

**UNIVERSITY OF MADRAS**  
**B.Sc. DEGREE PROGRAMME IN PHYSICS**  
 SYLLABUS WITH EFFECT FROM 2023-2024

**337C6A**

<b>COURSE</b>	<b>SIXTH SEMESTER – CORE COURSE-VIII</b>
<b>COURSETITLE</b>	<b>NUCLEAR AND PARTICLE PHYSICS</b>
<b>CREDITS</b>	<b>3</b>
<b>COURSE OBJECTIVES</b>	To understand constituents, properties and models of nucleus. To give reason for radioactivity and study their properties. To learn about the principles of various particle detectors and accelerators.  To acquire knowledge on different types of nuclear reactions and their applications. To know the reason for cosmic rays and their effect on the surface of earth and also understand the classification of elementary particles.

<b>UNITS</b>	<b>COURSE DETAILS</b>
<b>UNIT-I</b>	<b>PROPERTIES OF NUCLEUS:</b> constituents of nucleus – isotopes, isobars, isotones – nuclear size, mass, density, charge, spin, angular momentum, magnetic dipole moment, electric quadrupole moment (qualitative) – binding energy – mass defect – packing fraction – nuclear stability – binding energy per nucleon graph – properties of nuclear force – meson theory of nuclear forces – Yukawa potential.  <b>Nuclear Models:</b> liquid drop model – Weizacker’s semi-empirical mass formula – shell model – magic numbers.
<b>UNIT-II</b>	<b>RADIO ACTIVITY:</b> radio activity – laws of radioactivity – radioactive disintegration, decay constant, half-life, mean-life (only final formulae) – units of radioactivity – successive disintegration – transient and secular equilibrium – properties of alpha, beta and gamma rays – Geiger-Nuttal law – $\alpha$ -ray spectra – Gammow's theory of $\alpha$ -decay (qualitative) – $\beta$ -ray spectrum – neutrino theory of $\beta$ -decay – nuclear isomerism – K-shell capture – internal conversion – non-conservation of parity in weak interactions.
<b>UNIT-III</b>	<b>PARTICLE DETECTORS AND ACCELERATORS</b> <b>DETECTORS:</b> Gas Detectors – Ionization Chamber – G-M Counter – Scintillation Counter – Photo Multiplier Tube (Pmt) – Semiconductor Detectors – Neutron Detector. <b>Accelerators:</b> Linear Accelerators – Cyclotron – Synchrotron – Betatron – Electron Synchrotron – Proton synchrotron (Bevatron)
<b>UNIT-IV</b>	<b>NUCLEAR REACTIONS:</b> Types Of Nuclear Reactions – Conservation Laws in Nuclear Reaction – Q-Value – Threshold Energy – Nuclear Fission – Energy Released In Fission – Chain Reaction – Critical Mass – Nuclear Reactor – Nuclear Fusion – Sources Of Stellar Energy – Proton-Proton Cycle – Carbon-Nitrogen Cycle – Thermonuclear Reactions – Controlled Thermonuclear Reactions.

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<b>UNIT-V</b>	<p><b>COSMIC RAYS AND ELEMENTARY PARTICLES</b></p> <p><b>COSMIC RAYS:</b>  Discovery Of Cosmic Rays – Primary And Secondary Cosmic Rays – Cascade Theory Of Cosmic Ray Showers – Altitude And Latitude Effects –Discovery Of Positron – Pair Production – Annihilation Of Matter – Van-Allen Radiation Belts – Big-Bang Theory – Future Of The Universe (Elementary Ideas Only).</p> <p><b>Elementary Particles:</b>particles and antiparticles – classification of elementary particles – types of fundamental interactions – quantum numbers of elementary particles – conservation laws and symmetry – quarks and types – quark model (elementary ideas only).</p>
<b>TEXT BOOKS</b>	<ol style="list-style-type: none"> <li>1. R Murugesan&amp;KiruthigaSivaprasath, Modern Physics, S. Chand &amp; Co. (2013)</li> <li>2. Brijlal&amp; N. Subramaniyan, Atomic and Nuclear Physics S.Chand&amp; Co</li> <li>3. J.B. Rajam, Modern Physics, S Chand &amp;Co.Publishing Co.</li> <li>4. D.C. Tayal, Nuclear Physics, Himalayan Publishing House</li> <li>5. Atomic and Nuclear Physics, Brijlal&amp; N. Subramaniyan, S.Chand&amp; Co</li> </ol>
<b>REFERENCE BOOKS</b>	<ol style="list-style-type: none"> <li>1. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.</li> <li>2. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008)</li> <li>3. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).</li> <li>4. Introduction to the physics of nuclei &amp; particles, R.A. Dunlap. (Thomson Asia, 2004).</li> <li>5. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press</li> <li>6. Introduction to Elementary Particles, D. Griffith, John Wiley &amp; Son</li> <li>7. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi</li> <li>8. Radiation detection and measurement, G.F. Knoll (John Wiley &amp; Sons, 2000).</li> <li>9. Theoretical Nuclear Physics, J.M. Blatt &amp;V.F.Weisskopf (Dover Pub.Inc., 1991)</li> <li>10. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (AcademicPress, Elsevier, 2007).</li> <li>11. Nuclear Physics, S. N. Ghoshal, S Chand &amp; Co. Edition 2003</li> <li>12. 15. Elements of Nuclear Physics, M. L.Pandya&amp; R. P. S.Yadav, KedarNath&amp; Ram Nath</li> </ol>

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<b>WEBLINKS</b>	1. <a href="http://hyperphysics.phy-astr.gsu.edu/hbase/nucon.html">http://hyperphysics.phy-astr.gsu.edu/hbase/nucon.html</a> 2. <a href="https://www.kent.edu/physics/nuclear-physics-links">https://www.kent.edu/physics/nuclear-physics-links</a> 3. <a href="https://www2.lbl.gov/abc/links.html">https://www2.lbl.gov/abc/links.html</a>
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**COURSE OUTCOMES:**

At the end of the course, the student will be able to:

<b>COURSE OUTCOMES</b>	<b>CO1</b>	Describe various models that explain about the nuclear structures
	<b>CO2</b>	Give reason for various kinds of radioactivity and also know laws governing them
	<b>CO3</b>	Know the principles and applications of various particle detectors and accelerators.
	<b>CO4</b>	Discuss the concepts used in nuclear reaction.
	<b>CO5</b>	Classify various elementary particles and study the effect of cosmic rays.

**MAPPING WITH PROGRAM OUT COMES:**

Map course outcomes(CO) for each course with program outcomes(PO) in the 3-point scale of STRONG(S), MEDIUM(M) and LOW(L).

	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CO1</b>	S	M	S	S	S	S	S	M	S	S
<b>CO2</b>	S	S	M	S	M	M	S	M	M	M
<b>CO3</b>	M	M	S	M	S	M	M	S	S	S
<b>CO4</b>	S	S	S	S	S	S	S	M	M	M
<b>CO5</b>	S	M	S	S	M	M	S	M	M	S