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M. Sc End Semester Examination- IV, 2020

PHYSICS

Full Marks : 40

Time : 2 hours

PAPER- PHS-402

Use separate scripts for Group A & Group B

Group : A: PHS 402.1 : Nuclear Physics II

Answer any One of the following questions **[Marks : 20]**

Instruction:

The questions are of equal value for any paper. Candidates are required to give their answer in their own words (limit: 250 words) as far as practicable.

Q1. Explain direct and compound nuclear reactions? What is time reversable mechanism?

Q2. Write down the Messon theory of nuclear force. What do you mean by moderating ratio? Write its significances.

Q3. What do you mean by thermal neutrons? Calculate average log decrement of energy per collision.

Q4. Write the basic assumption of liquid drop model of a nucleus. Write down the semi-emperical mass formula and explain the terms.

Q5. What is magic numbers? Write an example of semi-magic and double magic numbers. Write short note on shell model.

Q6. State continuum theory of nuclear reaction. Derive and discuss the four factor formula for nuclear reactor.
Classify neutron according to energy scale.

Group : B: PHS 402.1 : Quantum Field Theory

Answer any One of the following questions **[Marks : 20]**

Instruction:

The questions are of equal value for any paper. Candidates are required to give their answer in their own words (limit: 250 words) as far as practicable.

Q1. Consider Dirac field with Lagrangian density $\mathcal{L} = \bar{\Psi}(i\gamma^{\mu}\partial_{\mu} - m)\Psi$.

a) Write down the expression for Dirac field in terms of creation and annihilation operators in Fourier integral form.

b) Obtain an expression for Hamiltonian of the corresponding field in terms of creation and annihilation operators for particles and antiparticles.

Q2. The Euler -Lagrange equation for A_{μ} should give the Maxwell equation $\partial_{\mu}F^{\mu\nu} = j^{\nu}$ for the

Lagrangian density

$$\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + [(\partial_{\mu} - iq\mathrm{A}^{\mu})\phi^{+}][(\partial_{\mu} + iq\mathrm{A}_{\mu})\phi] - m^{2}\phi^{+}\phi - V(\phi^{+}\phi).$$

Q3. a) Consider the complex scalar field $\mathcal{L} = (\partial_{\mu}\phi)^{+}(\partial^{\mu}\phi) - m^{2}\phi^{+}\phi - V(\phi^{+}\phi)$. Show that the Lagrangian is invariant under internal symmetry transformation $\phi \to e^{-iq\epsilon}\phi, \phi^{+} \to \phi^{+}e^{iq\epsilon}$.

b) Use Noether's theorem to find the corresponding conserved current j^{μ}.

Q4. a) Find the stress energy tensor for the e.m. field $\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu}$.

b) Find Wick's theorem for two fermionic operators $\psi(x)$ and $\psi'(x')$.

Q5. Draw the feynman diagram for pair annihilation $e^{+} + e^{-} \to \gamma + \gamma$.Compute the amplitude $\mathcal{M}$ assuming the electron and positron are at rest and in the singlet spin configuration. Also justify for taking singlet spin configuration only.

Q6. Consider a massive vector field given by Proca Lagrangian

$$\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \frac{1}{2}M^{2}\mathrm{A}^{\mu}\mathrm{A}_{\mu} - \mathrm{A}_{\mu}j^{\mu}.$$

Find the equation of motion. Show that the propagator $D_{\mu\nu}(k) = \frac{1}{k^{2}-M^{2}}\left(-g_{\mu\nu} + \frac{k_{\mu}k_{\nu}}{M^{2}}\right)$.