LUMS
A Not-for-Profit University

Physics Graduate Subject Test
Sample Question Paper

NOTE: Attempt all questions.

Duration: 2 hours

Question 01: As a result of friction, the angular speed of a wheel changes with time according to

$$\frac{d\theta}{dt} = \omega_o e^{-\sigma t} \tag{1}$$

where ω_o and σ are constants. The angular speed changes from 3.5 rad/s at $t = 0$ to 2.0 rad/s at $t = 9.3$ s. (a) Use this information to determine σ and ω_o. Then determine (b) the magnitude of the angular acceleration at $t = 3$ s, (c) the number of revolutions the wheel makes in the first 2.5 s, and (d) the number of revolutions it makes before coming to rest.

Question 02: Consider three solenoids A, B, and C. The solenoid A has length L and N turns, solenoid B has length $2L$ and $2N$ turns, and solenoid C has length $L/2$ and $2N$ turns. If each solenoid carries the same current, rank the magnitudes of the magnetic fields in the centers of the solenoids from largest to smallest.

Question 03: A particle with energy $E = \hbar\omega/2$ moves under the potential of a harmonic oscillator. Compute the probability that the particle is found in the classically forbidden region. Compare this result to the probability of finding the particle in higher energy levels.

Question 04: Consider two operators O_1 and O_2 such that:

$$O_1\psi(x) = x^3\psi(x) \tag{2}$$

$$O_2\psi(x) = x\frac{d\psi(x)}{dx} \tag{3}$$

Find the commutation relation $[O_1, O_2]$. *The commutation relation between two operators A and B are defined as $[A, B] = AB - BA$.*