M.Sc. 4th Semester Examination, 2010

PHYSICS

PAPER—PH-2202 (A & B)

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

Paper—PH-2202 A

Marks : 20

Time : 1 hour

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

(*a*) Discuss the different types of two-body nucleon-nucleon interactions in tabular form.

(*b*) Using experimental evidences, show that the Deuteron ground state wave function (ψ_0) can be expressed as

$$\psi_0 = a_0 \psi_{1s} + a_2 \psi_{1d}$$

(*c*) With the help of compound nuclear model explain nuclear reactions.

(*d*) Present graphically how Bohr - wheeler used the liquid-drop model to explain the process of nuclear fission.

(*e*) Write the shell configuration and predict the spin and parity of the following ground state nuclei on the basis of single particle shell model :

$${}_6C^{13}, \; {}_{13}Al^{27}.$$

(*f*) How does the collective model incorporate essential features of liquid-drop model of nuclei ?

(*g*) State and discuss the 'thermal neutron'.

(*h*) Illustrate using B^{10} (α, p) C^{13} nuclear the conservation of parity in nuclear reaction (S-wave) [B^{10}, α and $_1H^1$ is even while C^{13} is odd].

2. Answer any *one* bit : 10×1

(*a*) What are the resonance levels and resonances in the formation of the compound nucleus ? Give a simple derivation of the Breit-Wiger one level formula for the radiative capture cross-section of neutron reaction in nuclei to describe resonances. $3 + 7$

(*b*) Describe the various experimental techniques involved in neutron spectroscopy, giving special emphasis on time of flight method to select neutron beams of definite energies. $2 + 8$

Paper—PH-2202 B

(*Quantum Field Theory*)

Marks : 20

Time : 1 hour

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

1. Answer any *five* bits : 2×5

(*a*) Write down the Lagrangian for Fermion fields and gauge fields.

(*b*) Write down time-ordered product for fermionic fields.

(*c*) For real scalar field show that $a^{+}|n_k>$ and $a|n_k>$ are eigenstates of the number operator N_k.

(*d*) Show that the eigenvalues of the number operator of a Dirac field is either zero or unity.

(*e*) Draw a Feynman diagram for $e^{-} + \mu^{-} \rightarrow e^{-} + \mu^{-}$ scattering and write down its amplitude.

(*f*) Evaluate:

$$Tr\,(\not{p}_2\, r^{\mu}\, \not{p}_1\, r^{\mu'})$$

(*g*) Evaluate:

$$\hat{C}\,\hat{H}^{e.m}_{int}\,\hat{C}^{-1} \text{ and } \hat{P}\,\hat{H}^{e.m}_{int}\,\hat{P}^{-1}$$

where $\hat{C}$ and $\hat{P}$ are charge conjugation and parity operators.

(*h*) Discuss Higg's mechanism.

2. (*a*) Write down the Lagrangian density for complex scalar field. If this Lagrangian is invariant under global gauge transformation, using Noether's theorem find the corresponding conserved current j^{μ}. Verify $\partial_{\mu} j^{\mu} = 0$.

(*b*) Also show that total charge

$$Q = Q_{\text{fermion}} - Q_{\text{anti-fermion}}.$$

2 + 3 + 2 + 3

3. (*a*) Deduce an expression for Fermion propagator.

(*b*) Define parity, time reversal and charge conjugation operations. Obtain any two of the operators for the Dirac field.

(*c*) Give an idea about neutral current and symmetry breaking. 10
