BRAINWARE UNIVERSITY

Term End Examination 2022
Programme – B.Tech.(RA)-2022
Course Name – Physics I
Course Code - BSCR101
(Semester I)

Full Marks : 60   **Time : 2:30 Hours**
[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A
(Multiple Choice Type Question)   1 x 15=15

1. *Choose the correct alternative from the following :*

(i)   Two coherent sources of different intensities interfere with each other. The ratio of maximum intensity to minimum intensity is 25:1. The intensities of the sources are in the ratio

a) 25:1   b) 4:1
c) 9:4   d) 8:3

(ii) Interference phenomena indicates

a) Light is electromagnetic wave   b) Rectilinear propagation of light
c) The wave nature of light   d) None of these

(iii)
For the function $e^{\beta^2 x}$, **evaluate** the eigenvalue of the operator $\dfrac{d^2}{dx^2}$

a) β b) β^2

c) β^3 d) β^4

(iv) The metastable state has a mean life-time of more than

a) 10^{-1} s   b) 10^{-3} s
c) 10^{-5} s   d) 10^{-6} s

(v)   In the structure of fiber optic cable refractive index of core is always --------- the refractive index of cladding.

a) Less than   b) Equal to
c) Greater than   d) None of these

(vi) Intensity of light depends upon
a) Velocity
b) Wavelength
c) Amplitude
d) Frequency

(vii) In case of critical damping, the motion of a system is
a) Oscillatory
b) Vibratory
c) Harmonic
d) Non-oscillatory

(viii) The population of electron in different energy states of a system in the thermal equilibrium is governed by
a) Bragg's law
b) Einstein relations
c) Boltzmann distribution law
d) Wien's displacement law

(ix) When a spring with spring constant k is cut into three equal parts, the force constant of each of the part would be
a) k/3
b) 3k
c) k
d) None of these

(x) The quality factor Q for an L-C-R circuit is
a) $\omega R/L$
b) ω/LR
c) $\omega L/R$
d) $R/L\omega$

(xi) When the frequency of the applied force (ω') and the natural frequency of vibration (ω) are equal, the value of maximum amplitude is given by
a) $\dfrac{f}{\sqrt{2b\omega'}}$
b) $\dfrac{f}{2b\omega}$
c) $\dfrac{f}{\sqrt{2b\omega}}$
d) $\dfrac{f}{\sqrt{2b\omega\omega'}}$

(xii) Choose which pair of observables of a particle cannot be measured precisely at the same time.
a) Spin and color
b) Energy and torque
c) Position and momentum
d) Size and speed

(xiii) In a quarter-wave plate, the path difference between the O-ray and E-ray is
a) $\lambda/4$
b) 0
c) $\lambda/2$
d) 2λ

(xiv) The number of optic axes in a uniaxial crystal is
a) 1
b) 2
c) 3
d) 4

(xv) If ω_0 is the angular frequency of a body and k is the damping constant, then its quality factor is
a) ω_0/k
b) $2\omega_0/k$
c) $\omega_0/2k$
d) None of these

Group-B
(Short Answer Type Questions)   3 x 5=15

2. Distinguish between group velocity (v_g) and phase velocity (v_p)?   (3)

3.   (3)

Two polarizers are crossed to each other; a third polarizer is placed between them which makes an angle θ with the first polarizer. An unpolarized light of intensity I_0 is incident on the first one and passes through all the three polarizers. Calculate the intensity of the light which emerges from the second polarizer.

4. Describe the physical interpretation of wave-function in quantum mechanics. (3)

5. Calculate the time period of the liquid column of length l in a U-tube, if it is depressed in one arm by x, d is the density of the liquid and A is the cross-sectional area of the arm of the U-tube. (3)

OR

If the wavelength of the radiation of the He-Ne laser is 632.8 nm, calculate the energy of the radiation. (3)

6. Stimulated emission is used in laser action instead of spontaneous emission. Justify your answer? (3)

OR

Solve the normalization constant a if the wave function has the following form (3)
$$\psi(x) = a \sin\frac{\pi x}{L}, \text{ for } 0 \leq x \leq L$$
$$= 0, \text{ otherwise.}$$

Group-C
(Long Answer Type Questions)
$5 \times 6 = 30$

7. Express the relationship between Einstein's A and B coefficients. (5)

8. Sate the conditions for over damped, critically damped and under damped motion. (5)

9. What is Rayleigh criterion? What is the limit of resolution of an optical instrument? (5)

10. Write down Schrödinger's equation for one-dimensional motion for a free particle in a one-dimensional potential box. Apply appropriate boundary conditions to calculate its eigen energies. (5)

11. Derive the diameter of Airy disc. (5)

OR

(5)

A Newton's ring experiment is performed with a source of light having two wavelengths λ_1 and λ_2. It is found that the nth dark ring due to λ_1 coincides with $(n+1)^{th}$ dark ring due to λ_2. If the radius of curvature of the Plano-convex lens is R, then prove that the radius of the nth order dark ring for λ_1 is given by $\sqrt{\dfrac{\lambda_1 \lambda_2}{\lambda_1 - \lambda_2} R}$

(5)

12.

Derive the relation $v_g = v_p - \lambda \dfrac{dv_p}{d\lambda}$.

OR

(5)

Deduce Stefan's law from Planck's radiation formula.

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