

Name of the Course: Physics Major Course 11
MJ - 11: Nuclear Physics (2 Credits)

Sr. No.	Heading	Particulars
1	Description the course (Including but Not limited to)	: Introduction, relevance, Usefulness, Application, interest, connection with other courses, demand in the industry, job prospects etc.
2	Vertical	: Major/Minor/Open Electives /Skill Enhancement / Ability Enhancement/Indian Knowledge System
3	Type	: Theory
4	Credits	: 2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5	Hours Allotted	: 30 Hours
6	Marks Allotted	: 50 Marks
7	Course Objectives (CO): The students are expected to:	
	CO 1.	describe and analyze various radioactive decay processes, including alpha, beta, and gamma decays, along with their underlying mechanisms and laws of conservation.
	CO 2.	understand and compare different nuclear models, such as the liquid drop model and shell model, to interpret nuclear stability and reactions.
	CO 3.	discuss the principles, design, and applications of particle accelerators in probing nuclear and subatomic structures.
	CO 4.	explore the concepts of nuclear energy production, including fission and fusion processes, and their technological and societal implications
	CO 5.	introduce the fundamental ideas of elementary particles and their interactions, providing a bridge between nuclear and particle physics.
8	Course Outcomes (OC): After successful completion of the course, the student will be able to	
	OC 1.	analyze alpha, beta, and gamma decay processes using appropriate nuclear models and conservation laws.
	OC 2.	apply the liquid drop model and other nuclear models to interpret nuclear binding energy, stability, and reaction mechanisms.
	OC 3.	describe the working principles and functions of various particle accelerators and their role in nuclear and particle physics research.
	OC 4.	evaluate the principles of nuclear fission and fusion to understand the generation and applications of nuclear energy.
	OC 5.	classify elementary particles and explain their fundamental interactions within the framework of modern particle physics.
9	Modules / Units: - There will be One Module / Unit Per Credit	
	Module I / Unit I: Radioactive decay & Nuclear Models (15 Hours)	
	Unit I (15 Lectures)	
	1. Radioactive decay processes	
	Alpha decay: Velocity and energy, the absorption of alpha particles: range, ionization and stopping power, Geiger Nuttal law, Disintegration Energy of spontaneous alpha-decay, Gamow's theory of alpha decay IK: 13. 1, 13.2, SBP: 4. II. 1, 4. II. 2, 1.II.3	
	Beta decay: Introduction, velocity and energy of beta particles, Different modes of beta disintegration, Pauli's neutrino hypothesis, Detection of neutrino - Cowan and Reines Experiment(Qualitative) IK: 14.1, SBP: 4. III.1, 4. III.3, 4. III.5,	

	Gamma decay: Introduction SBP: 4. IV. 1		
	2. Nuclear Models: Liquid drop model, Weizsacker’s semi-empirical mass formula, Mass parabolas - Prediction of stability against beta decay for members of an isobaric family SBP: 5.1, 5.3, 5.4		
	Module II / Unit II Nuclear Energy, Force and Elementary Particles (15 Hours)		
	1. Nuclear energy: Introduction, Energy released in fission of U^{235} , Fission chain reaction, Nuclear reactors(Qualitative) SBP : 6.1, 6.5, 6.7, 6.9		
	Particle Accelerators: Cyclotron and Idea of Large Hadron Collider (Qualitative) SBP: 1.I.4 https://home.cern/science/accelerators/large-hadron-collider		
	2. Nuclear force and Elementary particles: Introduction, Meson theory of Nuclear Force. SBP: 8.1, 8.6		
	Elementary particles: Introduction, Classification of elementary particles, Conservation laws (linear & angular momentum, energy, charge, baryon number & lepton number) DCT: 18.1, 18.2, 18.4		
10	Reference Books: 1. SBP: Nuclear Physics, S.B. Patel (New Age International P. Ltd.). 2. IK: Nuclear Physics, Irving Kaplan (2nd Ed.) (Addison Wesley). 3. DCT: Nuclear Physics, D. C. Tayal (Himalayan Publishing House) (5th Ed.) 4. AB: Concepts of Modern Physics: Arthur Beiser, Shobhit Mahajan, S Rai Choudhury (6th Ed.) (TMH). Additional Reference Books: 1. SNG: Nuclear Physics, S. N. Ghoshal (S. Chand & Co.) 2. Modern Physics: Kenneth Krane (2nd Ed.), John Wiley & Sons. 3. Atomic & Nuclear Physics: N Subrahmanyam, Brij Lal. (Revised by Jivan Seshan.) S. Chand. 4. Introduction to Elementary Particles: David Griffith, Second Revised Edition, Wiley-VCH.		
11	Internal Continuous Assessment: 40% (20 Marks)	External Assessment: (60%) (30 Marks)	
12	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. (at least 3)		Evaluation: through Exam at the End of the Semester / Term.
13	Format of Question Paper for Semester End Examination Total Marks: 30 Marks Duration: One Hour		
	Module I / Unit-I 15 Marks	Q.1 A) Attempt any Two (Each carry 05 Marks) i) Theory ii) Theory iii) Theory iv) Theory	10 Marks

		Q.1 B) Attempt any One (Each carry 05 Marks) i) Problem / Theory ii) Problem	05 Marks
	Module II / Unit-II 15 Marks	Q.2 A) Attempt any Two (Each carry 05 Marks) i) Theory ii) Theory iii) Theory iv) Theory	10 Marks
		Q.2 B) Attempt any One (Each carry 05 Marks) i) Problem / Theory ii) Problem	05 Marks