M.Sc.

2011

4th Semester Examination

PHYSICS

PAPER—PH-2202

Full Marks : 40

Time : 2 Hours

The figures in the right-hand margin indicate full marks.

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

Illustrate the answers wherever necessary.

Group—A

(*Marks : 20*)

1. Answer any *five* from the following : 2×5

   (a) Discuss the exchange forces between the nucleons.

   (b) On the basis of the extreme single particle shell model, predict the spin and parity of the ground state of ${}_{9}F^{17}$ and ${}_{16}G^{31}$ nuclei.

   (c) What do you mean by single and double magic nuclei, discuss with examples?

   (d) Graphically discuss the compound nuclear reaction mechanism to explain nuclear reactions.

   (e) Discuss the basic principle of the time of flight method in neutron spectroscopy.

(Turn Over)

(f) State and discuss the IPM and S.I.M. with exampl

(g) What do you understand by the level width (Γ) a level Separation (D) between the levels of Continuum in nuclear reactions?

(h) What are the sources of neutrons?

2. Answer any *one* bit : 10×

(a) Write the wave equation for the ground state of t deuteron and solve it to obtain an expressi connection the depth (U_0) and range (r_0) of nucl potential with the binding energy of deuteron (B) 2-

(b) What are thermal neutrons? Calculate the m probable velocity and most probable energy of neutro at room temperature (20°C)

How can you establish that neutrons at low ene behave like a gas. 2+5+2-

Group—B

(*Marks* : 20)

Answer Q. No. 1 and any *one* from the rest.

1. Answer any *four* of the following : 4×2

(a) What do you mean by 'local' gauge invariance a 'global' gauge invariance?

(b) Assuming that Wick's theorem holds for product o fields, show that it holds also for the product of (n + fields.

(c) State and discuss Wick's expansion theorem.

(d) Investigate whether or not η exists for

$$\Lambda(\partial) = \gamma\partial + m\frac{1+\gamma\partial}{2}$$

(e) Show that appropriate Feynman diagrams can be drawn to describe the second order S-matrix element for the Compton scattering.

(f) Justify why a waveform interpretation of the Klein-Gordon equation is not possible.

2. (a) Show that

$$\left\{\psi(t,\vec{x}),\psi^{+}(t,\vec{y})\right\} = \delta^{3}(\vec{x}-\vec{y})$$

for Dirac field.

(b) Explain time-order product and normal order product.

(c) If $\hat{N} = \int d^{3}p\, a^{+}(p)a(p)$ be the number operator in Fock space, then show that

$$\left[\hat{N},\, a^{+}(k)\right] = a^{+}(k)$$

$$\left[\hat{N},\, a(k)\right] = -a(k)$$

4+2+2+2

3. (a) Consider the Lagrangian of a real scalar field ϕ

$$L = \frac{1}{2}(\partial_\mu \phi)^2 - V(\phi)$$

where $V(\phi) = \frac{1}{2}\mu^2\phi^2 + \frac{\lambda}{4}\phi^4$ with $\lambda > 0$.

(i) What is the symmetry under which the above Lagrangian invariant?

(ii) Sketch the potential $V(\phi)$ for $\mu^2 < 0$ and $\mu^2 > 0$.

(iii) Consider the quantum fluctuation $\eta(x)$ about the minimum for $\mu^2 < 0$. How is the above Lagrangian modified under this transformation

$\phi(x) = v + \eta(x)$; v is the minimum for $\mu^2 < 0$ case. What can you conclude from the new Lagrangian? Does this Lagrangian possess the above symmetry in (i)? 1+2+2

(b) For a Higg's boson multiplet $L_\phi = (D^\mu \phi)^+ (D_\mu \phi) - \mu^2 \phi^+ \phi - \lambda(\phi^+ \phi)^2$

where $D_\mu = \partial_\mu + igT_a^{(n)} W_\mu^a + ig' Y B_\mu$

with $T_a^{(n)}$ denote generators of SU(2) and $\phi = \begin{pmatrix} \phi^+ \\ \phi^0 \end{pmatrix}$ for charged field and neutral field.

Prove that mass of W-boson is $\frac{1}{2} gv$ and that for Z^0-boson is $\frac{v}{2}\sqrt{g^2 + g'^2}$.

where g, g′ are coupling constants. 2+3
