SEMESTER END EXAMINATION, APRIL-MAY, 2025

Course Name: - B.Tech **Semester:**-II

Paper Name: - Engineering Physics **Paper Code:**-NBS-201

Time - 3 Hrs + 20 minutes per hour extra time for V.I. & examinees with writer. **Max Marks-70**

Additional 30 Minutes for Mid-Test.

Instructions:
- The question paper consists of three sections namely A, B, C. All sections are compulsory.
- Section A- Each question carries **3 mark. All questions are compulsory.**
- Section B- Answer any **5 out of 7** given questions. Each question carries **7 marks.**
- Section C- Answer any **2 out of 3** given questions. Each question carries **10 marks.**
- Section D- Each question carries **02 mark**. All questions are compulsory.

Section – A (खण्ड–अ)
Objective Questions(वस्तुनिष्ठप्रशन)

1. Answer all the following questions. 5x3 =15

i) Which phenomenon justifies the particle-like property of light?
  (a) Polarization
  (b) Compton Effect .
  (c) Diffraction
  (d) Interference

ii) Which Maxwell equation accounts for the displacement current?
  (a) Gauss's law for magnetism
  (b) Modified Ampère's law .
  (c) Faraday's law
  (d) Gauss's law

iii) In Newton's Rings experiment, the diameter of the rings:
  (a) Decreases with increasing order
  (b) Is constant for all orders
  (c) Increases with increasing order .
  (d) Is independent of wavelength

iv) Which of the following determines the numerical aperture of an optical fiber?
  (a) Length of the fiber
  (b) Refractive index of core and cladding·
  (c) Light wavelength
  (d) Mode of propagation

v) Quantum dots exhibit discrete energy levels due to:
  (a) Surface scattering .
  (b) High electrical conductivity
  (c) Strong magnetic field
  (d) Carrier confinement in all directions

Short Answer Questions (लघुउत्तरीय प्रश्न)   5x7=35

2. Answer any five of the following questions.

   i)   Derive the Schrodinger Time dependent wave equation. Give physical significance of wave function Ψ.

   ii) Derive Maxwell's equations in differential form and explain the physical significance of each.

   iii) Explain the working principle of interference in wedge-shaped films. Derive the expression for fringe width.

   iv) Distinguish between step-index and graded-index fibers. Give two applications of optical fiber communication.

   v)   What is population inversion? Discuss He-Ne laser with suitable energy diagram.

   vi) Give the BCS theory for superconductors.

   vii) Explain the synthesis of nano-materials using Sol-Gel method.

Section – C (खण्ड–स)
Descriptive Questions (विवरणात्मकप्रश्न)

3. Answer any two of the following question.   2x10=20

   i) Derive an expression for the skin depth of electromagnetic waves in a conducting medium. Explain its dependence on conductivity and frequency.

   ii) Describe Fraunhofer diffraction at single slit. Derive the condition for maxima and minima and explain how it differs from interference.

   iii) Explain the Compton effect and derive the expression for Compton wavelength shift. Discuss how this experiment supports the particle nature of electromagnetic radiation.

Section – D (खण्ड–द)
MID-TEST

All questions are compulsory.
सभीप्रश्नअनिवार्यहैं।   2×10=20
Objective Questions.
बहुविकल्पीय प्रश्न।

   i)   Which theory explains blackbody radiation spectrum successfully at all wavelengths?
        (a) Stefan's Law
        (b) Wien's Law
        (c) Planck's Theory ·
        (d) Rayleigh–Jeans Law

   ii) Time-dependent Schrödinger wave equation is:
        (a) Non-linear
        (b) Complex ·
        (c) Imaginary
        (d) Real

   iii) Displacement current is present in:
        (a) Superconductors
        (b) Capacitors with time-varying field·

(c) Conductors

(d) Magnetic materials

iv) Which theorem connects line integral and surface integral of a vector field?

(a) Faraday's law

(b) Ampère's law

✓(c) Stokes' theorem'

(d) Gauss's theorem

v) In single-slit diffraction, the central maximum is:

(a) Absent

✓(b) Widest and brightest '

(c) Narrowest

(d) Dark

vi) Which parameter defines the acceptance of light in fiber optics?

(a) Coherence length

✓(b) Numerical aperture ·

(c) Dispersion

(d) Attenuation

vii) Which of the following causes signal degradation in optical fibers?

✗(a) None of these ·

✓(b) Both attenuation and dispersion

(c) Attenuation only

(d) Dispersion only

viii) Laser radiation is:

✓(a) Monochromatic and coherent₁

(b) Incoherent and divergent

(c) Incoherent and monochromatic

(d) Polychromatic and random

ix) What is the Meissner effect?

(a) Supercooling of a metal

(b) Zero resistance

✓(c) Expulsion of magnetic field from a superconductor

(d) Strong paramagnetic behavior

x) Quantum well is a structure in which charge carriers are confined in:

(a) Three dimensions

✓(b) Two dimensions·

✗(c) One dimension ·

(d) Zero dimension

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समय–3 घण्टे+ 20 मिनट प्रति घंटे अतिरिक्त–दृष्टिबाधित एवं सहलेखक परीक्षार्थियों के लिए। अधिकतम अंक–70

30 मिनट अतिरिक्तमिड–टेस्ट के लिए।

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निर्देश:
- प्रश्नपत्र में तीन खण्ड अ, ब, व स हैं। सभी खण्ड अनिवार्य हैं।
- खण्ड–अ में प्रत्येक प्रश्न तीन अंक का है। सभी प्रश्न अनिवार्य हैं।
- खण्ड–ब में सात प्रश्नों में से किन्हीं पाँच प्रश्नों के उत्तर दें। प्रत्येक प्रश्न सात अंक का है।
- खण्ड–स में तीन प्रश्नों में से किन्हीं दो प्रश्नों के उत्तर दें। प्रत्येक प्रश्न 10 अंक का है।
- खण्ड–द में प्रत्येक प्रश्न 02 अंक का है। सभी प्रश्न अनिवार्य हैं।

Section – A (खण्ड–अ)
Objective Questions(वस्तुनिष्ठप्रशन)

1. Answer allthe following questions.   5x3 =15

निम्नलिखित सभी प्रश्न अनिवार्य हैं।

i)   The ultraviolet catastrophe in blackbody radiation is explained by:

a) Wien's displacement law

b) Planck's assumption of quantized energy

c) Stefan–Boltzmann law

d) Rayleigh–Jeans law

ii)   Displacement current is significant in:

a) Resistors

b) Magnetic materials

c) Capacitors under varying electric field

d) Inductors

iii)   Resolving power of a grating increases with:

a) Decreasing slit width

b) Increasing wavelength

c) Increasing number of slits

d) Increasing distance between slits

iv)   Population inversion in laser medium implies:

a) Equal population of energy levels

b) Ground state has higher population

c) Excited state has higher population

d) All atoms are in ground state

v) **The Bottom-Up approach for nanomaterial synthesis includes:**

a) Grinding

b) CVD

c) Sol-Gel method

d) Ball milling

Section – B (खण्ड–ब)
Short Answer Questions (लघुउत्तरीय प्रश्न)

5x7=35

2. **Answer any five of the following questions.**
निम्नलिखितमें से किन्हीं पाँच प्रश्नों के उत्तर दें।

i) What is the significance of the group velocity in the context of a matter wave, and how is it related to particle velocity?

ii) Find the Schrodinger time dependent wave equation and give the physical significance of wave function ψ.

iii) Show that in Newton's ring experiment the diameter of nth dark ring is directly proportional to square root of natural number.

iv) Differentiate between step-index and graded-index optical fibres in terms of structure and mode of signal propagation. Where is each type typically used?

v) Derive the expression for displacement current and explain its role in modifying Ampère's law to make it consistent with the continuity equation.

vi) How ordinary light is dissimilar with Laser Light? Give construction and working of Ruby Laser with neat energy Level diagram.

vii) A type-I superconductor has a critical field $Hc(0)=0.2$ T at absolute zero. Calculate the critical field at $T=4K$. given $Tc=7$ K

Section – C (खण्ड–स)
Descriptive Questions (विवरणात्मकप्रश्न)

3. **Answer any two of the following question.**
निम्नलिखितमें से किन्हीं दो प्रश्नों के उत्तर दें।

2x10=20

i) Explain Planck's hypothesis and how it resolved the ultraviolet catastrophe in blackbody radiation.

ii) Derive the expression for the **skin depth** in a conducting medium when an electromagnetic wave is incident on it.

iii) What do you understand by induced Absorption, Spontaneous Emission? Establish relationship between Einstein A and B coefficients.

All questions are compulsory.
सभी प्रश्न अनिवार्य हैं।

2×10=20

Objective Questions.
बहुविकल्पीय प्रश्न।

1. The main reason classical mechanics fails at the atomic level is:

   (a) Inability to describe high-speed particles

   (b) Failure to account for energy quantization and wave-particle duality

   (c) Inaccurate predictions for large objects

   (d) It assumes relativistic time dilation

2. The significance of the wave function ψ \psi$ in quantum mechanics is:

   (a) It represents the energy of the system

   (b) It gives the trajectory of a particle

   (c) $|\psi|^2$ gives the probability density of finding a particle

   (d) It represents the momentum directly

3. Which of the following ensures conservation of charge in Maxwell's theory?

   (a) Gauss's law

   (b) Faraday's law

   (c) Displacement current

   (d) Continuity equation

4. Poynting vector represents:

   (a) Direction of electric field only

   (b) Rate of flow of energy per unit area

   (c) Velocity of electromagnetic waves

   (d) Magnetic flux through a surface

5. Why are coherent sources essential for observing interference patterns?

   (a) They emit light of varying frequencies

   (b) They are spatially separated

   (c) They maintain constant phase difference

   (d) They are of low intensity

6. A wedge-shaped film produces fringes due to:

   (a) Diffraction

   (b) Interference .

(c) Polarization

(d) Reflection

7. The Meissner effect in superconductors demonstrates:

   (a) Resistance becomes zero

   (b) A perfect diamagnetic behaviour (expulsion of magnetic field) ·

   (c) Increase in magnetic flux

   (d) Thermal expansion of material

8. Population inversion in a laser medium is necessary to:

   (a) Absorb incident photons effectively

   (b) Increase the refractive index

   (c) Stimulate coherent light emission

   (d) Reduce spontaneous emission

9. In fiber optics, total internal reflection occurs because:

   (a) Light is absorbed at the boundary

   (b) The core has a lower refractive index

   (c) The cladding reflects light physically

   (d) Light hits the core-cladding boundary at angles greater than critical angle ·

10. Quantum dots exhibit discrete energy levels due to:

    (a) Surface imperfections

    (b) High energy absorption

    (c) Carrier confinement in all dimensions

    (d) Thermally activated conduction