n-region and p-region respectively
      iii) Built in electric field at x=0. [6]

   b) Calculate the resistance of pure silicon cubic crystal of 1cm^3 at room temperature. What will be the resistance of the cubic when it is doped with 1 arsenic in 10^9 silicon atoms and 1 boron atom per billion silicon atoms? Atomic concentration of silicon is $5*10^{22}$cm^{-3}, $n_i=1.45*10^{10}$cm^{-3}. [8]

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13 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Ashwin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ *Values of commonly used constants are given below:*

Mass of electron, $m_e = 9.1\times10^{-31}$ kg
$h = 6.626\times10^{-34}$ Js
Permittivity of Silicon, $\varepsilon = \varepsilon_r\,\varepsilon_0 = 11.9\times8.85\times10^{-12}$ F/m
$n_i = 1.45\times10^{10}$ cm^{-3} for silicon
$\mu_h = 450$ cm^2/V.s (at 300 K)
1 eV $= 1.6\times10^{-19}$ J
$k = 1.38\times10^{-23}$ J/K
$\mu_e = 1350$ cm^2/V.s (at 300 K)
$N_A = 6.022\times10^{23}$ / mol

1. a) Derive the time independent Schrodinger's equation, starting with classical wave equation, $y = A\sin 2\pi\left(ft - \frac{x}{\lambda}\right)$, where notations have their usual meanings. [8]

   b) Find the probability that an energy state 5KT above the Fermi level will not occupied by an electron. [4]

2. a) Draw a neat diagram of face centered cubic (FCC) unit cell crystal structure for copper and find

   (i) Number of atoms per unit cell
   (ii) Packing density
   (iii)Atomic concentration if radius of copper atom is 0.128 nm
   (iv)Density of crystal given that atomic mass of Cu is 63.55 g mol^{-1} [8]

   b) What is an effective mass of a free electron? Show that effective mass of a free electron is equal to mass of free electron in vacuum. [1+3]

3. a) What is local field in polarization? Derive the Clasuius- Massotti equation for electronic polarization. [8]

   b) Differentiate between Ferro and Piezo electricity. [4]

4. a) Explain the significance of hysteresis loop while selecting materials for preparing magnetic materials. [4]

   b) Explain the domain theory of magnetism in detail. [6]

   c) Define superconductor, critical magnetic field, and critical current density. [4]

5. a) Explain how donor dopants contribute electrons in conduction band in n-type extrinsic semiconductor. Also prove that $\sigma = ne\mu_e$ where symbols have their usual meanings. [8]

   b) A silicon wafer is uniformly doped with 10^{16} Boron atoms per cm^3. Where will be the Fermi level compared to its intrinsic Fermi level? Where will be the Fermi level is shifted if the sample is further doped with 10^{17} antimony atom per cm^3? [6]

6. a) Explain the diffusion process in semiconductor and derive the Einstein relation for diffusion process. [8]

   b) Derive an expression of a built-in potential and depletion width of a pn junction with [8]

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INSTITUTE OF ENGINEERING
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2074 Chaitra

Exam.	Regular		
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Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
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- ✓ *Values of commonly used constants are given below:*

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$\mu_h = 450$ cm^2/V.s (at 300 K)

1 eV $= 1.6\times10^{-19}$ J
$k = 1.38\times10^{-23}$ J/K
$\mu_e = 1350$ cm^2/V.s (at 300 K)
$N_A = 6.022\times10^{23}$ / mol

1. a) Calculate the temperature at which there is 98% probability that a state 0.3 ev below the fermi energy level will be occupied by an electron. [4]
   b) Prove that the energy of a particle confined in an infinite potential well is quantized. Also find the expression for normalized wave function. [8]
2. a) Draw face centered cubic (FCC) unit cell and find body diagonal and packing density. [6]
   b) The conductivity and drift mobility of copper conductor is $63.5*10^6$ s/m and 43 cm^2/v/s. Calculate Fermi level for copper conductor. [4]
3. a) Show that the dielectric loss per unit volume is a function of frequency of the applied field and the loss tangent. [6]
   b) What do you mean by piezo-electric materials? Explain piezoelectric effect in terms of polarization. [4]
4. a) On the basis of magnetic vector, explain the ferromagnetism, ferrimagnetism and antiferromagnetism. [4+2]
   b) What is Meissner effect? Explain the difference between type I and type II superconductors. Type II superconductor is also called hard superconductor, why? [2+4+2]
5. a) Differentiate between non-degenerate and degenerate semiconductors. [6]
   b) What is Built-in potential and depletion width? Derive the expression of these with necessary diagram. [6]
   c) Calculate the resistance of pure silicon cubic crystal of 1 cm^3 at room temperature. What will be the resistance of the cube when it is doped with 1 arsenic in 10^9 silicon atoms and 1 boron atom per billion silicon atoms? Atomic concentration of silicon is $5*10^{22}$ cm^{-3}, ni = $1.45*10^{10}$ cm-3. [8]
6. a) Calculate the diffusion coefficient of electrons at 300K in n-type silicon semiconductor. Also find current density if electron concentration gradient is 10^3 electrons per centimeter. [4]
   b) Obtain the expression to evaluate built in potential and width of depletion layer of p-n junction with necessary diagrams. [10]

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INSTITUTE OF ENGINEERING
Examination Control Division
2074 Ahswin

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary Graph is attached herewith.***
- ✓ *Assume suitable data if necessary.*
- ✓ *Value of commonly used constants are given below:*

Mass of electron, $m_e = 9.1\times10^{-31}$ kg
$h = 6.626\times10^{-34}$ Js
Permittivity of Silicon, $\varepsilon = \varepsilon_r\,\varepsilon_o = 11.9\times8.85\times10^{-12}$ F/m
$n_i = 1.45\times10^{10}$ cm^{-3} for silicon
$\mu_h = 450$ cm^2/V.s (at 300K)

1 eV $= 1.6\times10^{-19}$ J
$k = 1.38\times10^{-23}$ J/K
$\mu_e = 1350$ cm^2/V.s (at 300K)
$N_A = 6.022\times10^{23}$ / mol

1. a) Explain the importance of quantum mechanics. Differentiate between classical and quantum mechanics with suitable examples. [8]

   b) In the photoelectric experiment, green light, with a wavelength of 522 nm is the longest wavelength radiation that can cause photoemission of electron from a clean sodium surface. Calculate the work function of sodium. If ultraviolet radiation with a wavelength 250 nm is incident to the sodium surface, what will be the kinetic energy of the photo-emitted electrons? [4]

2. a) What happen when inter-atomic separation between two helium atoms is very less? Describe on the basis of formation of bonding and antibonding molecular orbital. [6]

   b) Prove that for a simple cubic structure, the lattice constant: $a = \left[\frac{NM}{\rho N_A}\right]^{1/3}$ where, N is the number of atoms per unit cell, M is atomic weight, N_A is Avogadro's number and ρ is density of crystal material. [4]

3. a) Define local electric field and derive clausius-massotti equation. [6]

   b) The number of electrons per unit volume of Silicon is 6×10^{22}cm^{-3}. Calculate: [4]

      i) Electronic polarizability due to valence electrons per Silicon atom.

      ii) If the Silicon crystal sample is electrode on opposite faces, by how many times the local field is greater than the applied field?

4. a) What is a domain wall? How does a domain wall motion occur? [6]

   b) Explain about the applications of soft magnetic materials. [4]

5. a) A superconductor in its superconducting state expels all the magnetic lines of forces, justify. [6]

   b) Explain how carrier concentration of an n-type extrinsic semiconductor depends on temperature with necessary diagram and graphs. [6]

   c) Four micrograms of antimony are thoroughly mixed in molten form with 100 gms of pure germanium. Find the density of antimony atoms, density of donated electrons and the total resistance of a bar of such n-type material of 2 cm long, 0.012×0.012 cm in cross-section. Take, density of Ge = 5.46 gm/cm^3 and atomic weight of Sb = 121.76. [8]

6. a) The current density in semiconductor devices is affected both by diffusion and drifting of electrons and holes, justify. [6]

   b) Sample of silicon wafer is doped with 10^{15} Antinomy atoms/cm^3. Find the carrier concentrations, its resistance and the shift in Fermi level from its intrinsic Fermi level at 27°C. If this sample is further doped with 10^{22} Boron atoms/cm^3, what will be the change in its resistance. [6]

   c) Show that in n-type semiconductor minority carries concentrations are suppressed. [6]

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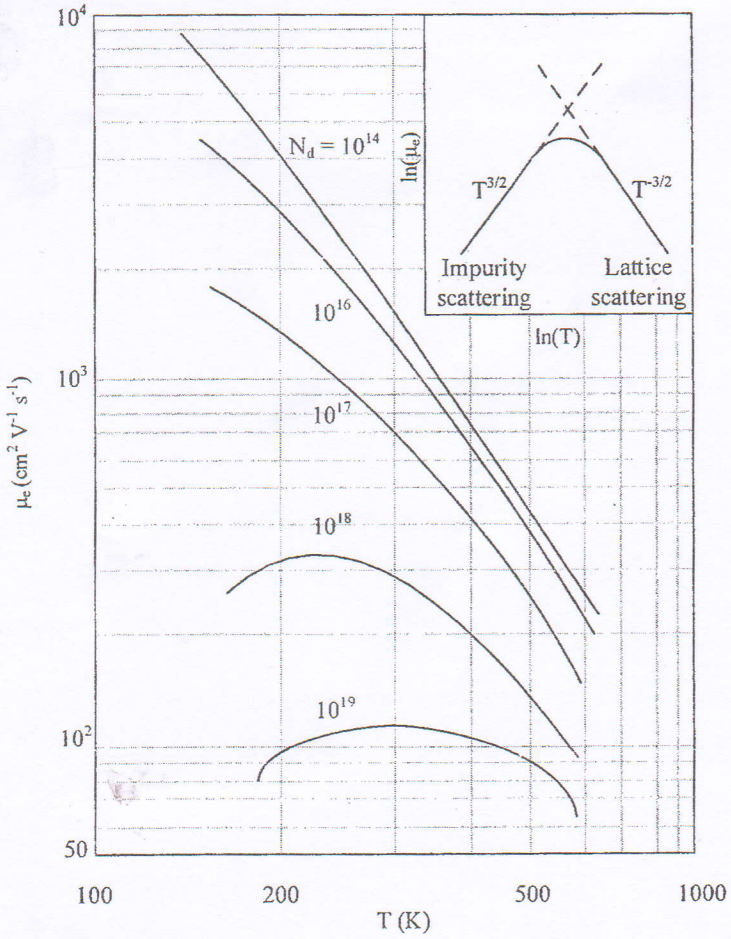

Figure: log-log plot of drift mobility versus temperature for n-type Silicon sample.

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INSTITUTE OF ENGINEERING
Examination Control Division
2073 Shrawan

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ ***Values of commonly used constants are given below.***
- ✓ ***Mass of electron ,m_e=9.1*10^{-31}kg; 1ev=1.6*10^{-19}J***
- ✓ ***h=6.65*10^{-34}Js; k=1.38*10^{-23}J/k;***
- ✓ ***Permittivity of silicon=$\varepsilon_0\varepsilon_r$=11.9*8.85*10^{-12}F/m***
- ✓ ***n_{i0}=1.45*10^{10}/cm^3 for silicon; μ_n=1350cm^2/v.s(at 300K)***
- ✓ ***μ_h=450 cm^2/v.s(at 300K); N_A=6.022*10^{23}/mol***

1. a) What do you understand by number of states and density of states in quantum mechanics? Derive appropriate expressions for them. [8]

   b) A transmitter type vacuum tube operated at 1500°C has a cylindrical Thorium coated Tungsten cathode which is 5 cm long with diameter of 1.5 mm. Determine the saturation current of vacuum tube if the cathode has emission constant of 3×10^4 Am^{-2}k^{-2} and work function of 2.6eV. [4]

2. a) Define and explain the effective mass of electron within a crystal. How do you understand negative and infinite mass of electron? [6]

   b) For silver with E_{FO} = 5.5ev and ϕ = 4.5 ev, calculate the total number of states per unit volume and compare this with atomic concentration of silver. Density and atomic mass of silver are 10.5g/cm^3 and 107.9g/mol respectively. [4]

3. a) Define local field in relation to polarization. Derive the Clausius-Massotti equation for ionic polarization, relating polarizability with the permittivity. [6]

   b) Name the field of application of different types of dielectric materials. [4]

4. a) Classify the magnetic material based on magnetization. [6]

   b) What type of magnetic material would you chose for electromagnetic relays? Justify. [6]

5. a) For a specimen of V_3Ga, the critical fields are 0.176T and 0.528T for 14K and 13K respectively. Calculate the critical temperature. Also calculate critical fields at 0K and 4.2K. [6]

   b) What is diffusion? Derive Einstein relationship for an n-type semiconductor. [6]

   c) A silicon ingot is doped with 10^{16} arsenic atoms/cm^3. Find the carrier concentrations conductivity of the sample and the shift in Fermi level from its intrinsic Fermi level at 27°C. [6]

6. a) Suppose a P-N junction is created on silicon wafer at room temperature. If the donor level on N-side is10^{17} cm^{-3} and acceptor level on P-Side is 10^{16} cm^{-3} calculate built in potential (V_o) and depletion width (W_o). [6]

   b) Calculate the resistance of pure silicon cubic crystal of 1 cm^3 at room temperature. What will be the resistance of the cube when it is doped with 1 arsenic in 10^9 silicon atoms and 1 boron atom per billion silicon atoms? Atomic concentration of silicon is $5*10^{22}$cm^{-3}, $n_i = 1.45*10^{10}$cm^{-3}. [6]

   c) What are energy bands? Distinguish between a conductor, an insulator and a semiconductor on the basis of energy diagram. Write two characteristic features to

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INSTITUTE OF ENGINEERING
Examination Control Division
2072 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ ***Values of commonly used constants are given below.***
- ✓ ***Mass of electron ,m_e=9.1*10^{-31}kg; 1ev=1.6*10^{-19}J***
- ✓ ***h=6.65*10^{-34}Js; k=1.38*10^{-23}J/k;***
- ✓ ***Permittivity of silicon=$\varepsilon_0\varepsilon_r$=11.9*8.85*10^{-12}F/m***
- ✓ ***n_{i0}=1.45*10^{10}/cm^3 for silicon; μ_n=1350cm^2/v.s(at 300K)***
- ✓ ***μ_h=450 cm^2/v.s(at 300K); N_A=6.022*10^{23}/mol***

1. a) Define Fermi Energy. What is the probability that an electron having energy less than Fermi energy will occupy an energy level at absolute zero temperature? Determine the expectation value for any property of a particle described by a wave functionΨ. [8]

   b) An electron is confined to an infinite potential well of size 0.1 nm. Calculate the ground energy of the electron and radian frequency. How this electron can be put to the third energy level? [4]

2. a) What is effective mass? The electron at the top of valence band is said to have negative effective mass. Explain with the help of E-k diagram. [2+4]

   b) Formation of H_2 molecule is more stable than the formation of H_3 molecule. Justify with the help of electron energy versus inter-atomic separation between H-atoms. [6]

3. a) Show that the dielectric loss per unit volume is a function of frequency of the applied field and the loss tangent. [6]

   b) Describe how thermal breakdown and electromechanical breakdown results in dielectric breakdown in solids. [4]

   c) Based on magnetization vector, explain the diamagnetism, ferromagnetism and ferrimagnetisms. [8]

4. a) Explain how strong magnetic field effects superconductor. Derive the relation of critical current in superconductor with necessary diagram. [8]

   b) How band bending occurs in semiconductors? Derive Einstein relationship. [10]

   c) If it is desired that the Fermi-level is to be raised to 0.1 eV above intrinsic Fermi-level at room temperature, what type of dopant is to be used? Determine its doping level. [6]

5. a) Present a comparison between Si and GaAs semiconductors with the help of their basic properties and E-k diagram. [6]

   b) Derive the expression of a built-in potential and depletion width of a pn junction with necessary diagrams. [8]

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Examination Control Division
2071 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ ***Values of commonly used constants are given below.***
- ✓ ***Mass of electron ,m_e=9.1*10^{-31}kg; 1ev=1.6*10^{-19}J***
- ✓ ***h=6.65*10^{-34}Js; k=1.38*10^{-23}J/k;***
- ✓ ***Permittivity of silicon=$\varepsilon_0\varepsilon_r$=11.9*8.85*10^{-12}F/m***
- ✓ ***n_{i0}=1.45*10^{10}/cm^3 for silicon; μ_n=1350cm^2/v.s(at 300K)***
- ✓ ***μ_h=450 cm^2/v.s(at 300K); N_A=6.022*10^{23}/mol***

1. a) What is Thermionic emission and work function? Derive the Richardson's expression for the thermionic emission for Schottky effect. [8]

   b) Consider two copper wires separated only by their surface oxide layer (CuO) of thickness 3 nm. The surface oxide layer offer potential barrier of height 10eV to the conduction electrons in copper. What is the transmission probability for conduction electrons in copper, which have kinetic energy of about 7eV? [4]

2. a) Define lattice and basis of a crystal and draw a neat diagram of body centered cubic structure of chromium and determine its packing density and state its co-ordination number. [2+4]

   b) What is an effective mass of a free electron? Show that effective mass of a free electron is equal to mass of free electron in vacuum. [1+3]

3. a) What are the different types of polarization mechanism in di-electric medium? [6]

   b) Describe how thermal breakdown and electromechanical breakdown results in dielectric breakdown in solids. [4]

4. a) Explain deperming method of demagnetization. If you place graphite in a non-uniform magnetic field what will happen? [3+3]

   b) What are magnetic domains? Explain the behavior of magnetic domains in presence of external magnetic field. [1+3]

5. a) What is Meissner effect? Explain in brief about type-I and type-II superconductor. [8]

   b) Differentiate Non-Degenerate and Degenerate semiconductors. [4]

6. a) In doped semiconductors, carrier concentration and drift mobility both are highly dependent on temperature, justify. [6]

   b) Compute the intrinsic concentration and intrinsic resistivity of silicon at 27°C. Given that: $m_e^* = 1.08m_e$ $\mu_e = 1350\ cm^2/V.s$ $m_h^* = 0.6m_e$ $\mu_h = 450\ cm^2/V.s$ [6]
   Where, m_e^* and m_h^* are effective masses of electron and holes respectively and μ_e and μ_h are electron and hole drift mobility's respectively. The band gap of Silicon = 1.1 eV

7. a) Find the resistance of 1 cm^3 silicon crystal doped with arsenic, the doping density is such that every Arsenic atom sites every 10^9 silicon atoms. Atomic concentration of silicon is $5\times10^{22}\ cm^{-3}$, $n_i = 1\times10^{10}\ cm^{-3}$, $\mu_e = 1350\ cm^2V^{-1}s^{-1}$ and $\mu_h = 450\ cm^2V^{-1}s^{-1}$. Find the resistance if the above silicon sample is further doped with Boron, the doping density is such that every Boron atom sites every 10^6 silicon atoms. [8]

   b) Prove that the position of Fermi level is near the middle of band gap in pure silicon semiconductor. [6]

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INSTITUTE OF ENGINEERING
Examination Control Division
2070 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ ***Values of commonly used constants are given below.***
- ✓ ***Mass of electron*** $m_e=9.1*10^{-31}kg$; $1ev=1.6*10^{-19}J$
- ✓ $h=6.65*10^{-34}Js$; $k=1.38*10^{-23}J/k$;
- ✓ ***Permittivity of silicon*** $=\varepsilon_0\varepsilon_r=11.9*8.85*10^{-12}F/m$
- ✓ $n_{i0}=1.45*10^{10}/cm^3$ *for silicon;* $\mu_n=1350cm^2/v.s$*(at 300K)*
- ✓ $\mu_h=450\ cm^2/v.s$*(at 300K);* $N_A=6.022*10^{23}/mol$

1. a) From free electron theory of metal, show that E-K diagram is parabolic. Also show the energy of electron in a linear metal is quantized. [4+4]
   b) Find the wavelength of an electron accelerated by 100V. [4]
2. a) Explain with neat diagram how energy levels are filled and different energy bands are formed when N numbers of Lithium atoms are brought together. [6]
   b) Calculate the lattice constants, face diagonal, body diagonal and packing density of body centered cube (BCC) crystal unit cell. [4]
3. a) What are the different types of dielectric breakdown? Explain any two of them. [4]
   b) Explain mathematically how relative permittivity is related with electronic polarizability using Clausius Massoti equation. [6]
4. a) A crystal of iron created magnetic field around it but a piece of iron doesn't why? [6]
   b) How hysteresis loop plays an important role in classifying magnetic materials? Explain. [4]
5. a) Define Critical magnetic field and Critical current in a super-conductor with mathematical relation involved. [8]
   b) What is reverse saturation current in pn junction semiconductor? [4]
6. a) Derive the Einstein relationship showing the relation between electron diffusion co-efficient in n-type semiconductor and electron mobility. [8]
   b) Explain how PN junction is formed when n-type and p-type semiconductor are brought together. Derive the relation of built-in-potential of a PN junction. [6]
7. a) Calculate the resistance of pure silicon cubic crystal of 1 cm^3 at room temperature. What will be the resistance of the cube when it is doped with1arsenic in 10^9 silicon atoms and 1 boron atom per million silicon atoms? Atomic concentration of silicon is $5*10^{22}$ cm^{-3}. Use other required data from above given list. [8]
   b) An n-type semiconductor doped with $10^{16}cm^{-3}$ phosphorus atoms has been doped with $10^{16}cm^{-3}$ boron atoms. Calculate the electron concentration in the semiconductor. [4]

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INSTITUTE OF ENGINEERING
Examination Control Division
2068 Baishakh

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
- ✓ *The figures in the margin indicate Full Marks.*
- ✓ *Assume suitable data if necessary.*
- ✓ $h = 6.624 \times 10^{-34}$ JS; $1\ ev = 1.6 \times 10^{-19} J$
- ✓ $k = 1.38 \times 10^{-23} JK$; $n_i = 1.45 \times 10^{10}/cm^3$ for s;
- ✓ $\mu_n = 1350 cm^2 v^{-1}s^{-1}$ (at 300K); $\mu_h = 450 cm^2 v^{-1}s^{-1}$ (at 300K)
- ✓ $\varepsilon = \varepsilon_0\varepsilon_r = 11.9 \times 8.85 \times 10^{-12}$ F/m; $Eg = 1.1ev$
- ✓ $N_A = 6.624 \times 10^{-23}$ /mol $e = 1.602 \times 10^{-19} C$
- ✓ $M_{at} = 16g/mol$ (oxygen) Mass of photon $= 1.673 \times 10^{-27} kg$
- ✓ Velocity of light $= 3 \times 10^8$ m/s

1. a) From the expression $E_h = \frac{h^2}{8ml^2}(h_x^2 + h_y^2 + h_z^2)$, define number of states and density of states functions in quantum mechanics. Derive appropriate expressions for them. [6]

   b) The mean speed of conduction electrons in copper is 1.5×10^6 m/s. The cross sectional area of scattering is $3.9 \times 10^{-22} m^2$. Estimate the drift mobility of electrons and conductivity of copper. Given density of copper is $8.96 g/cm^3$ and the atomic mass is 63.56 g/mole. [6]

2. a) Show that effective mass of an electron inside the crystal is inversely proportional to the curvature of energy with respect to wave number space. [6]

   b) Copper has FCC (Face- centered - cubic) structure. Find the packing density and atomic concentration for copper if radius of copper atom is 0.128nm. [4]

3. a) Define local field in relation to polarization. Derive the Clausius-Massotti Equation for ionic polarization, relating polarizability with the permittivity. [10]

   b) Classify the magnetic materials based on magnetization and explain each of them briefly. [10]

4. a) What is superconductor? Differentiate between Type-I and Type-II superconductor. [3+5]

   b) Explain how donor dopants contribute electrons in conduction band in n-type extrinsic semiconductor. Also prove that conductivity $\sigma \simeq e\ n\ \mu_e$; where symbols have their usual meanings. [10]

5. a) A pn-junction is formed at 300k. The acceptor and donor concentration in p-side and n-side are 10^{16} cm^{-3} and 10^{17} cm^{-3} respectively. Find :

   i) Built-in potential [2.5]
   ii) Width of deplection layer [2.5]
   iii) Maximum electric field [1]
   iv) Width in n and p sides [2]
   v) Fermi level n and p sides [2]

   b) Explain the diffusion process in semiconductor and derive Einstein relation for diffusion process. [10]

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Examination Control Division
2068 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEL, BEX	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Electrical Engineering Material *(EE 502)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*
- ✓ *Mass of electron me = 9.1 $\times 10^{-31}$kg; k= 1.38 $\times 10^{-23}$J/K; h =6.65 $\times 10^{-34}$JS; 1eV = 1.6 $\times 10^{-19}$ J; ni = 1.45 $\times 10^{10}$/cm^3 for Si;*
- ✓ *μ_h = 450cm^{2}v^{-1}S^{-1} (at 300K); μ_e = 1350cm^{2}V^{-1}S^{-1}(at 300K);*
- ✓ *N_A = 6.022 $\times 10^{23}$/mol;*

1. a) What do you mean by barrier penetration? How the wave function of particle is given when the particle penetrates the barrier? [8]

   b) A transmitter type vacuum tube has a cylindrical cathode, which is 4m long and 2mm diameter. Estimate the saturation current if the tube is operated at 160°C. The emission constant $A_0 = 3 \times 10^4$ Am^{-2}K^{-2}, work function ϕ= 2.6eV. [4]

   c) Conduction electrons with drift mobility of 53cm^{2}V^{-1}S^{-1} and mean speed of 2.2×10^6ms^{-1} collides. Calculate the mean free path of electrons between collision. [4]

2. a) Explain, how energy bands are formed in solids taking the example of N number of Lithium atoms for the explanation. [6]

   b) What is electric dipole moment? Derive the Clausius- Masotti equation for electronic polarization, relating polarizability with the permittivity. [3+7]

3. a) What is the significance of Hysteresis loop? Explain. [4]

   b) Explain the domain theory of magnetism. [6]

   c) A p-n junction is made by silicon doped with 10^{17} donor atoms per cm^3 with silicon doped 10^{16} acceptor atoms per cm^3 at room temperature. Calculate built in potential across the junction and diffusion co-efficient in both parts. [6]

4. a) A pn junction is formed at 300k. The acceptor and donor concentration in p-side and n-side are 10^{18} cm^{-3} and 10^{16}cm^{-3} respectively. Calculate: [8]

      i) Built in potential
      ii) Width of deplection layer
      iii) Maximum value of electric field

   b) What is Meisner effect? Explain the difference between type I and type II superconductors. [2+6]

5. a) Explain about intrinsic Fermi level of a pure semiconductor and derive a relationship of the intrinsic Fermi level assuming that intrinsic carrier concentration is known. [2+4]

   b) Explain how carrier concentration of a semi-conductor depends on temperature with necessary diagrams and graphs. [6]

   c) What do you understand by diffusion of charge carriers in semiconductor? How does diffusion contribute to conductivity of a semiconductor? [4]