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TERM END EXAMINATIONS (TEE) – May 2023

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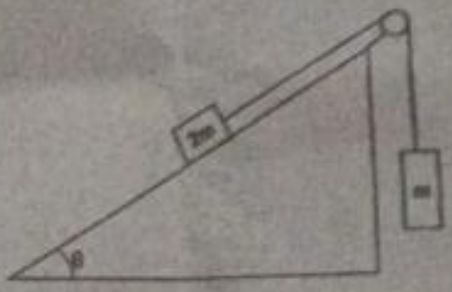
|---|---|---|---|---|---|
| Programme | : | B.Tech. | Semester | : | Winter 2023-24 |
| Course Title/ Course Code | : | Engineering Physics/ PHY1001 | Slot | : | B24+E22+F21 |
| Time | : | 3 Hrs. | Max. Marks | : | 100 |

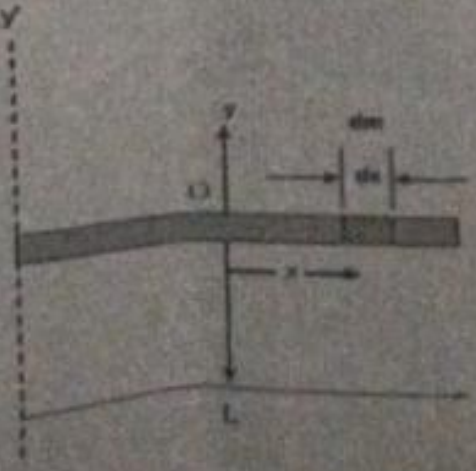
**Answer ALL the Questions**

| Q. No. | | Question Description | Marks |
|---|---|---|---|
| | | **PART A – (60 Marks)** | |
| 1 | (a) | A string connects two blocks of unequal mass over a smooth pulley. If the coefficient of friction is $\mu_s$, what angle $\theta$ of the incline allows the masses to move at constant speed? | 12 |




OR

| | | | |
|---|---|---|---|
| | (b) | Calculate the moment of inertia of a uniform rigid rod of length L and mass M about an axis perpendicular to the rod and passing through its centre of mass and the y' axis. | 12 |



2 (a) (i) What determines whether a given photon is an X-ray or ultraviolet? Could an X-ray have a wavelength larger than some ultraviolet light? 6

(ii) The wave function of a particle in a one-dimensional box of width $L$ is $\psi(x) = A \sin(\pi x/L)$. If we know the particle must be somewhere in the box, what must be the value of $A$? 6

OR

(b) Derive the time-independent Schrodinger wave equation. Give the physical significance of the wave function and what does the square of the wave function signify? 12

3 (a) Compare the quantum confinement and resulting structures like quantum dots, quantum wires and quantum wells and their physical significance. 12

OR

(b) What are carbon nanotubes? Discuss how various types of carbon nanotubes can be formed from graphene. 12

(a) Explain the He-Ne laser's principle, construction and working with a neat diagram. What are the merits and demerits of He-Ne lasers? 12

OR

(b) (i) Determine the energy and momentum of a photon of a laser beam of wavelength 632.8 nm. 6

(ii) Calculate the power per unit area delivered by a laser pulse of energy $4 \times 10^{-3}$ joule, the pulse length in time as $10^{-9}$ s and when the pulse is focused on the target to a tiny spot of radius $1.5 \times 10^{-5}$ m. 6

(a) (i) An electron moving perpendicular to a uniform magnetic field 0.500 T undergoes circular motion of radius 2.80 mm. What is the speed of the electron? 8

(ii) Explain briefly about the Lorentz force. 4

OR

(b) (i) Explain Snell's law and derive the relation between the critical angle and the refractive index. 6

(ii) An optical fibre has a core material with a refractive index of 1.55, and its cladding material has a refractive index of 1.50. The light is launched into it in the air. Calculate its numerical aperture, the acceptance angle and the fractional index change. 6

## PART B – (40 Marks)

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|---|---|---|
| 6 | Define angular momentum. Using Newton's second law in angular form verify that the vector sum of all torques acting on a particle is equal to the time rate of change of angular momentum of that particle. | 8 |
| 7 | What do you mean by the duality of matter? Derive the expression for deBroglie wavelengths and explain why we can't observe the deBroglie wavelength of a fast-moving cricket ball. | 8 |
| 8 | Explain in detail why the bandgap of nanomaterials increases with size reduction. | 8 |
| 9 | Derive the relation between Einstein's coefficients. | 8 |
| 10 | Starting from Maxwell's electromagnetic equations in free space, in the absence of charges and current, obtain the wave equation for the electric field. | 8 |

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