2021

PHYSICS—HONOURS

Paper : CC-7

Syllabus : 2019-2020

(Modern Physics)

Full Marks : 50

Answer *question no.1* and any *four* questions from the rest.

1. Answer *any five* questions: 2×5

   (a) Which significant result was supported by the Davisson-Germer experiment?

   (b) Which fundamental law of physics is apparently violated in beta decay? How is this resolved?

   (c) Show that the operator $\hat{x}\hat{p}_x$ is not Hermitian.

   (d) Show that the group velocity of a wave packet does not exceed the speed of light in vacuum.

   (e) What are the limitations of shell model?

   (f) How does a single gamma ray photon of energy exceeding 1·02 MeV create an electron-positron pair without violating conservation of momentum?

   (g) What are metastable states?

2. (a) Derive Wien's displacement law from the Planck distribution.

   (b) The 1*s*-electron inside a hydrogen atom carries no angular momentum. There is no 'centrifugal potential'. Why, then, does it not fall into the nucleus?

   (c) Calculate the de Broglie wavelength of an electron accelerated through a potential of 200V. (3+4+3)

3. (a) Given that the Bohr radius of the hydrogen atom is 0·53Å, estimate the binding energy of the ground state. Using your result, estimate the order of magnitude of the wavelength of light emitted in atomic transitions.

   (b) If $\rho(r, t) = \psi^*(r, t)\psi(r, t)$ is a probability density, then show that the conservation of probability requires that there must be a probability current $\vec{j}(r, t) = \frac{i\hbar}{2m}(\psi^*\nabla\psi - \nabla\psi^*\psi)$ that satisfies the equation $\frac{\partial}{\partial t}\rho(r, t) + \vec{\nabla}.\vec{j}(r, t) = 0$.

   (c) Evaluate the commutator $[L_z, Sin2\phi]$. 4+4+2

Please Turn Over

4. (a) If the operator representing an observable in quantum mechanics commutes with the Hamiltonian, what can you say about that observable?

(b) If $\hat{L}$ stands for the angular momentum operator, and given that

$$\hat{L}_z = \hat{x}\hat{p}_y - \hat{y}\hat{p}_x$$

Show that $[\hat{L}_z, \hat{x}] = i\hbar\hat{y}$, $[\hat{L}_z, \hat{y}] = -i\hbar\hat{x}$, $[\hat{L}_z, \hat{z}] = 0$.

(c) A particle of mass '*m*' is moving in the following potential *V(x)*

$$V(x) = 0 \quad x \leq 0$$

$$= V_0 \quad x > 0$$

For energy $E < V_0$, find the reflection coefficient. Is there any transmission in the classically forbidden region? 2+3+(3+2)

5. (a) What are *magic numbers*?

(b) Why is the O^{17} nucleus a spontaneous neutron emitter?

(c) Explain why closed-shell nuclei must be spherically symmetric. 4+3+3

6. (a) Compare the liquid drop model with the shell model of the nucleus.

(b) Calculate the binding energy in MeV of ^{4}He from the following data:

Mass of ^{4}He $= 4 \cdot 003875$ amu, Mass of ^{1}H $= 1.008145$ amu and Mass of a neutron $= 1.008986$ amu

(c) Why in stable heavier nuclei, all the numbers of neutrons are excess of protons? 4+4+2

7. (a) In a laser device, how is the stimulated emission collimated?

(b) How is a laser beam polarized?

(c) What is coherence length? How is it measured? 3+3+4

Syllabus : 2018-2019

(Digital Systems and Application)

Full Marks : 50

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Answer *question no.* **1** and *any four* questions from the rest.

1. Answer *any five* questions: 2×5

   (a) Convert $(10110011)_2$ into its decimal equivalent.

   (b) Show that $A \oplus B \oplus C = \overline{A}\,\overline{B}C + \overline{A}B\overline{C} + A\overline{B}\overline{C} + ABC$.

   (c) Add $(1010 \cdot 1101)_2$ with $(101 \cdot 01)_2$.

   (d) Write down the truth table of a J-K flip flop.

   (e) What is an encoder?

   (f) Explain the use of 'CLEAR' terminal in a sequential circuit.

   (g) Differentiate between combinational and sequential circuits.

2. (a) Implement AND gate using Diode logic. Explain with proper circuit diagram.

   (b) Evaluate the sum of $(8)_{16} + (F)_{16} = (?)_{16}$.

   (c) Convert $(247)_{10}$ into hexadecimal number. (4+2)+2+2

3. (a) Draw a D type flip flop using NAND gates and write down its truth table.

   (b) Draw and explain the circuit of a 4 bit shift register with serial loading and parallel reading.

   (3+2)+ (3+2)

4. (a) What is multiplexer? Write the truth table, Boolean expression and draw the circuit of a 4 : 1 MUX.

   (b) Why is a multiplexer called a data selector? (1+2+1+3)+3

5. (a) Draw the circuit diagram and explain the function of a edge triggered J – K flip flop.

   (b) Verify the Boolean identity by constructing a truth table

   (A+B) (B+C) (C+A) = AB + BC + CA

   (c) Simplify the truth table using K map:

A	B	C	Y
0	0	0	1
0	0	1	X
0	1	0	1
0	1	1	X
1	0	0	0
1	0	1	X
1	1	0	1
1	1	1	0

(2+3)+2+3

6. (a) What do you mean by Astable and Monostable Multivibrator?

   (b) Explain the astable mode of a 555 IC timer.

   (c) What is the difference between SRAM and DRAM? 3+5+2

7. Design a 4-bit ripple counter using MS-JK Flip Flop. Convert this ripple counter into MOD-10 counter and explain its operation. 4+2+4

_____