CHITKARA UNIVERSITY

2022-2023

SessionalTest I–Nov, 2022

Semester I

ID No: .....

[Total No. of Pages:

Time:90 minutes

Title of the Course: Modern and Computational Physics **Max. Marks: 40**

Course Code:22AS015

Instructions:

For Section A

- There is one question having five parts.Each part is having four distinct options out of which only one choice will be c
  There is no negative marking for incorrect answers.

For Section B

- There are 5 Questions of 3 marks each.All are compulsory.

For Section C

- There are 2 Questions of 10 marks each. All are compulsory.

Section-A

(All Questions are Compulsory;each question carries 01 mark)

1.

(a) Helium- Neon laser is a ..... level laser.

(i) two (ii) three

(iii) four (iv) Five

(b)The equation $(\vec{\nabla} \times \vec{E}) = -\frac{\partial \vec{B}}{\partial t}$ summarizes

(i) Gauss' law (ii) Faraday's law of em induction

(iii) Ampere's law (iv) Modified Ampere's law

(c) In He-Ne laser, population inversion is achieved by

(i) thermal pumping(ii) electric discharge

(iii)optical pumping(iv) in-elastic ion-ion collision

(d) In free space, the Gauss law in electrostatics is represented by

(i)$\vec{\nabla}.\vec{E} = 0$ (ii) $\vec{\nabla}.\vec{B} = 0$

(iii) $\vec{\nabla}.\vec{E} = \rho$(iv) $\vec{\nabla}.\vec{E} = \rho/\varepsilon_0$

(e) Equation of continuity for steady state current (dc current) is

(i)$\vec{\nabla}.\vec{J} = 0$ (ii) $\vec{\nabla}.\vec{J} + \frac{\partial \rho}{\partial t} = 0$

(iii) $\vec{\nabla}.\vec{J} = \epsilon \frac{\partial E}{\partial t}$ (iv) $\vec{\nabla}.\vec{J} + \epsilon \frac{\partial E}{\partial t} = 0$

Section-B

(Attempt all questions, each question carries 03 marks)

2. Determine the energy difference between upper energy level (E_2) and lower energy level (E_1) if the He-Ne Laser is capabl of emitting light at wavelength 6328Å.
3. Electromagnetic waves are able to transport energy in a medium or without medium. Maxwell equations are the basis electromagnetism and electrodynamics. Write down Maxwell's equations for free space.
4. A hologram is a three-dimensional image of an object, whereas photograph is a two-dimensional image.Compare th process of Holography and Photography?
5. If $\vec{A} = yz\hat{\imath} + xz\hat{\jmath} + xy\hat{k}$ is a position vector of a point in space, then prove that $\oint \vec{A} \cdot \vec{dl} = 0$.
6. What do you understand by the following terms:
   (i) Population Inversion
   (ii) Active medium
   (iii) Coherent sources of light

Section-C

(Attempt all questions, each question carries 10 marks)

7. (a) Which Maxwell equation proves that electric field can be generated by change in magnetic field? Derive that equation.

   (b)What are Einstein's coefficients? Derive the Einstein's relation between probabilities of spontaneous and stimulated emission coefficients.

8. Mention the role of Cr^{3+} ions in Ruby laser? Discuss the pumping scheme used to achieve population inversion and lasing action using appropriate energy level diagram. What are the drawbacks of Ruby Laser?

CHITKARA UNIVERSITY

2022-2023

Sessional Test II– Dec, 2022

Semester I

[Total No. of Pages: 02]

ID No: .....

Time: 90 minutes

Title of the Course: Modern and Computational Physics
Max. Marks: 40
Course Code: 22AS015
Instructions:

For Section A

- There is one question having five parts. Each part is having four distinct options out of which only one choice will be corre
  There is no negative marking for incorrect answers.

For Section B

- There are 5 Questions of 3 marks each. All are compulsory.

For Section C

- There are 2 Questions of 10 marks each. All are compulsory.

Section-A

(All Questions are Compulsory, Each question carries 01 mark)

1. MCQ

(a) The unit of magnetic susceptibility is,

(i) Wb/m (ii) amp/m

(iii) Wb/m^2 (iv) dimensionless

(b) Optical fibers are used in communication and for many other applications. The fiberscope device is used for

(i) medical applications (ii) as an fibre sensor

(iii) in heavy machine industry (iv) all of these

(c) In a paramagnetic material, susceptibility varies with temperature as:

(i) $1/T^2$ (ii) Finite

(iii) 1/T (iv) T

(d) If V no of an optical fibre is equal to 2. Then the no of modes propagating through step index fibres are:

(i) Infinite (ii) Four

(iii) One (iv) Two

(e) The magnetic field inside the superconductors will be .....when the superconductors placed in an external magnetic field.

(i) Infinite (ii) order of 10^6 Gauss

(iii) zero (iv) none of these

Section-B

(Attempt all questions, each question carries 03 marks)

2. Graphically represent the variation of χ_m with temperature for antiferromagnetic, ferromagnetic and paramagnetic materi

3. A step index fibre has a core of refractive index 1.5. If the NA of the fibre is 0.26, calculate the refractive index of the claddi material.

4. The magnetic susceptibility of silicon is -0.25×10^{-5} and magnetic field strength is 1000A/m. Find magnetization in silicon?

5. Optical fibres are used for various purposes besides the communications. The characteristics of the optical fibers based on s parameters, some of them are given below; express them in detail with formulation and pictures, where it is required:

(a) Critical Angle

(b) Numerical Aperture

(c) Acceptance Angle

6. Explain briefly type-I and type-II superconductors? Show figures or graphs in support of your explanation.

Section-C

(Attempt all questions, each question carries 10 marks)

7a) In superconductors two types of electrons are responsible for the conductivity, one is known as normal electron, while secon type are called super-electrons. By using the Maxwell's equations, two more equations can be derived for the superconductors, which is known as London's equations. Derive and explain significance briefly. (7 Marks

7b) Explain differences between the step index and graded index optical fibers.

(3 Marks)

8. When an iron rod is kept inside the electro-magnetic coil, it starts magnetize after some time. The loss of energy to magnetize t od can be explained by the B-H curve. Derive an expression for the energy dissipated in a Hysteresis cycle with figures, if required

DO NOT WRITE ANYTHING ON QUESTION PAPER EXCEPT ROLL NO.

Roll No. 22lo992579

Total No. of Pages: 01

END TERM EXAMINATION
FIRST SEMESTER, 2022-23
22AS015-MODERN AND COMPUTATIONAL PHYSICS

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

General Instructions:

- **Follow the instructions given in each section.**
- **Make sure that you attempt the questions in order.**

SECTION-A (10x2 marks=20 marks)

(All questions are compulsory, each question carries 02 marks)

Q1 Define equation of continuity and derive it.

Q2 What do you mean by ferromagnetism and gives an account on domain theory of ferromagnetism.

Q3 Find phase and group velocity of an electron whose De-Broglie wavelength is 1.2Å (neglect relativistic effect)

Q4 Define the terms:
(A) Pumping (B) Active System

Q5 Determine the intensity of magnetization and magnetic flux density in silicon, if its magnetic susceptibility is -4.2×10^{-6} and the magnetic field in it is 1.19×10^{5} A/m. What would be the value of relative permeability of the material?

Q6 Why is uncertainty principle important for microscopic particles but very significant in practical life?

Q7 Why optical fibre communications are so important?

Q8 Does an atom with one electron in outer shell can behave like a bar magnet? Justify your answer.

Q9 Explain why does fraction of power of a signal gets lost due to bending of the fibre?

Q10 Differentiate between hard and soft magnetic materials.

SECTION-B (8x5 marks=40 marks)

(Attempt any Eight Questions, each question carries 05 marks)

Q11 Derive electromagnetic wave equation for electric field in free space from Maxwell equations. Show that the speed of wave in free space is equal to speed of light.

Q12 (a) Depending upon structure and transmission properties, write the types of optical fibres and discuss the graded index multimode optical fibre.
(b) Derive the relation between acceptance angle and numerical aperture?

Q13 Derive Time Dependent Schrodinger Wave Equation for a free particle.

Q14 (a) Define Magnetic Susceptibility χ and relative permeability μ_r and establish a relation $\mu = \mu_0 (1+\chi)$
(b) Which material is suitable for the formation of permanent magnets? Explain

Q15 Explain with the help of neat and clean energy level diagram principle, construction and working of He-Ne laser?

Q16 What are Type-I and Type-II superconductors? How these superconductors behave in external magnetic field? Give some examples of each.

Q17 Show that the loss of energy due to Hysteresis per unit volume of material per cycle of magnetization.
(i) μ_0 X Area of I-H loop (ii) Area of B-H loop

Q18 Derive the London Equations and from there explain the variation of magnetic field with penetration depth.

Q19 (a) Find relative population of two states in a ruby laser that produces a light beam of wavelength 6943Å at 300K and 500K.
(b) Why four level laser systems is superior to three level laser system?

Q20 Obtain Schrodinger Wave Equation for a particle in one dimensional box and find boundary conditions and normalization condition for determination of a wave function?

DO NOT WRITE ANYTHING ON QUESTION PAPER EXCEPT ROLL NO.

Roll No. 2210991908 Total No. of Pages:02

END TERM EXAMINATION
FIRST SEMESTER 2022-23
22AS015-MODERN AND COMPUTATIONAL PHYSICS

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

General Instructions:

- **Follow the instructions given in each section.**
- **Make sure that you attempt the questions in order.**

SECTION-A (10x2 marks=20 marks)

(All questions are compulsory, each question carries 02 marks)

Q1 What is electric field? Differentiate between electric and magnetic fields.

Q2 Write the Maxwell equations. What changes are made to these equations in free space.

Q3 A glass is made with core glass of refractive index 1.5 and cladding is doped to give index difference of 0.0005. Determine cladding refractive index.

Q4 Give some applications of holography.

Q5 What are the various types of optical fibers? Which one of these is most suitable for long distance communication?

Q6 Differentiate between intramodal and intermodal dispersion.

Q7 Describe the effect of magnetic field on superconductivity.

Q8 Comment on the statement that superconductors are perfectly diamagnetic in nature.

Q9 A scanning electron microscope is focused to an electron in atom of diameter approximately 10^{-10} m. Calculate the maximum uncertainty in its momentum.

Q10 Draw susceptibility versus temperature curves for paramagnetic, ferromagnetic and anti ferromagnetic materials.

SECTION-B (8x5 marks=40 marks)

(Attempt any Eight Questions, each question carries 05 marks)

Q11 Derive a relation between Einstein's coefficients of spontaneous and stimulated emission of radiation. With the help of this relation explain why the atomic transitions between the energy levels with large separations are not considered in process of laser amplification? (4+1)

Q12 What is the role of He in He-Ne Laser? Describe the construction and working of a He-Ne Laser with the help of appropriate energy level diagram. Why one of the mirrors closing the ends of the tube is only partially silvered? (1+3.5+.5)

Q13 What are the physical significance of divergence and curl? A vector field is given as $\vec{F} = x^2yi - (z^3-3x)j + 4y^2k$, where i, j, k are the unit vectors along x, y, z, axis. Show that the flux is converging at point (-1,1,2). (2+3)

Q14 Derive the equations of electromagnetic waves in electric and magnetic field vectors. Show that the electromagnetic waves propagate with the speed of light in vacuum. (4+1)

Q15 Mention some of the applications of optical fibers. An optical fiber has core and cladding refractive indexes as 1.4810 and 1.478. The operating wavelength is 820 nm. Determine its numerical aperture? Also calculate the maximum incident angle so that light wave can propagate through the optical fibre. (2+3)

Q16 Differentiate between type-1 and type -2 superconductors. The material Lead in superconducting state has superconducting critical transition temperature of 6.2 K when no magnetic field is applied. It requires a magnetic field of 8.5 T to destroy the superconductivity (critical magnetic field) at 0K. Determine the critical magnetic field at 4.2 K. (2+3)

Q17 Discuss the phenomenon of flux penetration in superconductors. Explain how the flux penetration contradicts Meissner's effect? Give a brief account of London theory of flux penetration. Derive the expression for penetration depth with the help of London equations. (1+1+3)

Q18 What is hysteresis in magnetic materials? How hysteresis affects the properties of soft and hard magnetic materials. Write the properties of soft and hard magnetic materials along with some applications. (1+1+3)

Q19 Define intensity of magnetization and magnetic induction vectors. The magnetic flux density of silicon is -4.2 $\times 10^{-6}$. Determine the intensity of magnetization and magnetic flux density if the strength of applied field is 1.19×10^{5} A/m. (2+3)

Q20 Give the physical significance of wave function Ψ. Derive the time dependent Schrodinger wave equation for free particle.