Total No. of Questions : 9]

SEAT No. :

PB3587

[Total No. of Pages : 4

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F.E. (Common)
ENGINEERING PHYSICS
(2019 Credit Pattern) (Semester - I/II) (107002)

Time : 2½ Hours] *[Max. Marks : 70*

Instructions to the candidates:

1) ***Q. 1 is compulsory. Answer Q2 or Q3, Q4 or Q5, Q6 or Q7, Q8 or Q9.***
2) ***Figures to the right indicate full marks.***
3) ***Neat diagram must be drawn wherever necessary.***
4) ***Use of non-programmable Electronic pocket calculator is allowed.***
5) ***Assume suitable data, if necessary.***

Physical Constants:

- ***Plank's constant, $h = 6.63 \times 10^{-34}$ J.S***
- ***Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg***
- ***Charge on electron = 1.6×10^{-19} C***

Q1) Write the correct option with answers for the following questions (1mark each) **[10]**

a) De Broglie wavelength for matter waves associated with a matter particle is _____its Energy.

i) Inversely proportional to square of

ii) Directly proportional to

iii) Inversely proportional to the square root of

iv) Directly proportional to the square root of

b) A well behaved wave function satisfies which mathematical conditions.

i) Finite ii) Single valued

iii) Normalizable iv) All of the above

c) According to Heisenberg Uncertainty principle, in a narrow wave packet of de Broglie wavelength _____of a particle can be predicted correctly.

i) Position

ii) Momentum

iii) Position and momentum both

iv) Neither position nor momentum

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d) At absolute zero (T = 0 k), a semiconductor would be

i) Perfect semiconductor ii) Insulator

iii) Conductor iv) Intrinsic semiconductor

e) The Hall effect is true for

i) Semiconductors only and not metals

ii) Metals only and not semiconductors

iii) Both metals and semiconductors

iv) Insulators

f) The relation between magnetization (M), susceptibility (χ) and Magnetic field strength (H) is

i) χ = M×H ii) χ = H/M

iii) χ = M+H iv) χ = M/H

g) The relation between magnetic induction (B), Magnetic flux (ϕ), area (A) and is

i) ϕ = B/A ii) ϕ = BA

iii) ϕ = B - A iv) ϕ = A/B

h) The expulsion of magnetic flux from within the superconductor below Critical temparature is know as

i) Magnetic effect ii) Expulsion effect

iii) Meissner effect iv) Josephson effect

i) X rays or gamma rays are used in radiography testing technique due to which of their property.

i) High frequency ii) High wavelength

iii) High velocity iv) Low frequency

j) A quantum dot (nanoparticle) has all dimensions in the range of

i) 100 nm to 1μm ii) 1 - 100 nm

iii) 1 μm to 100 μm iv) 100 μm and above

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Q2) a) Derive schrodinger's time independent equation. **[6]**

b) What is the Heisenberg uncertainty Principle/ Explain it using narrow and broad wave packets. **[5]**

c) The lowest energy of an electron trapped in a potential well is 4.2 eV. Determine the width of the potential well in AU. **[4]**

OR

Q3) a) For a particle enclosed in a rigid box of infinite potential well, derive the equation for energy of the particle. Why is this energy quantized? **[6]**

b) What is the de Broglie hypothesis? Explain in brief properties of matter waves (any four). **[5]**

c) An electron is confined to a potential well of length 1.5 AU. Calculate the minimum uncertainty in its velocity (assume product of uncertainities equal to 'h'). **[4]**

Q4) a) With a neat and labeled diagram explain the Hall effect. Derive expression for Hall voltage. **[6]**

b) Difine Fermi level for a semiconductor. Draw a neat and labeled energy diagram for a PN junction diode showing Fermi levels when it is in **[5]**

(i) Zero bias (equilibrium)

(ii) Forward bias

c) A sample of intrinsic germanium has a carrier concentration of 4.41×10^{22} / cm^3. If the donor impurity is added in the ratio $1:10^7$ atoms / cm^3, determine resistivity of the sample. [Given, mobility of electrons, $\mu_e = 3800$ cm^2/V.s. **[4]**

OR

Q5) a) Derive the expression for electrical conductivity of a semiconductor. Discuss how this equation is modified for intrinsic, N-type and p-type semiconductors. **[6]**

b) Define efficiency of solar cell. Explain any four ways by which the efficiency of solar cell can be improved. **[5]**

c) An n-type semiconductor has a thickness of 0.15 mm and a current of 1mA is flowing along its length. Calculate Hall voltage developed along its width if a magnetic field of 2T is applied perpendicular to its thickness. [Hall coefficient, $R_H = 3.68\times10^{-4} m^3/C$]. **[4]**

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Q6) a) Differentiate between diamagnetic, paramagnetic and ferromagnetic materials. (Any three points). **[6]**

b) What is super conductivity? Explain any two applications of superconductors in brief. **[5]**

c) For Lead, the critical magnetic field at 0K , Hc (0) is 8×10^5 A/m. and it has a transition temparature (Tc) of 7.26 K. In a certain application, Lead has to be used as a superconductor subjected to a magnetic field of Hc(T) = 4×10^4 A/m. At what maximum temperature it can be operated? **[4]**

OR

Q7) a) What is the Meissner effect? Discuss the reason why it is observed? Showthat superconductors exhibit perfect diamagnetism below the critical temparature. **[6]**

b) Explain the process of recording and retrieving (reading) data in magnetic storage devices. **[5]**

c) Explain brief:

i) Magnetic Susceptibility (χ)

ii) Absolute permeability (μ) **[4]**

Q8) a) What is echo sounding? Using this technique, explain how ultrasonic waves can be used for flaw detection. **[6]**

b) What is quantum confinement? On its basis explain why nanoparticles exhibit different properties than corresponding bulk materials. **[5]**

c) State applications of nanotechnology in the field of electronics (any four). Explain any one application in brief. **[4]**

OR

Q9) a) Explain optical and electrical properties of nanoparticles. **[6]**

b) State the objectives of Non-Destructive Testing. Differentiate between destructive and non-destructive testing (any two points). **[5]**

c) An ultrasonic pulse of frequency 100 kHz is sent through a block of aluminum with velocity 6320 m/s and. The echo is recorded after 1.45 microseconds. Calculate the thickness of the block and the wavelength of the ultrasonic pulse. **[4]**

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