



DMM-1624
M. Sc. (Sem. IV) Examination
April / May - 2016
Physics : PH (T) - 544
(Group Theory & Quantum Field Theory)

Time : 3 Hours]

[Total Marks : 70

Instructions :

(1)

<p>नीचे दृष्टावेक निशानीवाणी विगतो उत्तरवही पर अवश्य लपवी. Fillup strictly the details of signs on your answer book.</p> <p>Name of the Examination :</p> <p>☛ M. Sc. (SEM. 4)</p> <p>Name of the Subject :</p> <p>☛ PHYSICS : PH (T) - 544</p> <p>☛ Subject Code No. : 1 6 2 4 ☛ Section No. (1, 2,.....) : Nil</p>	<p>Seat No. :</p> <table border="1" style="width: 100%; height: 20px;"><tr><td style="width: 15%;"></td><td style="width: 15%;"></td><td style="width: 15%;"></td><td style="width: 15%;"></td><td style="width: 15%;"></td><td style="width: 15%;"></td></tr></table> <div style="border: 1px solid black; border-radius: 15px; padding: 10px; text-align: center; margin-top: 10px;">Student's Signature</div>						

- (2) Attempt all questions.
- (3) Symbols used have their usual meaning.
- (4) Figures to the right indicate marks.
- (5) Assume data whenever necessary.
- (6) Scientific calculator may be used.

1 Attempt any two questions :

- (1) (a) Show that the set of all non-zero complex numbers form a group under multiplication. 3
- (b) Discuss permutation group with an example. 4
- (2) (a) Evaluate $C_4^{-1}m_xC_4$ for $m_x, C_4 \in C_{4v}$ 3
- (b) What are the elements of the symmetry group C_{5v} of a regular pentagon ? Determine the number of classes and number of irreducible representations of this group along with their dimensions. 4
- (3) (a) Write all the elements of the group of symmetries of a square C_{4v} . 3
- (b) Show that the matrices obtained by taking the direct product of the matrices of two representations also generate a representation of the group. 4

- 2** Attempt any two questions :
- (1) (a) What is meant by connectedness and compactness of a continuous group ? 2
 (b) Discuss the 3-dimensional rotation group $SO(3)$. 5
- (2) (a) What is Lie algebra ? What is its importance ? 3
 (b) Find the generators of the group of all orthogonal matrices of order 2 with determinant + 1. 4
- (3) (a) What is a Casimir operator ? Find the Casimir operator(s) of group $SO(3)$. 3
 (b) Discuss the pseudo-rotation group $O_{1,1}$. 4
- 3** Attempt any two questions :
- (1) (a) Discuss the Klein-Gordon equation for a free particle and mention the difficulties with this equation. 3
 (b) Write the free field Lagrangian density for the spin zero field and obtain the field equation corresponding to the Klein-Gordon equation. 4
- (2) (a) Define vacuum state of a free scalar field. 3
 (b) Find the interaction energy between two nucleons interacting through their real scalar meson fields. 4
- (3) (a) Write the commutation rules for the free scalar field in terms of creation and annihilation operators. 3
 (b) Discuss the Lagrangian formulation and quantization rules for a charged scalar field. 4
- 4** Attempt any two questions :
- (1) (a) Write the feynman diagram with one loop correction in the case of electron-electron scattering with a static charge. 3
 (b) Apply the Feynman rules for the above case and express the scattering amplitude. 4
- (2) (a) Establish the anti-commutation relations for the Dirac field. 3
 (b) Discuss in detail the idea of renormalization. 4
- (3) (a) Discuss the rules for Feynman graphs in momentum space. 3
 (b) Consider the electron – Photon interaction Hamiltonian in the covariant form and represent the various terms in the interaction diagrammatically. 4

- 5 Attempt any two questions :
- (1) (a) Discuss the local Gauge transformation of a Dirac field. 3
 - (b) Discuss the Higg's mechanism with reference to spontaneous symmetry breaking. 4
 - (2) (a) Discuss the U(1) gauge symmetry for Abelian transformations. Explain how does the gauge invariance force the vector meson to be massless. 3
 - (b) Write the interaction Lagrangian and draw the Feynman diagrams for the process : (a) emission of a photon by an electron; (b) electron-positron annihilation. 4
 - (3) (a) What are gauge transformations ? Explain the gauge principle and gauge fields. 3
 - (b) Discuss the spontaneous breaking of global symmetry in Goldstone model. 4
-