Dr Navneet 19/12/2023 (S) (M)

National Institute of Technology, Hamirpur, HP-177005
BTech Eng. Physics, Major Examination, 19-12-2023 (Engineering Physics, PH-101), Total Marks=50, Attempt all questions.

Q.1 (i) Define relaxation time. Give expression for electrical conductivity in terms of relaxation time.
(ii) What is effective mass? Give expression for it.
(iii) State and explain Meissner effect.
(iv) Give one success and one failure of free electron model
(v) What is the significance of metastable state in production of LASER? 5x1=5

Q.2 (i) Obtain Gauss law in integral form. From integral form of Gauss law prove that it can be written in differential form as

$$\vec{\nabla}.\vec{D} = \rho_f$$

where terms have their usual meanings.
(ii) If $\vec{r} = x\hat{\mathbf{i}} + y\hat{\mathbf{j}} + z\hat{\mathbf{k}}$ is the position vector of any point having coordinates (x,y,z) and n is any number. show that

$$\vec{\nabla} r^n = n r^{n-2}\vec{r}$$

[4+3]

Q.3 (i) Write down Maxwell's equations in electromagnetic theory. Using Maxwell equations, obtain an expression for wave equation satisfied by electric and magnetic fields in a medium having permeability μ and permittivity ϵ and σ=0. Further show that in vacuum, the speed of em wave is given by c=$1/\epsilon_0\mu_0$.
(ii) Define Poynting vector. Show that time average of poynting vector gives the intensity of wave.

OR

(i) Find the magnetic field at a distance r from infinitely long straight wire carrying time varying current I(t).
(ii) Determine induced Electric field using Faraday's law.

[4+3]

Q.4 (i) What is meant by acceptance angle for an optical fibre? Show how it is related to numerical aperture?
(ii) Explain how glass fibre guides light from one end to the other? (iii) A glass clad fibre is made with core glass of refractive index 1.5 and the cladding is doped to give a fractional index difference of 0.0005. Find,
(i) the cladding index
(ii) the critical internal reflection angle
(iii) the external critical acceptance angle
(iv) the numerical aperture
[3+3+1]

Q.5 (i)Further, obtain an expression for normalized wavefunction by applying appropriate boundary conditions. Obtain an expression for energy eigen values for a particle confined in one dimensional potential box of length L. It is given that V=0 inside the potential well and V=∞ outside it.
(ii) Discuss properties of wavefunction.
[5+2]

Q.6 (i) Explain, why we require two gases in case of He-Ne laser. With the help of clean and neat diagram explain the working principle of He-Ne LASER.
(ii) What is a superconductor. Distinguish between type-1 and type-2 superconductors.

[4+3]

Q.7 (i) What is a periodic potential? Explain Bloch theorem.
(ii) Comment on following properties of LASER
(a) Directionality (b) Divergence (c) Monochromaticity (d) Population inversion, why it is important in connection with LASER.
[5+2]