FIBRE OPTICS

1. What do you mean by splicer and connector? Give one example of each. (2) {JUN 15 [GNE]}
2. Why single mode fiber is preferred for long distance communication? (2) {JUN 15 [GNE]}
3. Define and derive expression for numerical aperture. Hence explain why numerical aperture is small for a graded index fiber in comparison to an identical step index fiber. (4) {JUN 15 [GNE]}
4. Write names of various losses taking place in the optical fiber. If the length of optical fiber is 2km and output power is 1/100 of input power, then find fiber loss and attenuation coefficient. (4) {JUN 15 [GNE]}
5. Why do we prefer small numerical aperture for long distance communication? (2) {DEC 14 [GNE]}
6. Differentiate single mode and multimode fiber. (2) {DEC 14 [GNE]}
7. Define acceptance angle and numerical aperture and hence derive mathematical relation between the two. (4) {JUN 14 [GNE]}
8. The core of a glass fiber has refractive index 1.5, while its cladding is doped to give a fractional change in refractive index equal to 0.005. Find (i) refractive index of clad (ii) critical internal reflecting angle (iii) acceptance angle and (iv) numerical aperture. (4) {JUN 14 [GNE]}
9. Why data carrying capacity of optical fiber is more than that of radio waves? (2) {JUN 14 [GNE]}

10. Find the numerical aperture of an optical fiber, whose core and clad have refractive index respectively 1.46 & 1.45. (2) {Dec 2013 [GNE]}
11. Define acceptance angle and derive mathematical relation for it. (4) {Dec 2013 [GNE]}
12. Find the core radius necessary for SMF for propagation of wavelength of 850nm and core and clad refractive index respectively as 15.0 & 1.49. (4)
13. Specify an application where Laser and optical fiber are used together. (2) {Jun 2013 [GNE]}
14. What do you mean by acceptance cone for an optical fiber? (2) {Jun 2013 [GNE]}
15. A step index fiber with refractive index of 1.458 and numerical aperture of 0.3 is to be used at 820nm. Find the core radius if the normalized frequency is 75. (3) {Jun 2013 [GNE]}
16. What are splicers and couplers? (2) {Dec 2012 [GNE]}
17. What is the principle of optical fibre? Discuss various applications of optical fibres. (4) {Dec 2012 [GNE]}
18. Calculate the numerical aperture and acceptance of an optical fibre with $n_1 = 1 \cdot 50 \,\&\, n_2 = 1 \cdot 45$. (4) {Dec 2012 [GNE]}

LASERS

1. **Define laser.**
2. **What is the full form of laser?**
3. **What is the principle on which laser is based?**
4. **What are the characteristics properties of laser light?**
5. **Why laser beam diverges?**
6. **Differentiate spontaneous and stimulated emission.**
7. **Is stimulated emission a must condition for laser action to take place? Justify your answer.**
8. **What is population inversion?**
9. **How population inversion can be achieved?**
10. **What conditions are required for laser action to take place?**
11. **Define: Lifetime of a energy state.**
12. **Differentiate Normal Excited state and Metastable state.**
13. **What is pump? How many types of pump can be there?**
14. **What is optical pumping?**
15. **Why we use optical pumping for solid state lasers and electric discharge pumping for gaseous state lasers?**
16. **Comment on the following statements:**
    i. **Laser is a non equilibrium device.**
    ii. **Laser is a device with negative absorption coefficient.**
    iii. **Laser is a negative temperature device.**
    iv. **Gaseous state lasers are better than solid state lasers.**
17. **Explain the working of three level laser.**
18. **Explain the working of four level laser.**
19. **Why four level laser is better than three level laser, although its efficiency is least?**
20. **What is optical resonator?**
21. **What is the function of optical resonator?**
22. **In word LASER, letter A should be replaced by letter O. Comment.**
23. **Explain spiking in Ruby laser.**
24. **Why He and Ne gases are mixed together in He-Ne laser?**
25. **What is the basic difference between He-Ne laser and CO_2 laser? (in terms of energy levels and output).**
26. **What is the role of He atoms in CO_2 laser?**
27. **Write the wavelengths obtained in the following lasers:**
    i. **Ruby laser**
    ii. **He-Ne laser**

iii. CO_2 laser
iv. Diode laser

28. Why diode laser is preferred for communication purposes?
29. Write applications of lasers.
30. Write applications of lasers in engineering.
31. Define coherence. Name its types.
32. Explain different types of coherence.
33. What is the significance of temporal coherence?
34. What is the significance of spatial coherence?
35. Discuss the principle, theory, construction and working of Ruby laser.
36. Discuss the principle, theory, construction and working of He-Ne laser.
37. Discuss the principle, theory, construction and working of CO_2 laser.
38. Write short note on diode laser.
39. Discuss in detail the applications of CO_2 laser.
40. Derive the relationship amongst various Einstein Coefficients and discuss the result obtained.
41. Define various Einstein Coefficients. Give their units and significance. Discuss Einstein Theory of matter and radiation. What are the conditions for lasing action to take place?

QUANTUM MECHANICS

1. If the mass of a neutron is $1\cdot 66\times 10^{-27}\,kg$, then find the de-Broglie wavelength at 300K. (Given $k = 1\cdot 38\times 10^{-38}\,JK^{-1}$) (2) {JUN 15 [GNE]}
2. A wavefunction of a particle in a one dimensional box of length L is given as $\Psi(x) = \sqrt{\frac{2}{L}}\sin\left(\frac{n\pi x}{L}\right)$; n = integer. Show that this wave function satisfies one dimensional time independent Schrodinger equation. Given that $E = \frac{n^2\pi^2\hbar^2}{2mL^2}$ and U = 0. (4) {JUN 15 [GNE]}
3. Define wavefunction. Give its significance and write conditions for a wavefunction to be well behaved. (4) {JUN 15 [GNE]}
4. Why a particle trapped in a box cannot be at rest? (2) {JUN 15 [PTU]}
5. What is the matter wave associated with a moving particle? Derive expression for phase and group velocities of such a wave packet. (4) {JUN 15 [PTU]}
6. Give a brief account of need and origin of quantum mechanics. (4) {JUN 15 [PTU]}
7. Derive expression for time independent Schrodinger wave equation. (4) {DEC 14 [GNE]}
8. Derive relation between group velocity and phase velocity. Hence discuss the cases of normal and anomalous dispersion. Which dispersion is must for group velocity to be less than velocity of light? (4) {DEC 14 [GNE]}
9. What are essential conditions for a wave function to be well behaved? (2) {DEC 14 [PTU]}
10. Discuss the formation of wave packet and hence prove that particle velocity is equal to the group velocity. (4) {JUN 14 [GNE]}
11. Calculate the energy Eigen values and Eigen functions for the motion of a particle in one dimensional box. (4) {JUN 14 [GNE]}
12. Can $\psi(x) = x^2$ be an acceptable wave function in quantum mechanics? (2) {JUN 14 [GNE]}
13. Calculate the de-Broglie wavelength associated with electrons, which are accelerated by a voltage of 50kV. (3) {JUN 14 [PTU]}
14. Solve Schrodinger equation for a particle confined to an infinite potential box of width L in order to derive the expression for energy eigen values. (5) {JUN 14 [PTU]}
15. What is the physical significance attached to the conditions of continuity and single valued nature of an acceptable wavefunction? (2) {JUN 14 [PTU]}
16. What do you understand by wave particle puzzle? (2) {Dec 2013 [PTU]}
17. Derive time dependent Schrodinger equation and discuss its significance in today's context. (4) {Dec 2013 [PTU]}
18. What is de-Broglie hypothesis. (2) {Dec 2013 [PTU]}

19. An electron is bound in one dimensional box of size $4\times10^{-10}\,m$. What will be the minimum energy? (2) {Dec 2013 [PTU]}
20. At time t = 0, a particle is represented by a wave function

$$\Psi(x)=\begin{cases} A\dfrac{x}{a} & \text{for } 0\le x\le a \\ A\dfrac{(b-x)}{(b-a)} & \text{for } a\le x\le b \\ 0 & \text{elsewhere} \end{cases}$$

; where A, a and b are constants.

(i) Normalize $\Psi(x,0)$

(ii) Sketch $\Psi(x,0)$ as a function of x.

(iii) Where is the particle most likely to be at t = 0 ?

(iv) What is the probability of finding the particle to the left of x = a at t = 0? (4) {Dec 2013 [PTU]}

21. Calculate the energy eigen values and eigen functions for the motion of a particle confined in a 1-D box. (4) {Dec 2013 [GNE]}
22. At a certain time, the normalized wave function of the particle moving along the X-axis is given by: $\Psi(x)=\begin{cases} x+\beta & \text{for } -\beta<x<0 \\ -x+\beta & \text{for } 0<x<\beta \\ 0 & \text{elsewhere} \end{cases}$. Find the value of β and the probability that the particle's position is between $x=\dfrac{\beta}{2}$ & $x=\beta$. (4) {Dec 2013 [GNE]}
23. Differentiate between phase velocity and group velocity. (2) {Jun 2013 [PTU]}
24. Obtain Bohr's condition of quantization of angular momentum using de Broglie's idea of matter waves. (3) {Jun 2013 [PTU]}
25. Write the expression of normalized wave function for a particle confined in a potential box. (2) {Jun 2013 [GNE]}
26. Find the probability of finding a particle in a region $0\cdot4L$ to $0\cdot6L$ trapped in an infinite potential well of width L. (4) {Jun 2013 [GNE]}
27. Derive an expression for energy of a particle of mass m confined to infinite potential well of width L. Why such a particle cannot have zero energy? (4) {Jun 2013 [GNE]}
28. What do you understand by wave-particle duality? (2) {Dec 2012 [GNE]}
29. A particle of mass m is confined to move inside an infinite potential well described by following function:

$$V(x)=\begin{cases} +\infty & \text{for } x<a \\ 0 & \text{for } 0\le x\le a \\ +\infty & \text{for } x>a \end{cases}$$

Calculate the wave function and energy of the particle. (4) {Dec 2012 [GNE]}

30. What do you understand by wave packet? (2) {Dec 2012}

31. Develop time independent Schrodinger equation and discuss its significance. (5) {Dec 2012}
32. What are matter waves? (2) {June 2012}
33. Compute the de-Broglie wavelength of a proton of wavelength whose kinetic energy is equal to the rest energy of an electron. Given that mass of proton is 1840 times the mass of electron. (4) {June 2012}
34. What do you mean by normalization of a wave function? (4) {June 2012}
35. Calculate the wave number of 10keV neutron. (3) {Dec 2011}
36. What is the significance of wave function? (2) {June 2011}
37. Derive an expression for time dependent Schrodinger wave equation. (6) {June 2011}
38. What is the energy of Gamma ray having wavelength of $1\mathring{A}$? (2) {June 2011}
39. What is de-Broglie's hypothesis? (2) {Dec 2010}
40. What is Born's interpretation of wave function? (2) {Dec 2010}
41. What is the difference between phase velocity and group velocity? Show that the de-Broglie group velocity associated with the wave packet is equal to the velocity of the particle. (6) {Dec 2010}
42. Why $n = 0$ state is not allowed for a particle confined to an infinite potential box? (2) {June 2010}
43. What is the physical significance attached to the conditions of continuity and single valued nature of an acceptable wave function? (2) {June 2010}
44. Establish time dependent Schrodinger wave equation and further deduce tie independent equation from it. (4) {June 2010}
45. What are the characteristics of a well behaved wave function? (2) {June 2010}
46. Find the probability of a particle trapped in a box of length L to be found in the region $0 \cdot 45L \; to \; 0 \cdot 55L$ for the ground state. (2) {June 2010}
47. Differentiate between phase velocity and group velocity. (2) {Dec 2009}
48. Define wave function and obtain the expression for time dependent Schrodinger wave equation. (4) {Dec 2009}
49. Define Eigen values and Eigen functions. (2) {June 2009}
50. Define wave function and calculate the expression for Time Independent Schrodinger wave equation. (4) {June 2009}
51. Distinguish between phase and group velocity. (2) {Dec 2007}
52. If the energy of a particle is zero, then prove using quantum mechanics that it cannot exist in a one dimensional box. (4) {Dec 2007}
53. What do you mean by matter waves? (2) {May 2007}
54. What is the de Broglie wavelength of an electron, which has been accelerated from rest through a potential difference of 150V? (3)
55. Explain de Broglie concept of matter waves. (2) {May 2006}
56. Write the Schrodinger equation for particle in a box and solve it to obtain energy Eigen values and Eigen functions. (6) {May 2006}
57. What voltage must be applied to an electron to produce electrons of wavelength $0 \cdot 5\mathring{A}$? Given that $h = 6 \cdot 62 \times 10^{-34} Js$, $e = 1 \cdot 6 \times 10^{-19} C$ & $m = 9 \cdot 1 \times 10^{-31} kg$. (2) {Dec2005}
58. What is the physical significance of wave function? (2) {Dec2005}

59. What do you understand by Eigenvalues and Eigen functions? (2) {May 2005}
60. What is the need for quantum mechanics? Discuss the Born's interpretation of wave function and normalization of the wave function. (2,2) {May 2005}
61. At a certain time, the normalized wave function of the particle moving along the X-axis is given by: $\Psi(x) = \begin{cases} x+\beta & \text{for } -\beta < x < 0 \\ -x+\beta & \text{for } 0 < x < \beta \\ 0 & \text{elsewhere} \end{cases}$. Find the value of β and the probability that the particle's position is between $x = \frac{\beta}{2}$ & $x = \beta$. (4) {May 2005}
62. Can every physical system be described by the time independent Schrodinger equation? Comment. (2) {May 2004}
63. Find the ground state energy of an electron confined to a one dimensional rigid box of length $1\mathring{A}$. (2)
64. What is the utility of normalization of wave function? (2) {Dec2003}

QUANTUM MECHANICS

1) An electron beam is accelerated from rest through a potential difference of 200 V
   a) Calculate the associated de-Broglie wavelength
   b) This beam is passed through a diffraction grating of spacing 3Å. At what angle of deviation from the incident direction will be first maximum observed?
2) An enclosure is filled with helium is heated at 400 K. A beam of He- atoms emerges out of the enclosure. Calculate de-Broglie wavelength corresponding to He-atoms, if mass of He is 6.7×10^{-27} Kg
3) Find the de-Broglie wavelength of
   a) An electron accelerated through a potential difference of 200 V.
   b) A 1 Kg object is moving with speed 1 m/sec compare the results and explain why wave nature of matter is not more apparent in daily observations
4) Find the probability of a particle trapped in a 1-dimensional box of length between 0.45L and 0.55L for the ground state energy level
5) An electron is confined to move in a 1-dimensional box of length 5Å. Find the quantized energy values for the lowest three energy states. Express the results in eV.
6) Find the lowest energy of an electron confined to move in a 1-dimensional box of length 1Å.
7) An electron is confined to move between two rigid walls separated by 1 nm. Find the de-Broglie wavelength representing first two allowed energy states of the electron & the corresponding energies.

(5) (b) Length of box = 5Å

$$E_n = \frac{n^2h^2}{8mL^2}$$

for ground state n=1

$$E_1 = \frac{h^2}{8mL^2}$$

$$E_1 = \frac{(6.63\times10^{-34})^2}{8\times9.1\times10^{-31}\times(5\times10^{-10})^2}$$

$$E_1 = 0.024\times10^{-17}\ J.$$

$$E_1 = \frac{0.027\times10^{-17}}{1.6\times10^{-19}}\ eV$$

$$= 0.01509\times10^{2}\ eV$$

$$E_1 = 0.151\ eV$$

$$E_2 = 4E_1 = 0.604\ eV$$

$$E_3 = 9E_1 = 1.359\ eV.$$

(6) The lowest energy of electron confined in a 1-dim box is the energy for ground state

ie $E_1 = \frac{h^2}{8mL^2}$

L = 1Å

$$E_1 = \frac{(6.63\times10^{-34})^2}{8\times9.1\times10^{-31}\times(1\times10^{-10})^2}$$

$$E_1 = 0.6038\times10^{-17}\ J$$

$$E_1 = \frac{0.6038\times10^{-17}}{1.6\times10^{-19}}\ eV$$

$$= 0.3773\times10^{2}\ eV$$

$$= 37.73\ eV$$

(2) De Broglie wavelength $\lambda = \frac{h}{\sqrt{3mkT}}$

$K = 1.38 \times 10^{-23}$ J/K.

$m = 6.7 \times 10^{-27}$ kg , $T = 400$ K.

$$\lambda = \frac{6.63 \times 10^{-34}}{\sqrt{3 \times 6.7 \times 10^{-27} \times 1.38 \times 10^{-23} \times 400}}$$

$$= \frac{6.63 \times 10^{-34}}{\sqrt{110.95 \times 10^{-48}}}$$

$$= 0.629 \times 10^{-10}$$

$$= 0.629 \text{ Å}$$

(3) a) Pot diff $= 200$V

$$\lambda = \frac{12.28}{\sqrt{200}} = 0.868 \text{ Å}$$

b) The mass of object $= 1$ kg

velocity " " $= 1$ m/sec

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

$$= \frac{6.63 \times 10^{-34}}{1 \times 1}$$

$$\lambda = 6.63 \times 10^{-34} \text{ m.}$$

The de-Broglie wavelength of $\bar{e}$ is about 10^5 times larger than its size ($\sim 10^{-15}$ m) & therefore it is significant & observable.

On the other hand the wavelength of object that is of mass 1kg or mesoscopic object is negligibly small & it is not apparent.

(4) The Probability to find the particle in 1-dim box is given by

$$P = \frac{2}{L}\int_{x_1}^{x_2} \sin^2\left(\frac{n\pi x}{L}\right) dx$$

For ground state $n=1$

$$P = \frac{2}{L}\int_{0.45L}^{0.55L} \sin^2\left(\frac{\pi x}{L}\right) dx$$

$$= \frac{\cancel{2}}{L}\int_{0.45L}^{0.55L} \underbrace{\left(1 - \cos\frac{2\pi x}{L}\right)}_{\cancel{2}} dx$$

$$= \frac{1}{L}\left[x - \frac{\sin(2\pi x/L)}{2\pi/L}\right]_{0.45L}^{0.55L}$$

$$= \frac{1}{L}\left[0.1L - \left\{\frac{1}{2\pi/L}\left[\sin 2\pi(0.55L/L) - \sin 2\pi\left(0.\frac{45L}{L}\right)\right]\right\}\right]$$

$$= \frac{1}{\cancel{L}}\left[0.1\cancel{L} - \frac{\cancel{L}}{2\pi}\left\{\sin 2\pi(0.55) - \sin 2\pi(0.45)\right\}\right]$$

$$= 1\left[0.1 - \frac{1}{2\pi}\left\{\sin\left(\pi.\frac{11}{10}\right) - \sin\left(\pi.\frac{9}{10}\right)\right\}\right]$$

$$= \left[0.1 - \frac{1}{2\pi}\left\{\sin\left(\pi + \frac{\pi}{10}\right) - \sin\left(\pi - \frac{\pi}{10}\right)\right\}\right]$$

$$= \left[0.1 - \frac{1}{2\pi}\sin\left(-\frac{\pi}{10}\right) - \sin\left(\frac{\pi}{10}\right)\right]$$

$$P = 0.198$$

This is the required probability.

(7) The distance of separation b/w walls = 1 nm

$$E_n = \frac{n^2 h^2}{8mL^2}$$

For $n = 1$ & 2

$$E_1 = \frac{h^2}{8mL^2}$$

$$E_2 = 4E_1$$

$$E_1 = \frac{h^2}{8mL^2} = \frac{(6.63 \times 10^{-34})^2}{8 \times 9.1 \times 10^{-31} \times (1 \times 10^{-9})^2}$$

$$= 0.6038 \times 10^{-19} \text{ J}$$

$$E_1 = \frac{0.6038 \times 10^{-19}}{1.6 \times 10^{-19}} \text{ eV}$$

$$E_1 = 0.3773 \text{ eV}$$

$$E_2 = 1.5095 \text{ eV}$$

De-Broglie wavelength is $\lambda = \frac{h}{\sqrt{2mE}}$

Corresponding to E_1, $\lambda_1 = \frac{h}{\sqrt{2 \times 10^{-31} \times 9.1 \times 0.6038 \times 10^{-19}}}$

$$= 0.8532 \times 10^{-9} \text{ m}$$

$$\lambda_1 = 8.532 \text{ Å}$$

λ_2 corresponding to $E_2 = \frac{h}{\sqrt{2m(4E_1)}}$

$$\lambda_2 = 4.266 \text{ Å}$$

1) Pot diff $V = 200$ Volts

De-Broglie wavelength $\lambda = \frac{12.28}{\sqrt{V}}$ Å

$$\lambda = \frac{12.28}{\sqrt{200}} = \frac{12.28}{14.14}$$

$$= 0.868 \text{ Å}$$

b) The grating spacing, $d = 3$ Å

Condition for diffraction maxima is

$$2d \sin\theta = n\lambda.$$

for Ist order maxima; $n = 1$

$$2d \sin\theta = \lambda$$

$$\lambda = 0.868 \text{ Å}$$

$$2(3) \sin\theta = 0.868$$

$$\sin\theta = \frac{0.868}{6} = 0.1447$$

$$\theta = 8.38^\circ.$$

Please check that this question paper contains 09 questions and 02 printed pages within first ten minutes.

[Total No. of Pages: 02]

[Total No. of Questions:09]

MORNING

Uni. Roll No. .....

10 MAY 2019

Program/ Course: B.Tech. (Sem 1st/2nd)

Name of Subject: Physics

Subject Code: BSC-101

Paper ID: 15925

Max. Marks:60

Time Allowed: 03Hours

NOTE:

1) **Parts Aand B are compulsory**
2) **Part-C** has two Questions Q8 and Q9. Both are compulsory, but with internal choice
3) Any missing data may be assumed appropriately
4) Use of scientific calculator is allowed

[Marks: 02 each]

Part – A

Q1.

a) Define Hooke's law.

b) Calculate energy of an electron which is moving in 1-D box of width 1 Å. Consider the electron to be in first excited state.

c) Intrinsic semiconductors behave as insulators at 0K. Comment.

d) What are nanomaterials? How can we classify them?

e) Give physical significance of Poynting vector.

f) In word LASER, **A** should be replaced by **O**. Comment.

[Marks: 04 each]

Part – B

Q2. Derive time independent Schrodinger equation for the 1-D motion of a restricted particle. Also give the shortcomings of Schrodinger equation, if any.

Q3. Write short note on (i) Dielectric materials (ii) Ferromagnetic materials.

Q4. What are oscillations? Explain briefly free oscillations, damped oscillations and forced oscillations.

Q5. Show that for intrinsic semiconductors, Fermi level lies in the middle of energy gap.

Q6. In a given laser, total number of lasing particles is 2.8×10^{19}. If laser emits a wavelength of 6328 Å, then calculate the energy of one photon being emitted by the laser. If the laser beam is focused on an area equal to the square of its wavelength for 1s, find intensity of the focused beam. Assume the efficiency of laser to be 100%.

Q7. The scalar potential at a point is given by $V = 2x-4xy+3z^2$. Find electric field intensity vector and then check whether the field vector is solenoidal or not.

[Marks: 12 each]

Part – C

Q8. (a) Derive the differential form of Gauss law of electrostatics and Gauss law of magnetostatics. Give significance of each equation.

(b) Derive mathematical relation amongst Einstein coefficients and find condition(s) for lasing action to take place. Also find the units of Einstein coefficients.

P.T.O

MORNING

10 MAY 2019

(c) Enlist various losses taking place in an optical fibre.

or

(a) Derive Maxwell's electromagnetic (em) wave equation for free space and show that speed of em waves in free space is $3x10^8$ m/s.

(b) Why four level laseris better than three level laser? Explain the construction and working of any four-level laser. Trace well labelled energy level diagram(s) for the same.

(c) Find acceptance angle, numerical aperture, critical angle and V-number of the optical fibre from the data given below:
Refractive index of core = 1.48, Fractional change in refractive index = 0.005, core radius 'a' = 50 μm, wavelength of radiation λ = 850 nm. Check whether the fibre is single mode or multimode.

Q9. (a) The instantaneous displacement of a particle executing SHM is given by $y=A \sin(\omega t + \phi)$. If the displacement of the particle at t=0 be y_o and the velocity at t=0 be v_o, then find the values of A and ϕ. Symbols have their usual meanings.

(b) Apply time independent Schrodinger equation to discuss the motion of a particle in 1-D box. Find eigen wavefunctions and energy eigen values of the moving particle.

(c) An electron and proton are moving with same speed. Which particle will be having large value of de-Broglie wavelength and why?

or

(a) Develop equation of motion of SHM. Find expression for time period, potential energy, kinetic energy and total energy of SHM.

(b) Derive London equations for Type I superconductors. Show that no electric field is required for steady current to flow through a superconductor. Using these equations, explain the concepts of flux penetration and flux expulsion.

(c) Find the wavelength of a photon which can break a Cooper pair if the critical temperature of a superconductor is 5K.

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[Total No. of Questions: 09] [Total No. of Pages: 02]

Uni. Roll No. …….

Program/ Course: B.Tech. (Sem. 1/2)
Name of Subject: Physics
Subject Code: BSC-18101
Paper ID: 15925

Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1) **Parts A** and B are **compulsory**
2) **Part-C** has Two Questions Q8 and Q9. Both are compulsory, but with internal choice
3) Any missing data may be assumed appropriately
4) Use of scientific calculator is allowed

Part – A [Marks: 02 each]

Q1.

a) Define polarization of light. Enumerate various types of polarization.
b) Explain spiking in Ruby laser.
c) How can we increase the conductivity of intrinsic semiconductors?
d) Differentiate damped and undamped oscillations.
e) Explain factors responsible for change in properties when we change from bulk to nanoscale.
f) What is dispersion relation? Give its mathematical expression and discuss various cases of dispersion.

Part – B [Marks: 04 each]

Q2. Write short notes on (i) Magnetic Anisotropy (ii) Magnetostriction.

Q3. Differentiate intrinsic and extrinsic semiconductors. Discuss the position of Fermi level in both cases.

Q4. Derive the differential equation for harmonic oscillator. Also show that total energy of the harmonic oscillator is constant at any instant of time.

Q5. The electric potential in a certain region of space is given by $V(x,y,z) = 20x^2+10y+5z^3$. Find the electric field intensity vector? Check the field thus obtained is (i) uniform (ii) solenoidal.

Q6. Wave function of a particle in 1-D box of length L is given as

$$\Psi(x) = \sqrt{\frac{2}{L}}\sin\left(\frac{n\pi x}{L}\right) \text{ ; n = integer}$$

Show that this wave function satisfies 1-D time independent Schrodinger equation. Given that $E = \frac{n^2\pi^2\hbar^2}{2mL^2}$ and U = 0.

Q7. Derive London equations of superconductivity. Hence explain Meissner effect and flux penetration using the same.

Part – C **[Marks: 12 each]**

Q8. (i) Show that electromagnetic waves are transverse in nature.

(ii) A beam of plane electromagnetic waves is travelling in vacuum in an arbitrary direction. The magnitude of electric field component of the wave changes according to the relation $E = E_0 Sin(\omega t - \vec{k}\cdot\vec{r})$, where $E_0 = 15\times10^{-5} NC^{-1}$, $\vec{k}$ is propagation vector, $\vec{r}$ is a vector along the direction of propagation and ω is angular frequency of the electromagnetic wave. This beam is incident at an angle of 60° on a small surface having area $5\times10^{-6} m^2$. Find the amount of energy received by the surface in 3milliseconds.

OR

(i) Discuss the working of He-Ne laser and CO_2 laser using well labeled diagrams?

(ii) Define acceptance angle and numerical aperture. Find their mathematical expressions. A step index fibre having length 2km is found to have n_1=1.55 and n_2=1.50. Find acceptance angle and numerical aperture of the fiber. If the radius of the core is 15 μm and the wavelength of the carrier is 850 nm, then check whether the fiber is SMF or MMF.

Q9. (i) Discuss the formation of wave packet. Define phase velocity and group velocity and show that group velocity is always equal to the particle velocity.

(ii) Find points of maximum probability for particle moving in 1-D box of width L present in first excited state.

(iii) Define Hooke's law for a three dimensional body and give its utility in daily life.

OR

(i) What are ferrimagnetic substances, ferromagnetic substances and ferrites? Give some important applications of ferrites.

(ii) Discuss in detail applications and risks involved in the use of nanomaterials.

(iii) If the critical magnetic field for a superconductor at 0K is $10^4 A/m$ and the radius of wire is 3mm, then find the value of critical current for superconductor at 0K (Assume that there is no external magnetic field).

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C2/116

Please check that this question paper contains 09 questions and 02 printed pages within first ten minutes.

[Total No. of Questions: 09] [Total No. of Pages: 02]

Uni. Roll No. .....

30/11/2019 (M)

Program: B.Tech. (Batch 2018 onward)
Semester: 1st /2nd
Name of Subject: Physics
Subject Code: BSC-101
Paper ID: 15925

Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1) Parts A and B are compulsory
2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice
3) Any missing data may be assumed appropriately

Part – A **[Marks: 02 each]**

Q1.

a) Write Maxwell's equations in differential form.

b) What is the need to achieve population inversion ?

c) Differentiate between undamped oscillator and damped oscillator.

d) Write short note on extrinsic semiconductors.

e) Why the quantum number n=0 is not possible for particle moving in one dimensional box?

f) What are the conditions for a material to be superconductor?

Part – B **[Marks: 04 each]**

Q2. Deduce London equations and define London penetration depth.

Q3. Define acceptance angle and derive mathematical expression for the same.

Q4. Find the constants a,b and c such that the vector field

$\vec{F} = (x+2y+az)\,\hat{i} + (bx-3y-2)\,\hat{j} + (4x+cy+2z)\,\hat{k}$ is **irrotational.**

Q5. A damped oscillator is subjected to a damping force proportional to its velocity. Set up the differential equation of the oscillation. Discuss the case of critically damped motion.

30/11/2019 (M)

Q6. Apply time independent Schrondinger equation to study the motion of a particle confined in a one dimensional box of length L. Hence find energy eigen values associated with the motion.

Q7. Drive an expression for Fermi energy in intrinsic semiconductor.What is the effect of temperature on Fermi level in an intrinsic semiconductor.

Part – C **[Marks: 12 each]**

Q8. (i) Derive mathematical relationship amongst Einstein coefficients and discuss the results thus obtained. Also find the ratio of rate of spontaneous emission to rate of stimulated emission at 300K corresponding to emission of green light photon with λ = 550 nm.

(ii) A manufacturer wishes to make a silica core, step index fiber with V= 75 and numerical aperture NA=0.30 to be used at 820nm. If n_1=1.458, what should the core size and cladding index be? Also find the value of critical angle and acceptance angle of the given fiber.

OR

(i) Deduce em wave equation for free space and prove that the electromagnetic waves are transverse in nature.

(ii) In an electric field the electric potential is given by $V(x,y,z) = (4x^2 + 3y^2 + 9z^2)^{-1/2}$. Calculate the electric field at point (1,1,1).

Q9. (i) Distinguish between the phase velocity and group velocity. Derive dispersion relation and discuss various cases possible.

(ii)Find the probability that a particle in a box L wide can be found between 0.45Land 0.55L for the ground and first excited states.

(iii) What do you understand by free oscillations and forced oscillations?

OR

(i) State and explain Meissner effect using London equations.

(ii) Write some important applications and risks of nanomaterials.

(iii) Penetration depth for a sample at 6K and 7K is 41.2nm and 180.3nm respectively. Calculate its transition temperature and the penetration depth at 0K .

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GURU NANAK DEV ENGINEERING COLLEGE
GILL PARK, GILL ROAD, LUDHIANA

MST-I

Subject Name:-Physics (BSC-18101) ***Max. Marks: 24***
Section:- CE12,CE56 ***Semester-2nd*** ***Time: 90 Minutes***

Note:- (i) All questions are compulsory.
(ii) Marks for each question are shown in the brackets.
(iii) Use of calculator is allowed.

Q.1. Write Maxwell's Electromagnetic equations for vacuum. ***(2)***

Q.2. What makes laser light different from normal? ***(2)***

Q.3. A step-index fiber has a core index of refraction 1.425.
The cut-off angle for light entering the fiber from air is found to be 8.50^{o}.
(a) What is the numerical aperture of the fiber?
(b) What is the index of refraction of its cladding?
(c) Find the Fractional Refractive Index change.
(d) If the fiber were submersed in water, what would be the new cut-off angle at the launching end of fiber? ***(4)***

Q.4. Explain the working of a Continuous Wave (CW) laser. ***(4)***

Q.5. Derive Maxwell's Electromagnetic equation from Faraday's Law of EM Induction. ***(4)***

Q.6. **(a)** Write the statements of Gauss Divergence Theorem and Stoke's Curl Theorem. ***(2)***
(b) Give brief significance of Einstein coefficients and show how they are related. ***(3)***
(c) What causes most fiber optic attenuation and propagation losses? ***(3)***

Guru Nanak Dev Engineering College, Ludhiana			
Department of Applied Sciences			
Program	B.Tech.(ME1,ME2, ME5,ME6)	**Semester**	2
Subject Code	BSC-18101	**Subject Title**	Engg. Physics
Mid Semester Test (MST) No.	1	**Course Coordinator(s)**	Dr Harpreet Kaur Grewal
Max. Marks	24	**Time Duration**	1 hour 30 minutes
Date of MST	23rd February, 2019	**Roll Number**	

Note: Attempt all questions

Q. No.	Question	Marks
Q1	Differentiate Stimulated Emission and Spontaneous emission?	2
Q2	In LASER, in place of 'A', it should be 'O' Why?	2
Q3	Explain the terms Acceptance angle and Figure of Merit. What do you mean by single mode and multimode fiber?	4
Q4	An optical fiber has NA of 0.15 and cladding refractive index is equal to 1.50.Find NA of the fiber in a liquid of refractive index 1.30.	4
Q5	Discuss the variation of Fermi Level with temperature for extrinsic semiconductor.	4
Q6	(a) Explain the energy level diagram of He- Ne Laser and what is the role of helium in He-Ne Laser?	6
	(b) What do you mean by Extrinsic Semiconductor?	2

GURU NANAK DEV ENGINEERING COLLEGE
GILL PARK, GILL ROAD, LUDHIANA

MST-I

Subject Name:-Physics (BSC-18101) ***Max. Marks: 24***
Section:- PE12 ***Semester-2nd*** ***Time: 90 Minutes***

Note:- (i) All questions are compulsory.
(ii) Marks for each question are shown in the brackets.
(iii) Use of calculator is allowed.

Q.1. What is meant by Inverted Population in laser? ***(2)***

Q.2. Calculate the de-Broglie wavelength of a virus particle accelerated by a potential difference of 30,000V. ***(2)***

Q.3. Describe the construction and working of Helium Neon laser. ***(4)***

Q.4. Show that how group velocity is related to phase velocity. ***(4)***

Q.5. Write a note on attenuation & propagation loss mechanisms in fibres. ***(4)***

Q.6. (i) Define acceptance angle for an optical fibre. Show that it is related to numerical aperture. ***(5)***
(ii) An optics fibre is made of glass with refractive index 1.55 and is clad with another glass of refractive index 1.51. The fibre has a core of diameter 50μm and is used at a light wavelength of 0.8 μm. Determine:
(a) Numerical aperture (b) Acceptance angle (c) V-number for the fiber. ***(3)***

Guru Nanak Dev Engineering College, Ludhiana			
Department of Applied Sciences			
Program	B.Tech.**(CE34)**	**Semester**	2
Subject Code	BSC-18101	**Subject Title**	Physics
Mid Semester Test (MST) No.	1	**Course Coordinator(s)** **Subject Expert**	Dr Harpreet Kaur Grewal Dr Randhir Singh
Max. Marks	24	**Time Duration**	1 hour 30 minutes
Date of MST	23rd Feb, 2019	**Roll Number**	

Note: Attempt all questions

Q. No.	**Question**	**Marks**
Q1	A vector field is given as : $\vec{A} = xy\hat{i} + yz\hat{k}$. Find $\vec{\nabla}\times\vec{A}$ and tell whether the field is conservative or not.	2
Q2	Define Poynting vector. Give its significance.	2
Q3	Define Meissner effect and differentiate type-I, type-II superconductors.	4
Q4	Derive London equations and give their significance.	4
Q5	The critical magnetic field for a superconductor at absolute zero is $9\times10^4\,Am^{-1}$ and at 6K is $5\times10^4\,Am^{-1}$. Find the critical temperature and energy required to break Cooper pair at absolute zero.	4
Q6	(i) Show that for plane electromagnetic waves propagating in vacuum, electric field is perpendicular to magnetic field as well as to direction of propagation. (ii) Write Maxwell's equations and give their significance.	5 3

Guru Nanak Dev Engineering College, Ludhiana			
Department of Applied Sciences			
Program	B.Tech.**(ME34)**	**Semester**	2
Subject Code	BSC-18101	**Subject Title**	Physics
Mid Semester Test (MST) No.	1	**Course Coordinator(s)** **Subject Expert**	Dr Harpreet Kaur Grewal Dr Randhir Singh
Max. Marks	24	**Time Duration**	1 hour 30 minutes
Date of MST	23rd Feb, 2019	**Roll Number**	

Note: Attempt all questions

Q. No.	**Question**	**Marks**
Q1	A vector field is given as : $\vec{A} = xy\hat{i} + yz\hat{k}$. Find $\vec{\nabla}\times\vec{A}$ and tell whether the field is conservative or not.	2
Q2	Define Poynting vector. Give its significance.	2
Q3	Define stress and strain and give their types.	4
Q4	Discuss briefly, the motion of a lightly damped oscillator.	4
Q5	The displacement of a particle executing SHM is changing with time as $x=A\cos\omega_o t$. Find the displacement at which kinetic energy of the particle is equal to its potential energy.	4
Q6	(i) Show that for plane electromagnetic waves propagating in vacuum, electric field is perpendicular to magnetic field as well as to direction of propagation. (ii) Write Maxwell's equations and give their significance.	5 3

Make Up Exam Aug 2019 Physics.

[Total No. of Pages: 2]

[Total No. of Questions:09]

Uni. Roll No. .....

Program/ Course: B.Tech. (Sem. 2)
Name of Subject: Physics
Subject Code: BSC-101
Paper ID: 15925

Max. Marks:60

Time Allowed: 3 Hours

NOTE:

1) **Parts A** and B are **compulsory**
2) **Part-C** has two Questions Q8 and Q9. Both are compulsory, but with internal choice
3) Any missing data may be assumed appropriately
4) Use of scientific calculator is allowed.

Part – A **[Marks: 02 each]**

Q1.

a) Write the units of Poynting vector. What is represented by this vector?
b) "Focusing of Laser light is better than the ordinary." Why?
c) What do you mean by Mechanical Impedance matching?
d) Find the de-Broglie wavelength of a 1.0 mg grain of sand blown by the wind at the speed of 20 m/sec.
e) What is the physical meaning of Fermi level?
f) How the surface to volume ratio changes with changing size of a Nanomaterial?

Part – B **[Marks: 04 each]**

Q2. With the help of necessary diagrams, explain the Energy levels for the working of any continuous wave (CW) laser.

Q3. Describe the role of fibre splicers and couplers in communication through optical fibers.

Q4. An optical fiber has a N.A. of 0.20 and a cladding refractive index of 1.59. Determine the acceptance angle for the fiber in water which has a refractive index of 1.33.

Q5. Explain the B.C.S. theory with key note of Cooper pairs in superconductors.

Q6. A wave packet propagates in a medium, which exhibits normal dispersion . Find the relationship between its phase velocity and group velocity.

Q7. Suppose an electromagnetic plane wave is moving in free space having electric field component of the form:

$\vec{E} = \hat{j}\, E_0 \gamma\left(\frac{2\pi x}{\lambda}\right) \sin \omega t$ where γ, ω and λ are constants. Determine the corresponding $\vec{H}$ field and its direction.

Part – C **[Marks: 12 each]**

Q8.

1) For a particular mass condition the position of the Fermi energy level for intrinsic semiconductor is below the center of the intermediate energy gap. Justify.

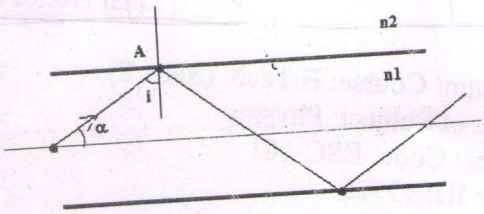
2) Show that equation of continuity $div.\vec{J} + \frac{\partial \rho}{\partial t} = 0$ is contained in Maxwell's Electromagnetic equation.

3) Compute the ratio of populations of the two states in a He-Ne laser that produces light of wavelength 6.328×10^{-5}cm at 27^0C.

or

1) An optical fiber of graded index type is made up of a core, where light travels, made of glass of refractive index $n_1 = 1.5$ surrounded by another layer of glass of lower refractive index n_2.

P.T.O



Find:

i. n_2 of the cladding so that the critical angle at the core cladding interface is 80°.

ii. Numerical Aperture of the fiber.

iii. V-parameter for core radius 50 μm and operating wavelength of 0.850 μm.

iv. Number of modes guided in the core.

2) For a three level laser system, explain the concept of transition probabilities and derive Einstein equations relating "A" and "B" coefficients.

3) Write a short note on semiconductor recombination.

Q9.

1) Consider a 1D box of length L/4 in which a particle is trapped. Find the particle wave-function and the corresponding energy for its 2nd excited state.

2) A damped oscillator is subjected to a damping force proportional to its velocity . Set up the differential equation of the oscillation. Discuss the under-damped, over-damped and critical damped motions of the oscillator.

3) What do you mean by Magnetic Domain? Using domain theory,explain why heating or dropping a magnet can cause it to lose its magnetization.

or

1) What are Nanoparticles, Nanotubes and Nanofilms? Are there any specific health or other risks from such nanoproducts?

2) At a certain time, the normalized wave function of a particle moving along X-axis has the form given by

$$\Psi(x) = \begin{cases} x+\eta \text{ for } -\eta < x < 0 \\ -x+\eta \text{ for } 0 < x < \eta \\ 0 \text{ elsewhere} \end{cases}$$

Find the value of η and probability that particle's position lies between $x = \eta/2$ and $x = \eta$.

3) What is penetration depth in superconductors? Derive the London differential equation describing the penetration of magnetic field into a superconducting surface.

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[Total No. of Questions: 09] [Total No. of Pages: 1]

Uni. Roll No. …….

Program: B.Tech.
Semester: 1,2 (2018)
Name of Subject: Physics
Subject Code: BSC-101
Paper ID: 15925

Time Allowed: 02 Hours **Max. Marks: 60**

NOTE:

1. Each question is of 10 marks.
2. Attempt any six questions out of nine
3. Any missing data may be assumed appropriately

06-07-21(M)

1. (i)What are Maxwell's equations? (2)
   (ii)Write down Maxwell's equations and state physical significance of each equation. (8)

2. (i)What is active medium, population inversion and optical pumping? (5)
   (ii)Give their importance in study of lasers. Why Helium is mixed with Neon in He-Ne laser? (5)

3. (i)Describe briefly the construction and working of an optical fibre. (5)
   (ii)What are the various kinds of losses, a light suffers while propagating through a fibre? (5)

4. (i)Distinguish between intrinsic and extrinsic semiconductors. (5)
   (ii)Discuss the location of Fermi levels under suitable limiting conditions with necessary theory. (5)

5. (i) Differentiate between group and phase velocities. Show that the group velocity of particle is equal to the velocity of the particle. (6)
   (ii)Calculate the velocity and de Broglie wavelength of a proton energy 10^5eV. Given that: mass of proton=1.66 $\times 10^{-34} g$; Planck's constant=6.6$\times 10^{-27} erg\ sec$; and charge on electron= 4.8$\times 10^{-10} e.s.u.$ (4)

6. Define a simple harmonic motion and derive a relation for velocity and acceleration of a particle executing S.H.M. (10)

7. Describe properties of diamagnetic, paramagnetic and ferromagnetic materials. (10)

8. Explain Meissner effect? Write some important applications of nanotechnology. (10)

9. (i)What do you understand by gradient of a scalar field? (4)
   (ii)Show that curl of grad ø =0, where ø is any scalar function. (6)

MORNING

12 MAR 2021

Please check that this question paper contains_____ questions and _____ printed pages within first ten minutes.

[Total No. of Questions: 09] [Total No. of Pages: 2]

Uni. Roll No. .....

Program: B.Tech. (Batch 2018 onward)
Semester: 1
Name of Subject: Physics
Subject Code: BSC-101
Paper ID: 15925

Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1) Parts A and B are compulsory
2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice
3) Any missing data may be assumed appropriately

Part – A **[Marks: 02 each]**

Q1.

a) What you understand by simple harmonic motion? Give examples.

b) What is the Physical signification of wave function ?

c) Differentiate between intrinsic and extrinsic semiconductors.

d) Write Maxwell's equations in differential form.

e) Describe how Laser radiation is different from ordinary light ?

f) What is the concept of displacement current?

Part – B **[Marks: 04 each]**

Q2. Solve the Schrodinger equation for one dimensional motion of a particle in a box of side L and show that its eigenvalues is inversely proportional to the square of side L.

Q3.Compare the properties of diamagnetic, paramagnetic and ferromagnetic materials.

Q4.Calculate the value of $\vec{\nabla} \cdot (r^3\vec{r})$ where $\vec{r} = x\,\hat{\imath} + y\hat{\jmath} + z\hat{k}$.

Q5. Prove by mathematical analysis that the mechanical energy of free oscillations of a simple harmonic oscillator is conserved.

Q6. Discuss the propagation mechanism of light waves in optical fiber.

Q7. Define damped harmonic oscillations.Solve its differential equation and discuss special cases of oscillatory motion.

MORNING

12 MAR 2021

Part – C **[Marks: 12 each]**

Q8. (i) Describe the Constuction and working mechanism of ruby laser. Also explain why He-Ne laser is superior to a ruby laser?

(ii) Calculate the refractive indices of the core and cladding material of a fiber from the following data: NA=0.22, relative refractive index is 0.012, where NA is numerical aperture.

OR

(i) . Deduce maxwell's equations using basic laws of electricity and magnetism.

(ii) Given $\vec{A} = x^2 y\,\hat{i} + (x-y)\hat{k}$. Find $\vec{\nabla} \times \vec{A}$ and $\vec{\nabla} \cdot \vec{A}$

Q9. (i) Show that Fermi level in case of intrinsic semiconductor lies in the middle of conduction and valence band. Also explain its variation with temperature.

(ii) The wave function of a certain particle is $\Psi = A\cos^2 x$ for $-\Pi/2 < x < \Pi/2$. Find the value of A. Also find the probability that a particle be found between x=0 and $x=\Pi/4$.

(iii) What do understand by damped and undamped Oscillations

OR

(i) Explain the terms Meissner effect and London penetration depth in superconductors Also discuss some applications of Meissner effect.(HOTS)

(ii) Write some important applications and risks of nano materials.

(iii) Determine the penetration depth in mercury at 0K , if the critical temperature of mercury is 4.2K and the penetration depth is 57 nm at 2.9K.

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