M.Sc. 4th Semester Examination, 2012

PHYSICS

PAPER— PHS-402 (A & B)

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

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

*Illustrate the answers wherever necessary*

PAPER — PHS - 402(A)

[*Marks* : 20]

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

   (*a*) Using experimental evidences, set up the wave -equation for the ground state of the deuterion.

   (*b*) Diagrammatically present the $p - p$ interactions system at below 10 MeV scattering energy.

(c) Discuss with example a different channels for nuclear reactions.

(d) What is magic numbers ? Write a semi-magic and magic numbers.

(e) State the name of the nuclear reaction which follow break up by chipping of following small fragments.

$$_{33}As^{75} \ (\alpha, \ 18 \ Z \ 419) \ _{17}Cl^{38}.$$
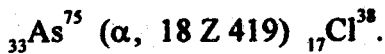
(f) What are the sources of neutrons ?

(g) On the basis of the extreme single particle shell model, using shell configuration predict the spin and parity of the ground state of $_6C^{12}$.

(h) Graphically represent the types of neutrons with energy.

2. Answer any *one* bit :

(a) What is S.I.M. ? Discuss picturally how Bohr and Wheeler used the liquid-drop model to explain the process of nuclear fission. $2 + 8$

(*Continued*)

(b) Discuss neutron optics. Derive the relation between refractive index (μ) and scattering length (a) of a material with nuclei per unit volume (N) due to neutron for wave length (λ). $2 + 8$

(*Quantum Field Theory*)

PAPER — PHS - 402(B)

[*Marks* : 20]

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

1.   Answer any *five* : 2×5

   (a) Define gauge co-variant derivative and why was it introduced ?

   (b) State the usefulness of normal ordering and time ordering.

   (c) Show that :

   $$a^+ \left| n_K \right\rangle \text{ and } a \left| n_K \right\rangle$$

   are eigen states of the number operator $N_{K'}$ for real scalar field.

(d) Why C_p is violated in weak interactions ?

(e) State why it is necessary to study quantum field theory to understand interactions of particles. What is meant by second quantization ?

(f) Show that for a Klein-Gordon field

$$a_k \left| n_k \right\rangle = \sqrt{n_k} \left| n_k - 1 \right\rangle$$
$$a_k^+ \left| n_k \right\rangle = \sqrt{n_{k+1}} \left| n_{k+1} \right\rangle$$

where each symbol has its usual meaning.

(g) What is Higg's mechanism ? Discuss briefly about it.

(h) Distinguish between 'local' gauge invariance and 'global' gauge invariance.

2. (a) Prove that the invariance of the scalar field Lagrangian under space time translation leads to stress-energy tensor

$$T^{\mu\nu} = \frac{\partial L}{\partial(\partial_\mu \phi)} \partial^\nu \phi - g_L^{\mu\nu}.$$

(Continued)

(b) Prove that :

$$T_r \left[(\not{p_2} + m)\gamma^\mu (\not{p_1} + m)\gamma^\lambda \right]$$
$$= 4 \left[p_2^\mu p_1^\lambda + p_2^\lambda p_1^\mu + m^2 g^{\mu\lambda} - p_1 \cdot p_2 \; g^{\mu\lambda} \right].$$
$$5 + 5$$

3. (a) Deduce an expression for Fermionic 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 with Feynman diagram. $4 + 2 + 4$