IIT Mandi
Proposal for a New Course

Course number	**: PH626**
Course Name	**: Elementary Theoretical Particle Physics**
Credit	**: 3**
Distribution	**: *3-0-0-3***
Intended for	**: UG/PG/I-PhD/PhD**
Prerequisite	**: PH612 (Nuclear and Particle Physics), PH301/PH513 (Quantum Mechanics)**

Mutual Exclusion: None

1. Preamble:

Our visible universe is made up of elementary particles. In this course student will study the different types of elementary particles like quarks and leptons that exist in nature and how they interact with each other via three fundamental forces such as weak, electromagnetic and strong interactions via the exchange of boson. Student will learn Feynman diagrams and rules and how to calculate cross-section for QED, QCD and Weak processes. Moreover, student will gain understanding of Lagrangian formulation and local gauge invariance, spontaneous symmetry-breaking and Higgs mechanism. The course will also includes important results from research at the LHC including the discovery and study of the Higgs boson.

2. Course Modules with quantitative lecture

(a) Feynman Calculus: (6 hours)

Decays, scattering and cross-sections, Mandelstem variables, Fermi Golden rule, Golden rule for two particle decays and scattering of particles, two-body scattering in the COM frame. Feynman rules and diagrams for a toy theory.

(b) Quantum Electrodynamics: (10 hours)

Dirac equation, solutions to the Dirac equation, and bilinear covariants, photon, Feynman rules for QED and examples, Casimir's Trick, cross-sections and lifetimes, and renormalization, hadron production in e+e- collisions, elastic electron-proton scattering.

(c) Quantum Chromodynamics: (8 hours)

Feynman rules for Chromodynamics, Color factors, quark and antiquark, Pair annihilation in QCD, asymptotic freedom.

(d) Weak Interactions: (10 hours)

Charged leptonic weak Interactions, decay of muon, neutron, and pion, charged weak interactions of quarks, neutral weak interactions, Electroweak unification and chiral fermion states, Weak isospin and hypercharge, Electroweak mixing.

(e) Gauge Theories: (8 hours)

Lagrangian formulation of classical particle mechanics and Lagrangians in relativistic field theory, Local gauge invariance and Yang-Mills Theory, Chromodynamics, Feynman rules and Mass term Spontaneous symmetry-breaking, Higgs Mechanism.

Laboratory/practical/tutorial Modules:

Not Applicable

3. Text books:

1. David Griffiths, Introduction to Elementary Particles, 2nd edition, Wiley (2008)
2. F. Halzen and A. D. Martin, Quarks and Leptons, 1st edition, John Wiley (2016)

4. References:

1. M. Thomson, Modern Particle Physics, 1st edition, Cambridge University Press India (2016)
2. M. E. Peskin, An Introduction to Quantum Field Theory, 1st edition, Westview Press (1995)
3. D. H. Perkins, Introduction to High Energy Physics, 4th edition, Cambridge (2000)

5. Similarity with the existing courses:

(Similarity content is declared as per the number of lecture hours on similar topics)

S. No.		Course Code	Similarity Content	Approx. % of Content
1.		**PH612**	4 hrs	10%

6. Justification of new course proposal if cumulative similarity content is >30%:

Not Applicable