B.Sc. DEGREE EXAMINATION APRIL 2022
BRANCH III - PHYSICS
SIXTH SEMESTER

COURSE   :   MAJOR – CORE
PAPER   :   QUANTUM MECHANICS AND RELATIVITY
TIME   :   3 HOURS

MAX. MARKS :100

SECTION – A

ANSWER ALL QUESTIONS: 25 MARKS
I   CHOOSE THE CORRECT ANSWER: (10 X 1 = 10)

1. De-Broglie wavelength for thermal neutrons
   a. $\lambda = h/\sqrt{2mkT}$ b. $\lambda = h/3mkT$ c. $\lambda = h\sqrt{2mkT}$ d. $\lambda = 1/h\sqrt{2mkT}$

2. The group velocity v_g with which a wave packet moves is
   a. $v_g = d\omega/dk$ b. $v_g = c$ c. $v_g = c/2$ d. $v_g = c/8$

3. The energy of a particle in a square well of length L is proportional to
   a. L^2 b. $1/L^2$ c. $\sqrt{L}$ d. $1/\sqrt{L}$

4. The wave function $\psi(x)$ must approach zero as
   a. $x \to \infty$ b. $x \to -\infty$ c. $x \to 0$ d. both a&b

5. Quantum operators for energy is
   a. $i\hbar$ b. $-i\hbar$ c. $i\hbar\frac{\partial}{\partial t}$ d. $-i\hbar\frac{\partial}{\partial t}$

6. If the function remains unchanged after operation, the operator is called _____
   a. null operator   b. identity operator c. del operator   d. momentum operator

7. Un accelerated frames are called
   a. Galilean or Inertial frames   b. non- Inertial frames
   c. static frames   d. none

8. The relativistic mass of a particle is twice its rest mass, what is the ratio of its speed to that of light.
   a. $\sqrt{3}/2$ b. $1/\sqrt{2}$ c. $1/2$ d. ¼

9. A rod 1 meter long moving with a velocity 0.6 c will appear to a stationary observer as
   a. 0.1m   b. 0.2m   c. 0.8m   d. 1m

10. A young lady of 25 years starts running at relativistic speed v, then she would appear to her stationary friend as
    a. thin and younger   b. fat and older
    c. fat and younger   d thin and older

II. FILL IN THE BLANKS   (5 x 1 = 5)

11. The de Broglie wave length for charged particle of charge q and accelerated through apotential difference of V volts is_____.

12. The potential outside a 1D Box is _____.

13. Michelson Morley experiment suggests that there is no _____motion between earth and ether.
14. The rest energy of an electron is _____ MeV.
15. the operators for momentum is _____ .

III. SHORT ANSWER   (5 x 2 =10)
16. What do you mean by wave – particle duality Explain?
17. Give Schroedinger's time independent equation
18. Give the equivalence between mass and energy. What is its importance?
19. State the postulates of special theory of relativity.
20. Give the operator representations of kinetic energy.

SECTION - B
ANSWER ANY FIVE QUESTIONS: (5 x 6 = 30)
21. Derive an expression for the relationship between phase velocity and group velocity.
22. Find the lowest energy of an electron confined to move in 1-D potential box of length1Å.
23. Derive an expression for total energy operator.
24. A rod of length 1 meter moves with a velocity 0.5c along its length. How long it will appear to an observer on the earth?
25. When an electron moves with a velocity 0.6c, calculate the kinetic energy?
26. Calculate the de Broglie wavelength of an electron moving with velocity $\frac{3}{5}c$.
27. Show that the momentum operator $\frac{\hbar}{i}\frac{\partial}{\partial x}$ is Hermitian.

SECTION - C
ANSWER ANY THREE QUESTIONS   (3 x 15 = 45)
28. Discuss Davisson and Germer experiment to prove wave particle duality.
29. Solve the Schrodinger's equation for particle in a one dimensional box. Calculate its values of energy and normalised wave function.
30. Describe the Michelson –Morley experiment and explain the significance of the negative result.
31. Deduce the expression for Mass- energy equivalence and explain what is unified mass unit.
32. Obtain the commutation relation for L_X, L_Y, and L_Z, the components of angular momentum operator. Show that L^2 commutes with any of the three components.

****