B.Sc. 4th Semester (Honours) Examination, 2021-22

PHYSICS

Course ID: 42412 **Course Code: SH/PHS/402/C-9**

Course Title: Elements of Modern Physics

Time: 1Hour 15 Minutes **Full Marks: 25**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Section-I

1. Answer *any five* questions: **(1× 5 = 5)**

(a) What do you mean by eigen value of a quantum mechanical operator?

(b) A light source of frequency 6×10^{14}Hz produces 10W power. How many photons are produced in 1 second?

(c) Why is it necessary to assign a wave packet to describe the motion of a particle instead of a single monochromatic wave?

(d) What are semi magic and double magic number?

(e) What is population inversion**?**

(f) What is the basic difference between spontaneous emissions and stimulated emissions?

(g) What do you mean by half-life and mean life of a radioactive material?

(h) What do mean by probability density of a quantum system?

Section-II

2. Answer *any two* of the questions: **(5× 2 = 10)**

(a) i) Normalize the following wave function

$\Psi(x) = A e^{-\alpha x}$ for $x>0$

$= A e^{+\alpha x}$ for $x<0$, where α is a positive constant.

ii) An electron of mass m is trapped within a length Δx . Estimate the approximate kinetic energy of the electron. [3+2]

(b) Free particle of mass m is kept in aone-dimensional box with rigid walls at x=0 and x=L whose potential is,

$V(x) = 0;\ 0<x<L$

$= \propto;\ \ 0 \geq x \geq L$

Find normalized wave functions and energy values. [5]

(c) What are Einstein's **A**and **B** coefficients?

Show that, $\frac{A}{B} = 8\pi h\frac{\gamma^3}{C^3}$, (Symbols have their usual meaning) [2+3]

(d) Describe Heisenberg's Thought experiment on the measurement of an electron's position by photon and arrive at the position-momentum uncertainty relation. [5]

Section -III

3. Answer *any one* of the questions: **$(10\times 1 = 10)$**

(a) i) Draw a schematic diagram of the arrangement of the Davisson-Germer experiment and elucidate the main observation. Based on this observation what conclusions were drawn.

ii) Find the smallest possible uncertainty in the position of an electron moving with velocity 3×10^7m/s.

iii) Calculate de-Broglie wavelength of an electron moving with velocity$\frac{3}{5}c$.

[2+2+2) +2+2]

(b) i) Discuss the classification of nuclear reactors. What are the differences between fission and fusion reaction? Describe how Pauli predicted the existence of neutrino in a beta decay process.

ii) Compute the Coulomb coefficient a_c of the semi-empirical mass formula using the following data: masses of $^{15}_{7}N$= 15.000108u. and$^{15}_{8}O$=15.003070u.

[(3+2+3)+2]
