Course Code	Course Name	Credits
26PH603	QUANTUM COLLISION THEORY	04

Course Objectives

- Electrons exist in more than one place at the same time.
- Electrons shoot from an electron gun as a particle, travel as a wave, and land on a detector as a particle.
- Electrons don't have definite properties until they have an interaction with another part of the physical universe.
- Particles travel backwards in time as in the delayed choice two-slit experiment.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Use the collision theory to explain why changes to a reaction can increase the rate of reaction (temperature, concentration, surface area and catalyst) 2. To understand why not all collisions are successful

Unit 1 - Introduction To Fields (12 Hrs.)

Lagrangian and Hamiltonian formulation of continuous systems. Field Examples & Applications -Euler-Lagrange Field Equations.

Unit 2 – Relativistic Field Theory (12 Hrs.)

Introduction to relativistic field theories, Noether's theorem, Four-vector notations, Lorentz transformations, natural units.

Unit 3 - Many Particle Systems (12 Hrs.)

Non-relativistic quantum systems, free fields, Klein-Gordon equation- non-relativistic many particle systems, relativistic free scalar fields, Dirac equation, antiparticles-free Dirac fields.

Unit 4 – Field Quantization (12 Hrs.)

Action principle, quantization of scalar fields, quantization of Dirac fields- quantization of vector fields, Lorentz transformation and invariance, parity, charge conjugation and time reversal-CPT theorem.

Unit 5 - Interactions Among Fields (12 Hrs.)

Interactive pictures, S-matrix, Wick's theorem, second-order processes, position space Feynman rules, momentum space Feynman rules; cross-sections.

Reference Books:

1. Peskin, M. E. and Schroeder, D. V., *Introduction to Quantum Field Theory,* (WestviewPress, 1995)
2. Weinberg, S., *The Quantum Theory of Field, Vol. I, II, III* (Cambridge University Press,2000)
3. Mandl, F. and Shaw, G., *Quantum Field Theory,* (John Wiley and Sons, 2010)
4. Perkins, D. H., *Introduction to High Energy Physics,* (Cambridge University Press, 2000)
5. Aitchison, I. J. R. and Hey Gauge, A. J. G., *Theories in Particle Physics,* (Taylor andFrancis Group, 2002)

Websites and eLearning Sources:

1. https://nptel.ac.in/courses/115106085
2. https://youtu.be/MOECgpuzpLI?si=vK4x80T0epms6V9v
3. https://youtu.be/tABaFuJYWVM?si=bfu1oZeasAOO1Rkj

COs and Bloom's Taxonomy Mapping – 26PH603		
Course Outcomes	**On successful completion of this course, students will be able to**	**BTL**
CO1	Recall and explain Lagrangian and Hamiltonian formulation of fields, relativistic invariance, and Lorentz transformations.	K1, K2
CO2	Apply relativistic quantum concepts to describe scalar and spinor fields using Klein–Gordon and Dirac equations.	K3
CO3	Analyze quantization of scalar, Dirac, and vector fields including symmetry properties such as CPT invariance.	K4
CO4	Analyze many-particle systems and field interactions using second quantization and quantum field formalism.	K5
CO5	Evaluate and develop theoretical models for particle interactions using S-matrix, Feynman diagrams, and cross-section calculations.	K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

Relationship Matrix – 26PH603													
Course Outcomes	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**						**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	
CO1	3	2	1	1	1	1	3	2	1	1	1	1	1.58
CO2	3	3	2	2	1	1	2	3	2	2	2	1	2.00
CO3	3	3	3	2	1	1	2	3	3	2	2	2	2.25
CO4	3	3	3	2	2	1	2	3	3	2	2	2	2.33
CO5	3	3	3	3	2	2	3	3	3	3	2	2	2.58
												Total	2.15

Mean Score: 3- High, 2- Medium/Moderate, 1-Low