M.Sc. Course					SC 602T NUCLEAR AND PARTICLE PHYSICS					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To develop the understanding of two nucleon system and deuteron problem.
- To introduce properties of nuclei and details of popular nuclear models.
- To overview the properties of nuclear decays and nuclear reactions in detail.
- To familiarize with the fundamental forces and the dynamics of elementary particles under these forces.
- To overview basic relativistic quantum mechanics and quantum electrodynamics for particle physics.

UNIT 1: TWO NUCLEON SYSTEMS & NUCLEAR FORCES **12 Hrs.**

Nuclear properties, Dipole and quadrupole moments of the deuteron, Central and tensor forces, Evidence for saturation property, Neutron-proton scattering, exchange character, spin dependence (ortho and para-hydrogen), charge independence and charge symmetry. S-wave effective range theory. Proton- proton scattering (qualitative idea only). Evidence for hardcore potential. Meson theory.

UNIT 2: NUCLEAR MODELS **10 Hrs.**

Concept of Liquid drop model, Magic nuclei, nucleon separation energy, Single particle shell model (including Mean filed approach, spin orbit coupling), Physical concepts of the unified model (Collective Model).

UNIT 3: NUCLEAR DECAYS AND REACTIONS **11 Hrs.**

Electromagnetic decays: selection rules, Fermi theory of beta decay. Kurie plot. Fermi and Gamow-Teller transitions. Log(ft) value, Parity violation in beta-decay. Gamma decay, selection rules, Introduction to Nuclear Reactions (Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section), Concept of Direct and compound nuclear reaction.

UNIT 4: ELEMENTARY PARTICLES **12 Hrs.**

Relativistic kinematics, Various Interactions, Parity, Charge Conjugation and Time Reversal, Classification: spin and parity determination of pions and strange particles. Gell-Mann Nishijima scheme. Properties of quarks and their classification. Elementary ideas of SU(2) and SU(3) symmetry groups and hadron classification. Introduction to the standard model. Electroweak interaction-W & Z Bosons.

Max. 45 Hrs.

COURSE OUTCOMES

After completion of this course students will be able to;

CO1: Identify the strengths and limitations of various nuclear models and theories of nuclear decay.

CO2: Describe fundamental forces, kinematics of elementary particles, parity violation, symmetry and transition rules by studying nuclear and weak forces.

CO3: Apply the knowledge of basic laws of conservation and momentum in the determination of particle properties and processes in the subatomic world.

CO4: Understand nuclear structure and reaction dynamics will provides knowledge of nuclear-nucleon interaction.

CO5: Determine and work on elementary problem solving in nuclear and particle physics, and relating theoretical predictions and measurement results.

CO6: Demonstrate the ability to critically evaluate the results in nuclear and particle physics.

TEXT/REFERENCE BOOK

1. Nuclear Physics – Theory & Experiments, R.R. Roy & B.P. Nigam, New Age International, 2005.
2. Nuclear Physics by V. Devanathan. Narosa Publishing House, Delhi.
3. Nuclear Structure Vol. 1 & 2., Aaghe Bohr & Ben R. Mottelson, World Scientific.
4. Fundamentals In Nuclear Physics, Jean-Louis Basdevant, James Rich, Michel Spiro, Springer.
5. Introductory Nuclear Physics, Samuel S. M. Wong, Wiley-Vch.
6. Source Book on Atomic Energy, Samuel Glasstone, Litton Educational Publishing.
7. Introduction to Elementary Particles, D. Griffiths, Academic Press, 2nd Ed. 2008.
8. Nuclear Physics, S. N. Ghoshal, First edition, S. Chand Publication.

Course Delivery Methods

Lecture by use of boards/LCD projectors/OHP projectors Yes

Tutorials/Assignments	Yes
Seminars	Yes
Mini projects/Projects	No
Laboratory experiments/teaching aids	No
Industrial/guest lectures	Yes
Industrial visits/in-plant training	No
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	No

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment:

Assessment Tool		% Contribution during CO Assessment	Maximum Marks	Exam Duration
Internal Assessment Examiantion	Assignment	10 %	-	-
	Quiz	15%	-	-
	Mid Semester Examination	25%	50	2 hours
	End Semester Examination	50%	100	3 hours

Assessment Components	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	YES	YES	YES	NO	NO	NO
End Sem Examination Marks	YES	YES	YES	YES	YES	YES
Assignment	YES	YES	YES	YES	YES	YES

Indirect Assessment :

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Programme Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1: Identify the strengths and limitations of various nuclear models and theories of nuclear decay.	H	L	M	H	L
CO2: Describe fundamental forces, kinematics of elementary particles, parity violation, symmetry and transition rules by studying nuclear and weak forces.	H	M	M	H	M
CO3: Apply the knowledge of basic laws of conservation and momentum in the determination of particle properties and processes in the subatomic world.	H	H	H	H	L
CO4: Understand nuclear structure and reaction dynamics which provides knowledge of nuclear-nucleon interaction.	H	H	H	H	L
CO5: Determine and work on elementary problem solving in nuclear and particle physics, and relating theoretical predictions and measurement results.	H	H	H	H	M
CO6: Demonstrate the ability to critically evaluate the results in nuclear and particle physics.	H	M	H	M	H

Lecture wise Lesson planning Details:

Weak No.	Unit No.	Topics To be covered	CO Mapped	Remarks by Faculty
1	1	Nuclear properties, Dipole and quadrupole moments of the deuteron,	CO1,CO2	
2		Central and tensor forces, Evidence for saturation property, Neutron-proton scattering, exchange character, spin dependence (ortho and para-hydrogen), charge independence and charge symmetry. S-wave effective range theory. Proton-proton scattering (qualitative idea only).		
3		Evidence for hardcore potential. Meson theory.		

4 5 6		Concept of Liquid drop model, Magic nuclei, nucleon separation energy, Single particle shell model (including Mean filed approach, spin orbit coupling), Physical concepts of the unified model (Collective Model).	CO1, CO3
7 8 9 10	3	Electromagnetic decays: selection rules, Fermi theory of beta decay. Kurie plot. Fermi and Gamow-Teller transitions. Log(ft) value, Parity violation in beta-decay. Gamma decay, selection rules, Introduction to Nuclear Reactions (Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section), Concept of Direct and compound nuclear reaction.	CO3,CO4,CO5
11 12 13 14	4	Relativistic kinematics, Various Interactions, Parity, Charge Conjugation and Time Reversal, Classification: spin and parity determination of pions and strange particles. Gell-Mann Nishijima scheme. Properties of quarks and their classification. Elementary ideas of SU(2) and SU(3) symmetry groups and hadron classification. Introduction to the standard model. Electroweak interaction-W & Z Bosons.	CO4,CO5,CO6
15		Revision	