Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU
SCHOOL OF ENGINEERING

MIDTERM EXAMINATION **SET - A**

Odd Semester: II Sem (AY 2021-22)
Course Code: PHY1002
Course Name: Optoelectronics and device physics
Program & Sem: B.Tech, & 2nd Semester

Date: 10.MAY.2022
Time: 01:30 PM to 03.00 PM
Max Marks: 50
Weightage: 25%

Instructions:

(i) *Read the question properly and answer accordingly.*
(ii) Question paper consists of 3 parts.
(iii) Scientific and Non-programmable calculators are permitted.
(iv) Given: Planck's constant h = 6.625×10^{-34} Js; Charge of the electron e =1.6×10^{-19} C

Part A [Memory Recall Questions]
Answer all the questions. Each question carries TWO marks. (10Qx2M=20M)

1. Identify the solid material which has low resistivity and high conductivity (C.O.1) (Knowledge)
   a) Aluminum b) Diamond c) Wood d) Silicon
2. Identify the critical field required to destroy the Type-II superconductor (C.O.1) (Knowledge)
   a) 30 T b) 0.1 T c) 1 T d) 3.0 T
3. In the Hall Effect, the electric field is in the X-direction and current is in the Y-direction. What is the direction of the magnetic field? (C.O.1) (Knowledge)
   a) X b) Y c) XY plane d) Z
4. Which dopant will result in p-type semiconductor? (C.O.1) (Knowledge)
   a) P b) Si c) B d) Ge
5. Identify the diamagnetic material (C.O.1) (Knowledge)
   a) Iron b) Nickel c) Gold d) Platinum
6. Identify the high susceptibility magnetic material (C.O.1) (Knowledge)
   a) Diamagnetic b) Paramagnetic c) Ferromagnetic d) Superconductor
7. Fermi level lies in P-type semiconductor (C.O.1) (Knowledge)
   a) Below the conduction band
   b) Above the Valence band
   c) Middle of the Energy gap
   d) None of the above.
8. Fermi level lies in intrinsic semiconductor at …….. (C.O.1) (Knowledge)
   a) Below the conduction band
   b) Above the Valence band
   c) Middle of the Energy gap
   d) None of the above

9. Choose the wrong statement? (C.O.1) (Knowledge)
   a) Superconductivity is a phenomenon in which electric current pass through a material without any resistance.
   b) Superconducting state of material is observed only below a temperature called transition or critical temperature.
   c) superconductors are perfect diamagnetic
   d) Superconductivity is not possible to destroy by applying external magnetic field.
10. Which of the following are the properties of superconductors? (C.O.1) (Knowledge)
   a) They are diamagnetic in nature
   b) They have zero resistivity
   c) They have infinite conductivity
   d) All of the above

Part B [Thought Provoking Questions]

Answer all the questions. Each question carries FIVE marks. (3Qx5M=15 M)

11. The conversation of intrinsic semiconductor to extrinsic semiconductor helps to improve the conductivity of semiconductors, what is the process involved in improving the conductivity, explain with neat diagrams?. (C.O.1) (Comprehension)

12. Materials are having high, low and negative susceptibilities, identify the materials and distinguish between them? (C.O.1) (Comprehension)

13.The process in which a transverse electric field is developed in a solid material when the material carrying an electric current is placed in a magnetic field that is perpendicular to the current. Identify the effect, explain the same with neat diagram (C.O.1) (Comprehension)

Part C [Problem Solving Questions]

Answer all the questions. Each question carries FIFTEEN marks. (1Qx15M=15 M)

14. (a) C, Sn, Si, Ge are present in the same group but Si and Ge are semiconductors while C and Sn are not. State the reasons? (C-Band gap-5.2 eV, Si-Band gap-1.1 eV, Ge-Bandgap-0.7 eV, Sn-Energy bap-0 eV). (3M)

(b)The Resistivity of conductor decreases with temperature and at particular temperature resistivity is equal to zero, is there any theory developed to explain above property? and explain the same in detail. (7M)

(c) N-type semiconductors are donor type, calculate the number of donor atoms per m3 of n-type material having resistivity of 0.25 Ω-m, the mobility of electrons is 0.3 m^2/V-s. (5 M)(C.O.1)(Application)

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MIDTERM EXAMINATION **SET - A**

Odd Semester: II Sem (AY 2021-22)
Course Code: PHY1002
Course Name: Optoelectronics and device physics
Program & Sem: B.Tech, & 2nd Semester

Date: 10.MAY.2022
Time: 01:30 PM to 03.00 PM
Max Marks: 50
Weightage: 25%

Instructions:

(v) *Read the question properly and answer accordingly.*
(vi) Question paper consists of 3 parts.
(vii) Scientific and Non-programmable calculators are permitted.
(viii) Given: Planck's constant h = 6.625×10^{-34} Js; Charge of the electron e =1.6×10^{-19} C

Part A [Memory Recall Questions]

Answer all the questions. Each question carries TWO marks. (10Qx2M=20M)

4. Identify the solid material which has low resistivity and high conductivity (C.O.1) (Knowledge)

a) Aluminum b) Diamond c) Wood d) Silicon

5. Identify the critical field required to destroy the Type-II superconductor (C.O.1) (Knowledge)

a) 30 T b) 0.1 T c) 1 T d) 3.0 T

6. In the Hall Effect, the electric field is in the X-direction and current is in the Y-direction. What is the direction of the magnetic field? (C.O.1) (Knowledge)

b) X b) Y c) XY plane d) Z

4. Which dopant will result in p-type semiconductor? (C.O.1) (Knowledge)

b) P b) Si c) B d) Ge

6. Identify the diamagnetic material (C.O.1) (Knowledge)

a) Iron b) Nickel c) Gold d) Platinum

6. Identify the high susceptibility magnetic material (C.O.1) (Knowledge)

a) Diamagnetic b) Paramagnetic c) Ferromagnetic d) Superconductor

7. Fermi level lies in P-type semiconductor (C.O.1) (Knowledge)

e) Below the conduction band
f) Above the Valence band
g) Middle of the Energy gap
h) None of the above.

8. Fermi level lies in intrinsic semiconductor at …….. (C.O.1) (Knowledge)

a) Below the conduction band
b) Above the Valence band
c) Middle of the Energy gap

d) None of the above

9. Choose the wrong statement? (C.O.1) (Knowledge)
   e) Superconductivity is a phenomenon in which electric current pass through a material without any resistance.
   f) Superconducting state of material is observed only below a temperature called transition or critical temperature.
   g) superconductors are perfect diamagnetic
   h) Superconductivity is not possible to destroy by applying external magnetic field.
10. Which of the following are the properties of superconductors? (C.O.1) (Knowledge)
   e) They are diamagnetic in nature
   f) They have zero resistivity
   g) They have infinite conductivity
   h) All of the above

Part B [Thought Provoking Questions]

Answer all the questions. Each question carries FIVE marks. (3Qx5M=15 M)

11. The conversation of intrinsic semiconductor to extrinsic semiconductor helps to improve the conductivity of semiconductors, what is the process involved in improving the conductivity, explain with neat diagrams?. (C.O.1) (Comprehension)

12. Materials are having high, low and negative susceptibilities, identify the materials and distinguish between them? (C.O.1) (Comprehension)

13.The process in which a transverse electric field is developed in a solid material when the material carrying an electric current is placed in a magnetic field that is perpendicular to the current. Identify the effect, explain the same with neat diagram (C.O.1) (Comprehension)

Part C [Problem Solving Questions]

Answer all the questions. Each question carries FIFTEEN marks. (1Qx15M=15 M)

14. (a) C, Sn, Si, Ge are present in the same group but Si and Ge are semiconductors while C and Sn are not. State the reasons? (C-Band gap-5.2 eV, Si-Band gap-1.1 eV, Ge-Bandgap-0.7 eV, Sn-Energy bap-0 eV). (3M)

(b) The Resistivity of conductor decreases with temperature and at particular temperature resistivity is equal to zero, is there any theory developed to explain above property? and explain the same in detail. (7M)

(c) N-type semiconductors are donor type, calculate the number of donor atoms per m3 of n-type material having resistivity of 0.25 Ω-m, the mobility of electrons is 0.3 m^2/V-s. (5 M)(C.O.1)(Application)

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PRESIDENCY UNIVERSITY
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MIDTERM EXAMINATION

SET – B

Winter Semester: 2021-22
Course Code: PHY1002
Course Name: Optoelectronics and device physics
Program & Sem: B.Tech, & 2nd Semester

Date: 10.MAY.2022
Time: 01:30 PM to 03.00 PM
Max Marks: 50
Weightage: 25%

Instructions:

(ix) *Read the question properly and answer accordingly.*
(x) Question paper consists of 3 parts.
(xi) Scientific and Non-programmable calculators are permitted.
(xii) Given: Planck's constant h = 6.625×10^{-34} Js; Charge of the electron e =1.6×10^{-19} C

Part A [Memory Recall Questions]

Answer all the questions. Each question carries TWO marks. (10Qx2M=20M)

7. A semiconductor in its purest form is called (C.O.1) (Knowledge)
   a) Insulator b) Superconductor
   c) Intrinsic semiconductor d) Extrinsic semiconductor

8. Fermi energy is the highest energy level occupied by an electron at
   a) 0^0C b) 273 K c) 273^0C d) 0 K (C.O.1) (Knowledge)

9. In the Hall Effect, the induced electric field is in the X-direction and the current is in the Y-direction. What is the direction of the magnetic field?
   c) X b) Y c) XY plane d) Z (C.O.1) (Knowledge)

4. Aluminum can be used as (C.O.1) (Knowledge)
   c) Pentavalent Impurity b) Trivalent Impurity
   c)Tetravalent Impurity d) None of the above

7. The temperature at which a material undergoes a transition from the normal state to the superconducting state by losing its resistivity is called.
   a) Critical Temperature b) Absolute Temperature (C.O.1) (Knowledge)
   b) Curie Temperature d) Crystallization temperature

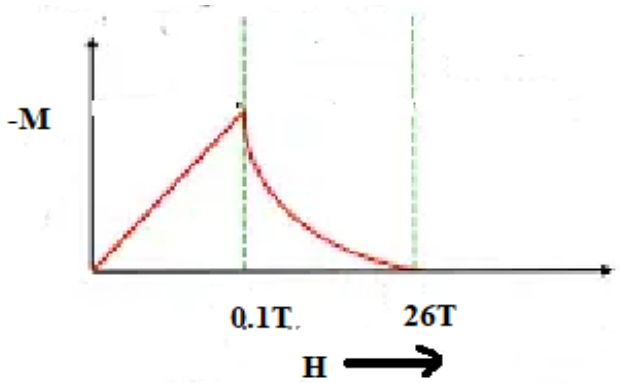
6. In the Hall effect, the output voltage produced across the crystal is due to
   a) Drop across the crystal is due to the current passed through it
   b) Due to repulsive force between unlike charges.
   c) Movement of charge carriers towards one end
   d) All the above (C.O.1) (Knowledge)

7. Type I superconductors are not used as superconducting magnets because
   a) The value of the critical field is low b) They have two critical fields
   c) They don't have any critical field d) None of the above (C.O.1) (Knowledge)

8. High relative permeability magnetic material
   a) Diamagnetic b) Paramagnetic c) Ferro d) Superconductor (C.O.1) (Knowledge)

9. Cooper pairs are (C.O.1) (Knowledge)
   a) Pairs of electrons b) Pairs of neutrons
   b) Pairs of protons d) Pairs of photons

10. All superconductors are (C.O.1) (Knowledge)
   a) Diamagnetic in nature b) Paramagnetic in nature
   c) Ferromagnetic in nature d) Antiferromagnetic in nature



Part B[Thought Provoking Questions]

Answer all the questions. Each question carries FIVE marks. (3Qx5M=15 M)

11. The expulsion of magnetic flux from a superconducting material in superconducting state. Identify the effect, explain the same with neat diagram. (C.O.1) (Comprehension)

12. Electron-electron interaction via phonon. Explain the theory behind the concept. (C.O.1) (Comprehension)

13. The Hall coefficient of certain Si specimen was found to be -7.35×10^{-5} m^3 C^{-1} from 100 to 400 K. Determine the nature of the semiconductor. If the conductivity was found to be 200 Ohm $^{-1}$ m^{-1}. Estimate the density and mobility of the charge carrier.

(C.O.1) (Comprehension)

Part C [Problem Solving Questions]

Answer all the questions. Each question carries 15 marks. (1Qx15M=15 M)

14.

a) What type of material is illustrated in the graph? (2Marks)

b) Analyze the graph and explain the properties of the given material. (5 Marks)

c) Redraw the graph with complete labelling. (2 Marks)

d) The electron mobility and hole mobility in Si are 0.125 m^2 V^{-1} s^{-1} and 0.058 $\mathbf{m^2\ V^{-1}\ s^{-1}}$ respectively at room temperature. If the carrier concentration is 1.2×10^{16} m^{-3}. Estimate the resistivity of **Si** at room temperature. (6 Marks)

(C.O.1) (Application)

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PRESIDENCY UNIVERSITY
BENGALURU
SCHOOL OF ENGINEERING

MIDTERM EXAMINATION — SET – B

Winter Semester: 2021-22
Course Code: PHY1002
Course Name: Optoelectronics and device physics
Program & Sem: B.Tech, & 2nd Semester

Date: 10.MAY.2022
Time: 01:30 PM to 03.00 PM
Max Marks: 50
Weightage: 25%

Instructions:

(xiii) *Read the question properly and answer accordingly.*
(xiv) Question paper consists of 3 parts.
(xv) Scientific and Non-programmable calculators are permitted.
(xvi) Given: Planck's constant h = 6.625×10^{-34} Js; Charge of the electron e =1.6×10^{-19} C

Part A [Memory Recall Questions]

Answer all the questions. Each question carries TWO marks. (10Qx2M=20M)

10. A semiconductor in its purest form is called (C.O.1) (Knowledge)
    b) Insulator b) Superconductor
    c) Intrinsic semiconductor d) Extrinsic semiconductor

11. Fermi energy is the highest energy level occupied by an electron at
    a) 0^0C b) 273 K c) 273^0C d) 0 K (C.O.1) (Knowledge)

12. In the Hall Effect, the induced electric field is in the X-direction and the current is in the Y-direction. What is the direction of the magnetic field?
    d) X b) Y c) XY plane d) Z (C.O.1) (Knowledge)

4. Aluminum can be used as (C.O.1) (Knowledge)
    d) Pentavalent Impurity b) Trivalent Impurity
    c)Tetravalent Impurity d) None of the above

8. The temperature at which a material undergoes a transition from the normal state to the superconducting state by losing its resistivity is called.
    a) Critical Temperature b) Absolute Temperature (C.O.1) (Knowledge)
    b) Curie Temperature d) Crystallization temperature

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    e) Drop across the crystal is due to the current passed through it
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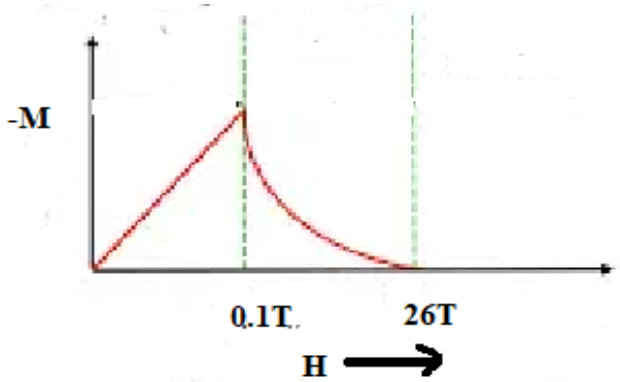
    g) Movement of charge carriers towards one end
    h) All the above (C.O.1) (Knowledge)

7. Type I superconductors are not used as superconducting magnets because
    b) The value of the critical field is low b) They have two critical fields
    c) They don't have any critical field d) None of the above (C.O.1) (Knowledge)

8. High relative permeability magnetic material
   a) Diamagnetic b) Paramagnetic c) Ferro d) Superconductor (C.O.1) (Knowledge)

9. Cooper pairs are (C.O.1) (Knowledge)
   c) Pairs of electrons b) Pairs of neutrons
   d) Pairs of protons d) Pairs of photons

10. All superconductors are (C.O.1) (Knowledge)
   b) Diamagnetic in nature b) Paramagnetic in nature
   c) Ferromagnetic in nature d) Antiferromagnetic in nature



Part B[Thought Provoking Questions]

Answer all the questions. Each question carries FIVE marks. (3Qx5M=15 M)

11. The expulsion of magnetic flux from a superconducting material in superconducting state. Identify the effect, explain the same with neat diagram. (C.O.1) (Comprehension)

12. Electron-electron interaction via phonon. Explain the theory behind the concept. (C.O.1) (Comprehension)

13. The Hall coefficient of certain Si specimen was found to be -7.35×10^{-5} m^3 C^{-1} from 100 to 400 K. Determine the nature of the semiconductor. If the conductivity was found to be 200 Ohm $^{-1}$ m^{-1}. Estimate the density and mobility of the charge carrier.

(C.O.1) (Comprehension)

Part C [Problem Solving Questions]

Answer all the questions. Each question carries 15 marks. (1Qx15M=15 M)

14.

a) What type of material is illustrated in the graph? (2Marks)

b) Analyze the graph and explain the properties of the given material. (5 Marks)

c) Redraw the graph with complete labelling. (2 Marks)

d) The electron mobility and hole mobility in Si are 0.125 m^2 V^{-1} s^{-1} and 0.058 $\mathbf{m^2\ V^{-1}\ s^{-1}}$ respectively at room temperature. If the carrier concentration is 1.2×10^{16} m^{-3}. Estimate the resistivity of **Si** at room temperature. (6 Marks)

(C.O.1) (Application)

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END TERM EXAMINATION

Odd Semester: II Sem (AY 2021-22) **Date**: 30th June 2022

Course Code: PHY1002 **Time**: 1:00 AM to 4.00 PM

Course Name: Optoelectronics and Device Physics **Max Marks**: 100

Program & Sem: B.Tech, & II Sem **Weightage**: 50%

Instructions:

(i) *Read the question properly and answer accordingly.*

(ii) Scientific and Non-programmable calculators are permitted.

(iii) Given : Planck's constant h = 6.625×10^{-34} Js; Charge of the electron e =1.6×10^{-19} C

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries TWO marks. (20Qx2M=40M)

1. A semiconductor at very low temperature behaves as (CO1) [Knowledge]

a) Conductor b) Semiconductor c) Insulator d) None of the above

2.It is found that the number of free electrons are equal to number of free holes in a material. Identify the material.

(CO1) [Knowledge]

a) Conductor b) Intrinsic Semiconductor c) Extrinsic Semiconductor d) Superconductor

3. According to the de-Broglie, the wavelength of electron is larger if the momentum is

(CO3) [Knowledge]

a) smaller b) Larger c) Wavelength is independent of momentum d) Infinity

4. The physical nature exhibited by the radiation

(CO3) [Knowledge]

a) Particle nature b) Wave nature c) Neither Particle nor wave d) Particle and Wave nature

5. When an electron is accelerated by a potential V volt, then the de Broglie wavelength is

(CO3) [Knowledge]

a) 1.227 A°/√V b) 1227 A°/√V c) 122.7 A°/√V d) 12.27 A°/√V

6. When the band gap of LED is increased then the wavelength

(CO2) [Knowledge]

a) Decreases b) Increases c) Remains same d) doubles

7. Identify the principle of an optical fiber. (CO4) [Knowledge]

a) Total Internal reflection b) Electroluminescence c) Both A &B d) None of these

8. The wavelength of a matter wave associated with lighter particle (CO3) [Knowledge]

a) Larger b) Smaller c) no change d) Zero

9. The Charge carriers in semiconductors are (CO1) [Knowledge]

a) Both electrons and holes b) Electrons c) Holes d) Cations

10. Matter waves are independent of (CO3) [Knowledge]

a) Mass b) Charge c) Velocity d) Kinetic energy

11. If the kinetic energy of particle is quadrupled then the wavelength of the matter wave (CO3) [Knowledge]

a) Doubles b) Quadruples c) Triples d) Halves

12. Identify diode used as a Voltage regulator (CO2) [Knowledge]

a) Zener Diode b) LED c) Photodiode d) all

13. Identify the name of the scientist explained uncertainty principle (CO3) [Knowledge]

a) Broglie b) Maiman c) Heisenberg d) Tyndall

14. Superconductors have (CO1) [Knowledge]

a) Infinite resistivity b) Infinite conductivity c) both a&b d) none of these

15. Arsenic can be used as (CO1) [Knowledge]

a) Pentavalent dopant b) Trivalent dopant c) Tetravalent dopant d) Hexavalent dopant

16. The physical nature exhibited by the matter (CO3) [Knowledge]

a) Particle nature b) Wave nature c) Neither Particle nor wave d) Particle and Wave nature

17. Laser light is highly (CO4) [Knowledge]

a) Monochromatic beam of light b) Intense beam of light c) Convergent beam of light d) All

18. Identify type of superconductor obeys complete Meissner effect. (CO1) [Knowledge]

a) Type-I b) Type-II c) Both a and b d) Neither a or b

19. The life time of an atom in metastable state is (CO4) [Knowledge]

a) Many times larger than ordinary higher energy state

b) Many times smaller than ordinary higher energy state

c) Many times larger than ground state

d) Double the life of an atom in the ordinary higher energy state

20. Identify the physical property of wave. (CO3) [Knowledge]

a) Wavelength b) Amplitude c) frequency d) All

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries TEN marks. (3Qx10M=30 M)

21.a) The silicon semiconductor at a temperature of 300 K has p number of free electrons q number of free holes. When the temperature of silicon is increased to 400 K, then the number free electrons become P and number of free holes become Q. Mention the relationship between the following quantities.

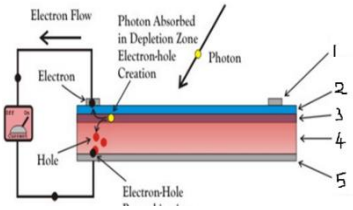
(4M)(CO1) [Application]

(1) p and q (2) q and Q (3) P and Q (4) $\frac{p}{P} = \frac{q}{Q}$

b) Are there any conditions of LASER? If yes, what are they and explain it? (6M) (CO4) [Application]

22. The device shown in the figure develops meaningful voltage when exposed to the sun light. Identify the device. Mention the type of material used to make the device. Label the parts of the device and explain the principle and working of this device.

(10M) (CO2) [Application]



23. a) Nature demonstrates two types of emissions of light. In one case, highly incoherent polychromatic divergent weak beam of light is emitted and in other case, highly coherent monochromatic convergent strong beam of light is emitted. Identify the types of emission processes involved and explain them in detail. (5M)

b) The ratio of population of two energy levels is 1.069×10^{-30}. The wavelength of light emitted at 628nm. Calculate the temperature of the system.

(5M) CO4) [Comprehension]

Part C [Problem Solving Questions]

Answer all the Questions. Each question carries FIFTEEN marks. (2Qx15M=15 M)

24. a) It is observed that a direct band gap based p-n junction diode ($E_g > 1.8$ eV) emits Infra-red and visible light when it is forwarded biased with a suitable knee voltage. Identify the device and describe the principle, construction and working of this device with neat diagram. Mention how band gap of this device to be changed if one is interested in blue light instead of red light. (9M)(CO2) [Application]

b) Gallium Arsenide (GaAs) LED has a band gap of 2.6 eV. Find the wavelength of light emitted by it and identify the color of the light (5+1).

(CO2) [Application]

25. a) It is observed that the sub microscopic particles in motion exhibit wave properties. Identify the waves and discuss their properties.

(4M) (CO3) [Application]

b) Calculate the de Broglie wavelength associated with electrons if the accelerating voltage is 6000.

(4M) (CO3) [Application]

c) Identify the high band width cable which is used in communication system. Explain the communication process from transmitter to receiver with schematic diagram.

(7M) (CO4) [Application]