

## Second Semester 2015–2016

### Course Handout Part II

Date: 05/01/2016

In addition to Part I (General Handout) for all courses (appended to the time table), this portion gives further specific details regarding the course.

Course No : PHY F343

Course Title : Nuclear & Particle Physics

Instructor-in-Charge / Other Instructor : BISWANATH LAYEK / MADHUKAR MISHRA

#### 1. Scope and Objectives of the course

The course is designed to give a pedagogical overview and some working knowledge of theoretical (mainly) and experimental aspects of Nuclear & Particle Physics. Knowledge on quantum mechanics and basic (special) relativity are essential to understand the topics covered in this course. This course will prepare/motivate students to take advanced courses either in Nuclear and/or Particle Physics, later on, in their career in preparation for pursuing active research in these areas.

#### 2. Text Books:

- (I) Theoretical Nuclear Physics; J. M. Blatt & V. F. Weisskopf, Dover Publications, New York
- (II) Introduction to Elementary Particle Physics, David J Griffiths, 2<sup>nd</sup> Revised Ed., Wiley, 2008

#### 3. Ref. Books:

- (I) Nuclear Physics; S. N. Ghoshal, S. Chand Company Ltd.
- (II) Quarks and Leptons: An Introductory Course in Modern Particle Physics, F. Halzen and A. Martin, Wiley, 2008

#### 4. Course Plan: CN stands for Class Notes

Sl. No.	Topic & description of material covered	# of Lect	Reference to Textual Material
	<i>Nuclear Physics (Total 23 lectures)</i>		
1	<i>General Properties of Nuclei : (Total 5 lectures)</i>		
	<i>Nuclear size, Nuclear Charge, Nuclear Spin, Nuclear magnetic moment</i>	1	
		1	
	<i>Electric multipole moments: Spherically and axially symmetric charge distribution, electric quadrupole moment</i>	3	
	Bethe-Weizsacker mass formula & its applications in Fission		



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	& Nuclear Decays, <i>Concept of Mirror Nuclei</i>		
2	<b><i>Nuclear Force &amp; its Properties:</i></b> <b><i>I: Two Body Nuclear Problem: Deuteron ( Total 4 lectures )</i></b>		
	Deuteron wave function, Using central potential, Radial wave function	2	
	Electric quadrupole moment & magnetic moment of Deuteron nucleus	2	
3	<b><i>II: Nucleon–Nucleon Low Energy Scattering : (Total 4 lectures)</i></b>		
	Short range force, General form of the nucleon–nucleon potential, Types of Exchange forces	2	
	Low energy nucleon–nucleon scattering : Partial Wave Analysis Method The scattering length Spin dependence of n–p scattering	2	
4	<b><i>Nuclear Alpha Decay: (Total 2 lectures)</i></b>		
	The Q–value of alpha decay	1	
	Emission of alpha particle: Coulomb potential barrier	1	
5	<b><i>Nuclear Beta Decay: (Total 3 lectures)</i></b>		
	Fermi's theory : Density of final states	1	
	Nuclear transition : Fermi & Gamow–Teller transitions, Allowed & forbidden transitions	2	
6	<b><i>The Nuclear Shell Models: (Total 3 lectures )</i></b>		
	Magic numbers, Independent particle model.	3	
	Nuclear ground state configurations and spins, Low-lying energy levels		
7	<b>Nuclear Energy (Total 2 lectures)</b>		
	Nuclear Fission & Fusion, Criticality Condition	2	
	Nuclear Reactors & its Applications		
	<b><i>Particle Physics: (Total 22 lectures)</i></b>		



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1	Brief history of particles	3	Text (II) : Ch1 & Self study
2	Relativistic Kinematics	3	Text (II) : Ch3
3	Particle Classifications, Quantum Numbers & Conservation Laws, Resonances, Eightfold way, Quark Model	5	Text (II) : Ch1, Ref.(II) : Ch2
4	Isospin/Flavor symmetries, Discrete symmetries (C, P, CPT)	3	Text (II) : Ch4 and CN
5	Quantum description of relativistic particles with spin. Klein-Gordon (K-G) Equation (spin-0), Dirac Equation (spin-1/2) and Maxwell's equation (spin-1)	6	Ref. (II) : Ch3, Ch5
6	Fundamental Interactions, (Pedagogical) Introduction of Feynman Diagrams	2	Text (II) :Ch2
7	Dynamics of particle interaction : Time dependent perturbation theory, Transition Amplitude, Invariant amplitude, Crossing symmetry etc.	***	Ref.(II) : Ch3, Ch4
Total No. of Lecture Hours: 45 + Last topic depending on number of lectures available			

## 5. Evaluation Scheme

Component	Duration	Weightage(%)	Date & Time	Remarks
Mid-semester Test	90 Mins.	30 %	14/3 2:00 -3:30 PM	Closed Book
Tutorials		30%	<i>Total 6 tutorial tests out of which the best 5 will be taken into consideration.</i>	
Comprehensive Exam.	180 Mins.	40 %	16/5 FN	Partly Open and partly Closed Book

**6. Chamber Consultation Hours:** To be announced in the lecture Class

**7. Notices:** In *Nalanda*

**8. Make-up Policy:** Make-up will be given only in genuine cases, that is, due to serious illness etc. There are no make-ups for the tutorials .

*Instructor-in-charge*



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