

Ex/M.Sc./Math/22/4.3/A2.8/2018
MASTER OF SCIENCE EXAMINATION, 2018
(2nd Year, 2nd Semester)
MATHEMATICS
Unit - 4.3 (A - 2.8)
(Quantum Mechanics)

Full Marks : 50

Time : Two Hours

The figures in the margin indicate full marks.

Symbols / Notations have their usual meanings.

Answer any *five* questions.

1. Derive the Klein-Gordon equation for the relativistic description of a free particle. Discuss the validity of the equation. 10
2. Find the free particle solutions of the Dirac equation. How is the negative energy spectrum explained ? 10
3. (a) Show that the orbital angular momentum is not a constant of motion for the Dirac particle. Also show that the total angular momentum includes the spin of the Dirac particle. 6

[*Turn over*]

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- (b) Find the velocity operator for the Dirac particle. 4
4. (a) Write the Dirac Equation in covariant form. 4
- (b) Find the commutation relations for the γ -matrices. 3
- (c) Show that γ^0 is Hermitian but γ^k ($k = 1, 2, 3$) is anti-Hermitian. 3
5. What is the parity operation ? Investigate the parity operation on the positive energy solutions of Dirac equation for a free particle. 5+5
6. (a) Define Elastic and Inelastic scattering. Find an expression for the differential scattering cross-section for inelastic scattering. 2+2
- (b) What is the significance of the centre of mass co-ordinates for the scattering phenomenon ? How are the cross-sections in the Laboratory and centre of mass systems related ? 2+4
7. Use the method of partial waves to obtain the scattering cross-section in terms of the phase shifts. 10