Reg. No…….. Name…… **18U505**

B. Sc. DEGREE END SEMESTER EXAMINATION OCTOBER/NOVEMBER 2018

SEMESTER **–5: PHYSICS (CORE COURSE)**

COURSE: **15U5CRPHY05: CLASSICAL AND QUANTUM MECHANICS**

(Common for Regular 2016 admission & Supplementary 2015 & 2014 admissions)

Time: Three Hours Max. Marks: 60

PART A (Very short answer questions)

*Answer **all** questions. Each question carries **1** Mark*

1. For a pendulum with an extensible string, the constraint belongs to which type?
   (a) dissipative (b) nonholonomic (c) rheonomic (d) scleronomic
2. If Lagrangian is not an explicit function of time, the quantity remaining conserved is
   (a) Hamiltonian (b) linear momentum (c) angular momentum (d) time
3. The dimension of action is same as that of
   (a) linear momentum (b) angular momentum (c) energy (d) acceleration
4. Rayleigh-Jeans law matches with Planck's law at
   (a) low frequencies (b) high frequencies (c) all frequencies (d) none of these
5. The dual behavior of electrons is
   (a) only a theory (b) an experimental fact (c) an artifact (d) meaningless
6. For a wave function to be normalizable, the norm is to be
   (a) finite (b) infinite (c) zero (d) complex
7. When the number of waves forming a wave packet is increased, what happens to the width of the wave packet?
   (a) becomes wider (b) becomes narrower (c) becomes zero (d) becomes infinity
8. The quantum mechanical operator for momentum is
   (a) $-i\hbar\frac{\partial}{\partial x}$ (b) $i\hbar\frac{\partial}{\partial x}$ (c) $-i\hbar\frac{\partial}{\partial t}$ (d) $i\hbar\frac{\partial}{\partial t}$
9. An eigen function of the operator $i\frac{\partial}{\partial t}$ is $e^{-i\omega t}$. What is the corresponding eigen value?
   (a) ω (b) $i\omega$ (c) $i\omega t$ (d) t
10. For a rigid rotator,
    (a) The energy levels are equally spaced (b) energy levels are un-equally spaced
    (c) ground state energy is non-zero (d) none of these (1 x 1 0 = 10)

PART B (Short answer)

*Answer **any Seven** questions. Each question carries **2** Marks*

11. What do you mean by a cyclic co-ordinate? What is the nature of the conjugate momentum?
12. State the Hamilton's principle for a conservative system.
13. Compare Lagrange's and Hamilton's equations of motion.
14. What is the importance of Davisson-Germer experiment?
15. What do you mean by the expectation value of an operator? Give an expression for the same.
16. What do you mean by a stationary state?
17. Distinguish between the terms phase velocity and group velocity. Give expressions for the same.
18. What are the eigen functions and eigen values of the operators L^2 and L_z?
19. Explain the term degeneracy of eigen functions. (2 x 7 = 14)

PART C (Problem/Derivations)

*Answer **any Four** question. Each question carries **4 Marks***

20. Obtain the equation of motion of a one-dimensional harmonic oscillator employing Lagrangian formalism.
21. Using Euler-Lagrange equation, prove that the shortest distance between two points is a straight line.
22. An X-ray beam of wavelength 1 pm suffers Compton scattering from a target. Estimate the maximum and minimum wavelength of the scattered X-rays.
23. Estimate the de Broglie wavelength of an electron which is accelerated through a potential difference of 100 V.
24. Find the expectation value of the momentum of a particle enclosed in a one-dimensional box.
25. Verify the commutation relation $[L_x, L_y] = i\hbar L_z$. (4 x 4 = 16)

PART D (Long answer questions)

*Answer **any Two** question. Each question carries **10** Marks*

26. Obtain the Lagrange's equation of motion for a conservative system from D'Alembert's Principle.
27. Derive the least action principle for a conservative system.
28. What are the important conclusions of photoelectric effect? Give explanations for these effects based on Einstein's photoelectric equation.
29. Obtain the Schrödinger equation for a one-dimensional simple harmonic oscillator. Give expression for the energy eigen values. Plot the corresponding eigen functions. (10 x 2 = 20)