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PG/4th Sem/PHS/19

2019

PG

4th Semester Examination

PHYSICS

Paper - PHS 402

Full Marks : 20

Time : 2 Hours

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

Group - A

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

1. Answer any five bits : 5×2=10

- (a) The only bound two-nucleon configuration that occurs in nature is the deuteron 2_1D , with total angular momentum $J=1$ and binding energy = 2.224 MeV. Show that the n-p force must be spin dependent. 2

[Turn Over]

- (b) What do you understand by the level width (Γ) and level separation (D) between the levels of a continuum in nuclear reactions ? 2
- (c) Give the range of life-time and nucleon traverse-time on the formation and disintegration of the compound nucleus. 2
- (d) Compare the spin and parity predicted by the extreme single particle shell model for the ground states of the nuclei with the experimental values given in the parenthesis : ${}_{9}\text{F}^{17} \left(\frac{5^+}{2} \right)$ 2
- (e) Write the disadvantages of reactor as a neutron source. 2
- (f) Diagrammatically present the p-p interactions system at below 10 MeV scattering energy. 2
- (g) Find the magnetic moment of the ground state of ${}_{8}\text{O}^{17}$ due to odd neutron considering shell model. 2
- (h) State the principles of velocity selector neutron monochromator. 2

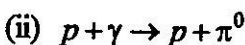
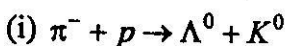
2. (a) Experimentally the study of p-p scattering, is capable of much higher accuracy than n-p scattering, why? 2

(b) Deduce Bohr-Wheeler's theory of nuclear fission. 4

(c) Derive the relation between refractive index (μ) and scattering length (a) of a material with nuclei per unit volume (N) due to neutron for wavelength ' λ '. 4

3. (a) How magic numbers are explained using shell model ? 4

(b) Classify the following processes as strong, electromagnetic, and weak.



(c) Calculate the average energy loss for neutrons which have made one collision with carbon nuclei, for carbon is 0.158. 3

[Turn Over]

Group - B

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

1. Answer any *five* bits : 2×5=10

- (a) Write down momentum and angular momentum of the Dirac field.
- (b) What is the time ordering? Write down Feynman propagator in terms of time ordering.
- (c) If the Dirac field is quantized according to the Bose-Einstein rather than Fermi-Dirac statistics, what would be the energy of the field?
- (d) For e.m. field, Prove that

$$T^{00} = \frac{1}{2}(\vec{E}^2 + \vec{B}^2)$$

- (e) Prove that Feynman propagator for photon is

$$D_F^{\mu\nu}(\kappa) = \frac{-g_{\mu\nu}}{\kappa^2 + i\epsilon}$$

- (f) Prove that $\not{p}^2 = p^2$

(5)

- (g) Evaluate $[\sigma_{\mu\nu}, \sigma_{\rho\lambda}]$ where $\sigma_{\mu\nu} = \frac{i}{2}[\gamma_\mu, \gamma_\nu]$.
- (h) Find the transformation law $V_\mu(x) = \bar{\psi} \gamma_\mu \psi(x)$ under Lorentz transformation.
2. (a) Let the Lagrangian density be given by $\mathcal{L} = i\bar{\psi}\gamma^\mu \partial_\mu \psi - gx^2\bar{\psi}\psi$ where g is a constant.
- (i) Derive the expression for the energy momentum tensor $T_{\mu\nu}$. Find its divergence $\partial_\mu T^{\mu\nu}$. Comment on this result.
- (b) Calculate the commutator $[P^0(t), P^j(t)]$.
- (c) Find the four divergence of the angular momentum operator $M^{\mu\alpha\beta}$. 3+5+2
3. (a) Find the differential cross section for scattering of an electron in the external potential $A^\mu = (0, 0, 0, ae^{-k^2x^2})$. where the vertex is $ie\gamma_\mu(1-\gamma_5)$. The initial electron is moving along z-axis. 5+3+2

[Turn Over]

(b) Using Wick's theorem evaluate

$$(i) \quad \langle 0 | T(\phi^4(x) \phi^4(y)) | 0 \rangle$$

$$(ii) \quad T(:\phi^4(x)::\phi^4(y):)$$
