VEER SURENDRA SAI UNIVERSITY OF TECHNOLOGY (VSSUT), ODISHA

Odd Mid Semester Examination for Academic Session 2023-24

COURSE NAME: B.Tech. SEMESTER: I

BRANCH NAME: Section D –J

SUBJECT NAME: Physics

FULL MARKS: 30 TIME: 90 Minutes

Answer All Questions.

The figures in the right hand margin indicate Marks. *Symbols carry usual meaning*

[2 × 3]

Q1. Answer all Questions.

a) Mention any three elements of a mechanical oscillator, and their electrical circuit analogies? - CO1

b) Show the pictorial representation of superposition of waves of equal frequency and in opposite phase. What is the expression for intensity? - CO2

c) Find unit normal to surface $x^2 + y^2 = z$ at point (1,-2,-1)? - CO3

[8]

Q2. What is damped simple harmonic motion? Mention about various forces involved for this system to evaluate the wave equation. How the behaviour of the system varies in heavy and critical damping? - CO1

OR

What are forced vibrations? Derive the differential equation of motion of a particle under theory of forced vibrations. Prove the various cases between force and displacement. - CO1

[8]

Q3. Describe the experimental arrangement for the formation of Newton's Rings with diagram. Derive the expression for diameter of the bright and dark rings, and wavelength of the given light source. - CO2

OR

Draw the experimental set up for Fraunhoffer diffraction at a single slit and obtain the conditions for central maxima, minima, and secondary maxima. Draw the curve for Intensity distribution in this case based on the above. - CO2

[8]

Q4. (a) Give the representation for time derivative of a vector field. Find out the time derivative of a vector field which is given by $\vec{A}(t) = \hat{i}\, a \sin \omega t + \hat{j}\, b e^{i\omega t}$ - CO3

[4]

(b) What is Gradient of a scalar field? Determine the scalar field whose Gradient is given by $\vec{\nabla}\phi = \hat{i}(1+2xy) + \hat{j}(x^2+3y^2)$. [4]

OR

(a) Write the expression for Divergence of a vector field and its properties. What is the condition for solenoidal field? - CO3

[4]

(b) What is the curl of a vector field and write the condition for irrotational field. Evaluate $\vec{\nabla} \times \vec{A}$ where $\vec{A} = \hat{i}\, 2xy + \hat{j}\, xy^2 - \hat{k}\, e^{az} x^2$. where 'a' is constant. [4]

B. Tech-1st

Engineering Physics

Full Marks : 50

Time : $2\frac{1}{2}$ hours

Answer **all** questions

The figures in the right-hand margin indicate marks

Symbols carry usual meaning

Any supplementary materials to be provided

1. Answer *all* questions : 2×5

(*a*) What is the defining characteristic equation for a simple harmonic oscillator and give two examples of simple harmonic oscillations ?

(*b*) Differentiate between division of wavefront and division of amplitude in the context of coherent sources. Provide a brief explanation of why coherence is important in interference.

(c) Define the gradient, divergence, and curl mathematical concepts briefly. Provide an example illustrating each concept.

(d) Define necessary conditions for a wave function in Quantum Mechanics and state the role of wave function in describing the state of a quantum system.

(e) Define what a LASER is and briefly explain its principle of operation.

2. (a) Write the mathematical equation a damped harmonic oscillator and discuss in terms of mathematical parameters the concept of heavy, critical, and light damping. 4

(b) Define the quality factor (Q) of a harmonic oscillator. Explain its significance and how it relates to the sharpness of resonance. 4

Or

(a) Describe the response of a forced electrical oscillator. Include discussions on resonance and amplitude response. 4

(b) Explain the concept of steady-state motion in a forced damped harmonic oscillator. Discuss the influence of damping on the steady-state response. 4

3. (a) Describe the experimental setup of Newton's rings and explain how the rings are used to determine both the wavelength of light and the refractive index of a liquid. 4

(b) Explain the differences between Fresnel and Fraunhofer diffraction. Provide examples where each type is observed and discuss the conditions under which they occur. 4

Or

(*a*) Provide a detailed explanation of Fraunhofer diffraction resulting from a single slit, including the mathematical expressions for the intensity pattern. Discuss the factors influencing the diffraction pattern. 4

(*b*) Discuss the qualitative features of the diffraction pattern produced by a diffraction grating. Explain how the grating parameters influence the resulting pattern. 4

4. (*a*) State the Gauss Divergence Theorem and elaborate on its mathematical expression. Explain how it connects surface and volume integrals. 4

(*b*) Derive the electromagnetic wave equations for the electric field (E) and magnetic field (B) in vacuum and calculate the electric and magnetic fields wave velocity. 4

Or

(*a*) State and explain Stoke's theorem, emphasizing its significance in relating surface and line integrals in vector calculus. 4

(*b*) Explain in detail why electromagnetic waves are considered transverse. Discuss the significance of this property in the context of wave propagation in terms of medium parameters. 4

5. (*a*) Describe the relationship between phase velocity and group velocity in wave mechanics. Explain under what conditions they might be equal or different. 4

(*b*) Explain the normalization of wave functions and the concept of expectation values in Quantum Mechanics. Provide a mathematical example for a wave function to demonstrate normalization. 4

Or

(*a*) Discuss the time-dependent and time-independent forms of the Schrödinger equation. Explain their significance and how they are used in Quantum Mechanics. 4

(*b*) Describe the concept of a particle in a box and how it is used as a simple model in quantum mechanics. Solve the Schrödinger equation for a particle in a one -dimensional box. 4

6. (*a*) Discuss four main characteristics of LASERs, explaining how each contributes to their unique properties. 4

(*b*) Explain the concepts of three-level and four-level pumping schemes in the context of LASER operation. Discuss their advantages and disadvantages. 4

Or

(*a*) Provide an overview of the Ruby LASER, including the active medium used, the pumping mechanism, and the wavelength of emitted light. Discuss any unique features or applications. 4

(*b*) Describe the He-Ne LASER, including the active medium, pumping method, and the wavelength of the emitted light. Discuss the characteristics that make it suitable for specific applications. 4