PARVATHANENI BRAHMAYYA
SIDDHARTHA COLLEGE OF ARTS & SCIENCE
*Autonomous*
Siddhartha Nagar, Vijayawada–520010
*Re-accredited at 'A+' by the NAAC*

# QUANTUMMECHANICS–II

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| Offered to : M.Sc.(PHYSICS) | Course Code : 22PH3T1 |
| Course Type : Core | Course : QUANTUMMECHANICS-II |
| Year of Introduction : 2004 | Year of offering : 2022 |
| Year of Revision : 2022 | Percentage of Revision : Nil |
| Semester : III | Credits : 4 |
| Hours Taught: 60 hrs. per Semester | Max.Time : 3 Hours |

**CourseDescription:**Quantum Mechanics - II is a second course in quantum theory leads from quantum basics to basic quantum field theory, and lays the foundation for research-oriented concepts. This course is aimed to give insights on angular momentum, basic concepts of scattering cross-section & amplitude and to solve simple problems on scattering besides relativistic quantum physics

CourseObjectives:

1. Toapplytheformalismtostudytheorbitalangularmomentumconcept
2. Toapplytheformalismtostudythespinandtotalangularmomentumconcept
3. Tolearnthescattering processesofdifferent problems
4. Tolearntheformalismofrelativisticquantummechanics
5. TolearncovaianceofDirac'sequationunderdifferenttransformations

**Course Outcomes :**At the end of this course, students should be able to:

CO1: Analyze the problems related to orbital angular momentum
CO2: Analyze the problems related to spin and total angular momentum
CO3: Understand different scattering problems
CO4: Analyze and compare Klein Gordan theory and Dirac's theory
CO5: Understand the concept of covariance under different transformations.

| CO-POMATRIX | | | | | | | | |
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| | **CO-PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** |
| 22PH3T1 | **CO1** | H | | | | | L | M |
| | **CO2** | H | | | | | L | M |
| | **CO3** | | H | | | | L | M |
| | **CO4** | | M | | | | L | M |
| | **CO5** | H | H | | | | L | M |

| Syllabus | | |
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| **Unit** | **LearningUnits** | **Lecture Hours** |
| I | **Orbitalangularmomentum**<br>Introduction, Orbital Angular momentum, commutation relations for angularmomentum operator. Ladder operators, Angular Momentum in spherical polarcoordinates, Eigen valueproblem for $L^2$ and Lz, Eigen value problem for L+andL- operators,EigenvaluesandEigenfunctionsofRigidrotatorand Hydrogenatom. | 12 |
| II | **SpinandTotalAngularMomentum**<br>Spinangularmomentum,Pauli'sexclusionprincipleandconnectionwithstatistical mechanics, Pauli spin matrices for electron, Commutation relations,Paulioperators,Paulieigenvaluesandeigenfunctions,Totalangularmomentum J,Commutationrelationsoftotalangularmomentumwithcomponents.Eigenvalues of $J^2$ and $J_z$,Eigenvalues of $J_+$ and $J_-$,Explicit matricesforJ,$J_x$,$J_y$&$J_z$. | 12 |
| III | **ScatteringTheory**<br>Scattering cross section, scattering amplitude, Partial waves, Scattering by acentral potential: Partial wave analysis, significant number of partial waves,Scatteringbyanattractivesquarewellpotential,scatteringlength,Bornapproximation–Criteria for the validityofBornapproximation. Scatteringduetoscreenedcoulombpotential,Formfactor,Opticaltheorem, Lowenergylimit. | 12 |
| IV | **Relativisticquantummechanics**<br>Klein-Gordonequation-continuityequation(probabilityandcurrentdensity), Klein-Gordonequation in the presence of electromagnetic field, Diracequation for a free particle,Diracmatrices-properties probability and currentdensity,Diracequationinpresenceofelectromagneticfield,Constantsofmotion–Linearmomentum–Totalangularmomentum (existenceofelectronspin), Velocityoperator, Helicityoperator, Zitterbewegungoperator. | 12 |
| V | **Covariantnotation**<br>Covariantnotation,covarianceofDiracequation,InvarianceofDiracequationunder Lorentztransformation,PurerotationandLorentztransformation,Chargeconjugation,Holetheory,Projectionoperatorsforenergyandspin, Diracequationfor Zeromassandspinhalfparticles. | 12 |

## ReferenceBooks:


1 N.ZETTILI,Quantummechanics:ConceptsandApplications,(JohnWiley&Sons).
2 S.L. KAKANI and H. MCHANDALIA, Quantum Mechanics: Theory & Problems,SultanChand&Sons.2004
3 R.K.PRASAD,QuantumChemistry,NewAgeInternational(P)Limited,PublishersSecondedition,2002
4 G.ARULDHAS,QuantumMechanics,PrenticeHallof IndiaPrivateLimited,2002