



# SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

## M.Sc. (Physics) Semester – II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCPHY01	Nuclear and Particle Physics	4-0-0	120	04

### Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply the knowledge of quantum mechanics for nuclear physics problems, analyze the results and appraise the development of advanced theoretical framework for more complex problems.

CLO2: Distinguish between different fundamental forces of interaction and investigate underlying physical principles for nuclear and particle physics phenomena.

CLO3: Evaluate the radioactive decay processes considering known principles and formulate relevant rules for them.

CLO4: Review the development of nuclear models and the standard model of particle physics and validate their contents and address anomalies observed experimentally.

CLO5: Formulate methodologies to analyze nuclear and particle physics processes to validate the chances of their occurrence in nature.

CLO6: Investigate the applications of nuclear physics in medical diagnosis and therapy.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<b>The deuteron Problem:</b> The ground state of deuteron, the Schrödinger wave equation and its solution shape of ground state wave function, Normalization of deuteron wave, radius of deuteron, Mixing of orbitals in deuteron, Magnetic moment of Deuteron, Quadrupole moment of deuteron. <b>Nuclear Forces:</b> Charge independence, charge symmetry, Non central (Tensor) force, Exchange forces. <b>Nuclear Models:</b>	ICL, SM, ICT, PBL, MPR, SDL	CLO1 CLO2 CLO4



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	Single particle shell model, Explanation of nuclear data, Nordheim's rules for odd Z - odd N nuclei, Islands of isomerism, Successes and failures of shell model, Collective nuclear model, Rotational motion of the nucleus, Vibration of spherical nuclei, classification of vibration of spherical nuclei, Quadrupole moment of deformed nuclei.		
II	<p><b>Alpha Decay:</b> Basic alpha decay processes, Geiger-Nuttall Law for Alpha Decay, Theory of alpha emission, Angular momentum and parity in alpha decay.</p> <p><b>Beta decay:</b> Experimental information about Beta particles, Energy released in beta decay (Q-value). Continuous beta spectrum and neutrino hypothesis including M.N. Saha and D.S. Kothari's contribution, Fermi theory of beta decay, Fermi-Kurie plot. Angular momentum and parity selection rules, Experimental detection of neutrino.</p> <p><b>Gamma decay:</b> Electromagnetic transitions, Radiation field multipolarity, selection rules, gamma ray transition probability.</p>	ICL, SM, PBL, ICT, SDL	CLO1 CLO3
III	<p><b>Interaction of heavy charged particles with matter:</b> Energy loss by electrons, Absorption curve and range, Interaction and slowing down of neutrons in matter.</p> <p><b>Nuclear reaction theory:</b> Nuclear Reaction mechanism, pre-equilibrium mechanism, Compound nucleus, Direct interaction process in nuclear reactions, Coupled channel theory of inelastic scattering. Nuclear Fusion, Sources of energy in stars, nucleo - synthesis processes, Controlled fusion, Lawson Criterion.</p> <p><b>Applications of Nuclear Physics:</b> Trace element analysis, Alpha decay applications, Diagnostic and therapeutic nuclear medicine.</p>	ICL, SM, ICT, SDL	CLO2 CLO4 CLO6
IV	<p><b>Elementary particle and forces of Interactions:</b> Classification of fundamental forces, Elementary particles and their quantum numbers, Conservation laws, CPT theorem, Gellmann- Nishijima formula, Quark model, Baryons and mesons- their quark structure, Parity non-conservation in weak decays, Wu's experiment, CP Violation in weak decays, Bhabha scattering and prediction of muons, Summary of Standard model of Particle Physics.</p> <p>Introduction to basic concepts of field theory, Gauge theory, Electro-Weak theory, Spontaneous symmetry breaking, Higgs boson, Grand Unification attempts and Early Universe.</p>	ICL, SM, PBL, ICT, IBL, SDL	CLO2 CLO4 CLO5



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## M.Sc. (Physics) Semester – II

### (\* Learning Pedagogies/Methods

- (a) ICL: Interactive Classroom Lecture
- (b) SM: Seminars (Student-led and Faculty-moderated)
- (c) PBL: Problem-Based Learning
- (d) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (e) IBL: Inquiry-Based Learning
- (f) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

### • Assessment Methodologies/Tools

#### (A) Internal Assessment [Total: 50 Marks]

##### a. Internal Formative assessment [25]

- (a) Assignment, Self-learning and Terms work
- (b) Seminar/Presentation
- (c) Class regularity

##### b. Internal Summative Assessment [25]

- (a) Mid-term tests
- (b) Quizzes

#### (B) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1, 2, 4	30	2	3	7	12
II	1, 3	30	2	2	9	13
III	2, 4, 6	30	2	2	8	12
IV	2, 4, 5	30	2	3	8	13
		<b>120</b>	<b>8</b>	<b>10</b>	<b>32</b>	<b>50</b>

#### Assessment and Evaluation:

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50



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## M.Sc. (Physics) Semester – II

### CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	3	3	-	2	-	-	2	3	-
2	3	2	3	-	2	-	-	2	3	-
3	3	2	3	-	2	-	-	2	2	-
4	3	3	3	-	2	-	-	3	3	-
5	3	3	3	-	3	-	-	3	3	-

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

### Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Introductory Nuclear Physics	Kenneth S Krane	3 <sup>rd</sup> Edition 2022	John Wiley & Sons, Singapore
2	Fundamentals of Nuclear Physics	J. C. Verma, R. C. Bhandari & D.R.S. Somayajulu	1 <sup>st</sup> Edition 2017	CBS Publishers, New Delhi
3	Introduction to Elementary particles	David Griffiths	2 <sup>nd</sup> Edition 2008	John Wiley & Sons Singapore
4	Introduction to Particle Physics	M P Khanna	1 <sup>st</sup> Edition 1999	Prentice Hall of India
5	Introduction to High energy Physics	D H Perkins	4 <sup>th</sup> Edition 2000	Addison Wesley
6	Introduction to Elementary Particle Physics	A Bettini	3 <sup>rd</sup> Edition 2024	Cambridge Univ Press
7	Introduction To Nuclear And Particle Physics	R C Verma, V K Mittal S C Gupta	4 <sup>th</sup> Edition 2018	Prentice Hall of India, New Delhi



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## M.Sc. (Physics) Semester – II

### Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Nuclear Physics: Fundamentals and Applications by Prof. H.C. Verma (IIT Kanpur – NPTEL)	<a href="https://www.youtube.com/playlist?list=PLbMVogVj5nJRvq-w3zway7k3GzmUDte3a">https://www.youtube.com/playlist?list=PLbMVogVj5nJRvq-w3zway7k3GzmUDte3a</a>
2	Nuclear and Particle Physics by Prof. Poulouse Poulouse (IIT Guwahati – NPTEL)	<a href="https://nptel.ac.in/courses/115103101">https://nptel.ac.in/courses/115103101</a>
3	MIT OpenCourseWare Introduction to Nuclear and Particle Physics	<a href="https://ocw.mit.edu/8-701F20">https://ocw.mit.edu/8-701F20</a>
4	Stanford Lecture Collection: Particle Physics – The Standard Model	<a href="https://www.youtube.com/playlist?list=PL8BCB4981DD1A0108">https://www.youtube.com/playlist?list=PL8BCB4981DD1A0108</a>



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## M.Sc. (Physics) Semester – II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCPHY02	Electrodynamics and atomic and molecular physics	4-0-0	120	04

### Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply Maxwell's equations in matter to analyze charge conservation, energy flow, and momentum transfer, along with electromagnetic wave propagation in vacuum including polarization and energy-momentum relations.

CLO2: Evaluate electromagnetic wave behavior in material media using boundary conditions, reflection and refraction, and transmission at interfaces through Fresnel equations.

CLO3: Apply scalar and vector potentials, gauge conditions, and retarded formulations to determine electromagnetic fields of time-varying sources

CLO4: Analyze radiation from accelerated charges and localized sources using Larmor formula and its relativistic generalization, including dipole radiation, radiation patterns, and mechanisms such as synchrotron and bremsstrahlung radiation.

CLO5: Apply quantum mechanical approximation methods to calculate and interpret fine/hyperfine structures, energy levels, and electronic properties of one-, two-, and many-electron atoms as well as simple diatomic molecules.

CLO6: Provide fundamental and advanced knowledge of laser spectroscopy, covering both conventional and unconventional laser systems, along with the theoretical understanding of Raman scattering and advanced nonlinear Raman phenomena.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<b>Electromagnetic Fields and Wave Propagation</b> Maxwell's equations in matter: Continuity equation, Poynting theorem – Momentum conservation, Maxwell's stress tensor – Angular momentum. Electromagnetic Waves in Vacuum: Wave equation for E and B fields, Monochromatic plane waves, Energy & momentum in electromagnetic waves, Polarization of electromagnetic waves: linear and circular polarization. Electromagnetic waves in matter: Propagation in linear media-Boundary conditions, Reflection and Refraction – Snell's law. Reflection and Transmission at normal and oblique incidence – Fresnel's equations.	ICL, PBL, CDV, ACA	CLO1 CLO2



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II	<p><b>Electromagnetic Potentials and Radiation from Accelerated Charges</b></p> <p>Electromagnetic potentials: Scalar and vector potentials, Gauge transformations. Fields due to time-varying sources: Jefimenko's equations.</p> <p>Radiation from moving charges: Liénard–Wiechert potentials, Fields of a uniformly moving and accelerated charge, Near-field and radiation field.</p> <p>Radiation from localized sources: Electric and magnetic dipole radiation, Radiation pattern and angular distribution.</p> <p>Power radiated by charges: Larmor formula and its relativistic generalization. Radiation from non-relativistic and relativistic charges. Synchrotron and bremsstrahlung radiation. Radiation reaction.</p> <p>Python simulations for electromagnetic fields, waves, and radiation.</p>	ICL, PBL, ICT, SDL, CDV, ACA	CLO3 CLO4
III	<p><b>Application of Schrodinger Equation to Atoms and Molecules:</b></p> <p>One-electron atoms, H-atom, the dipole selection rules. Fine structure of hydrogenic atoms, The Lamb shift and its determination, Hyperfine structure and isotopic shifts.</p> <p>Schrödinger equation for Two-electron atoms, the role of Pauli exclusion principle, Energy levels of Helium atom, Doubly excited states, Auto-ionization in Helium. Thomas-Fermi model for many electron atoms. The Born-Oppenheimer approximation for molecule, electronic structure of diatomic molecules, LCAO approximation for H<sub>2</sub><sup>+</sup> ion.</p>	ICL, PBL, SDL	CLO5
IV	<p><b>Laser Spectroscopy Emission and absorption spectroscopy:</b></p> <p>UV-visible-IR absorption (introduction), Classical view of Einstein coefficients; two-level system, Three-level Laser system, Variation of Laser power around threshold. NH<sub>3</sub> maser, He-Ne Laser (energy level diagram), CO<sub>2</sub> Laser, Semiconductor Lasers, Rayleigh and Raman scattering, Stimulated Raman effect, Hyper-Raman effect: Classical treatment, Quantum mechanical treatment, Coherent anti-stokes Raman scattering (CARS), Spin-flip Raman Laser, Free-electron Laser.</p>	ICL, PBL, SDL	CLO6



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### (\* Learning Pedagogies/Methods

- (g) ICL: Interactive Classroom Lecture
- (h) SM: Seminars (Student-led and Faculty-moderated)
- (i) PBL: Problem-Based Learning
- (j) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (k) IBL: Inquiry-Based Learning
- (l) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)
- (m) CDV: Computational Demonstration and Visualization
- (n) ACA: Analytical-Computational Approach

### Assessment Methodologies/Tools

#### (C) Internal Assessment [Total: 50 Marks]

##### a. Internal Formative assessment [25]

- (d) Assignment, Self-learning and Terms work
- (e) Seminar/Presentation
- (f) Class Regularity

##### b. Internal Summative Assessment [25]

- (c) Mid-term tests
- (d) Quizzes

#### (D) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1,2	30	3	4	6	13
II	3.4	30	3	4	5	12
III	5	30	3	3	7	13
IV	6	30	3	4	5	12
		<b>120</b>	<b>12</b>	<b>15</b>	<b>23</b>	<b>50</b>

### Assessment and Evaluation:

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50
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2	3	2	3	-	2	1	1	2	3	-
3	3	3	3	-	2	-	-	3	3	-
4	3	3	3	-	2	-	-	3	3	-
5	3	3	3	-	3	1	-	3	3	-
6	3	2	3	1	3	2	1	3	3	1

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Introduction to Electrodynamics	David J Griffiths,	3 <sup>rd</sup> , 2002	Prentice Hall, India
2	Modern Electrodynamics	Andrew Zangwill	2013	Cambridge University Press
3	Electrodynamics Tutorials with Python Simulations	Taejoon Kouh Minjoon Kouh	2024	CRC press
4	Physics of Atoms and Molecules	B. Bransden and C. J. Joachain	2 <sup>nd</sup> Edition 2004	Pearson Education Publication
5	LASERS Theory and Applications.	K. Thyagarajan and A. K. Ghatak	2008	Macmillan India Ltd.,
6	Lasers and Non-linear Optics	B. B. Laud	2 <sup>nd</sup> , 1996	New Age International



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## M.Sc. (Physics) Semester – II

### Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL: Electromagnetic Theory (Prof. D.K. Ghosh, IIT Bombay)	<a href="https://www.youtube.com/playlist?list=PL0B9E3A1A8B5E5A5">https://www.youtube.com/playlist?list=PL0B9E3A1A8B5E5A5</a>
2	NPTEL: Introduction to Electromagnetic Theory (Prof. Manoj Harbola, IIT Kanpur)	<a href="https://nptel.ac.in/courses/115104088">https://nptel.ac.in/courses/115104088</a>
3	MIT Open Course Ware: Atomic and Optical Physics I	<a href="https://ocw.mit.edu/courses/8-421-atomic-and-optical-physics-i-spring-2014/resources/lecture-6-atoms-ii/">https://ocw.mit.edu/courses/8-421-atomic-and-optical-physics-i-spring-2014/resources/lecture-6-atoms-ii/</a>
4	NPTEL: An Introduction to Lasers and Laser Systems	<a href="https://onlinecourses.nptel.ac.in/noc26_ph07/preview">https://onlinecourses.nptel.ac.in/noc26_ph07/preview</a>



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## M.Sc. (Physics) Semester – II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCPHY03	Quantum Mechanics and Solid State Physics	4-0-0	120	04

### Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply time-independent perturbation theory to calculate first- and second-order corrections in energy and wave function, including the analysis of degeneracy removal

CLO2: Apply advanced approximation techniques such as the Variation Method and the WKB approximation to solve quantum mechanical problems that cannot be solved analytically.

CLO3: Apply perturbation theory, sudden approximation, Fermi's Golden Rule, and the interaction picture to compute transition probabilities, scattering, and atomic interactions with electromagnetic radiation.

CLO4: Analyze the behaviour of electrons in periodic potentials using Bloch theorem and the Kronig-Penny model to interpret energy band formation and evaluate electronic properties through effective mass, charge carriers, and Brillouin zone concepts.

CLO5: Analyze Fermi surfaces in metals by constructing free-electron models in k-space and interpreting their geometry while assessing quantum oscillation techniques such as de Haas-van Alphen and Shubnikov-de Haas effects for determining Fermi surface properties.

CLO6: Apply the theory of Landau levels and related high-frequency magnetic phenomena (cyclotron resonance, anomalous skin effect, magneto-acoustic effects) to interpret electron behaviour in strong magnetic fields and size-dependent effects in metals.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<p><b>Time Independent Perturbation theory:</b>            Perturbation theory for discrete levels, Equation in various orders of perturbation theory, The non-degenerate case for first and second order corrections, The degenerate case-removal of degeneracy, Stark effect</p> <p><b>The variation method:</b>            Upper bound on ground state energy, Application to excited states, The ground state of a two-electron atom. The Hydrogen molecule-exchange interaction.</p> <p><b>The WKB approximation:</b>            One-dimensional Schrödinger equation, asymptotic solution, Solution near turning point, The Bohr-Sommerfeld quantum condition. WKB solution of the radial wave equation.</p>	ICL, SM, PBL, ICT, SDL	CLO1 CLO2



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II	<p><b>Evolution with time:</b> The Schrödinger equation and general solution, Propagators, Sudden approximation.</p> <p><b>Perturbative theory for time evolution problems:</b> Perturbative solution for transition amplitude, Constant perturbation and Fermi's golden rule, Scattering of a particle by a potential-elastic scattering, Harmonic perturbations, Interaction of an atom with electromagnetic radiation, The dipole approximation, Einstein coefficients-spontaneous emission.</p> <p><b>Alternative pictures of time evolution:</b> The Schrödinger picture, Heisenberg picture, interaction picture.</p>	ICL, SM, PBL, ICT, SDL	CLO3
III	<p><b>Energy Band Theory of Solids</b> Periodic potential in crystals, Statement and proof of Bloch theorem, Kronig–Penny Model, Formation of energy bands. Effective Mass of an Electron, Definition from band curvature, Effective mass tensor, Electrons and holes in semiconductors, Construction of Brillouin zones, Reciprocal lattice vectors First, second and higher order zones, Zone Schemes: Extended zone scheme, Reduced zone scheme, Periodic zone scheme, Empty lattice approximation, Plane wave method, Orthogonalized Plane Wave (OPW) method, Tight Binding Approximation.</p>	ICL, SM, ICT, PBL	CLO4
IV	<p><b>Fermi Surfaces</b> Fermi Surfaces, Free Electron Fermi Surface, Construction in k-space, Shape for simple metals, Measurement of Fermi Surfaces, Quantum oscillation techniques, de Haas–van Alphen Effect, Magnetization oscillations in strong magnetic fields, Determination of Fermi surface geometry, Oscillatory Galvanomagnetic Effects, Shubnikov–de Haas effect, Quantum oscillations in conductivity, Landau Levels, Free electron Landau levels, Bloch electron Landau levels, Other Oscillatory Phenomena, Effect of electron spin, Magneto-acoustic effect, Ultrasonic attenuation, High Frequency and Magnetic Phenomena, Anomalous skin effect, Cyclotron resonance, Size effects in metals.</p>	ICL, SM, ICT, PBL	CLO5 CLO6

**(\*) Learning Pedagogies/Methods**

- (o) CL: Classroom Lecture
- (p) SM: Seminars (Student-led and Faculty-moderated)
- (q) PBL: Problem-Based Learning
- (r) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (s) IBL: Inquiry-Based Learning
- (t) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

**Assessment Methodologies/Tools**

**(E) Internal Assessment [Total: 50 Marks]**

**a. Internal Formative assessment [25]**

- (g) Assignment, Self-learning and Terms work
- (h) Seminar/Presentation
- (i) Class Regularity



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### b. Internal Summative Assessment [25]

- (e) Mid-term tests
- (f) Quizzes

### (F) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1, 2	30	2	3	8	13
II	3	30	2	2	8	12
III	4	30	2	5	6	13
IV	5,6	30	2	4	6	12
		<b>120</b>	<b>8</b>	<b>14</b>	<b>28</b>	<b>50</b>

### Assessment and Evaluation:

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

### CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	3	3	-	1	-	-	2	3	-
2	3	3	3	-	1	-	-	2	3	-
3	3	3	3	-	2	-	-	2	3	-
4	3	2	3	-	1	2	2	2	3	1
5	3	2	3	-	2	1	1	2	3	1
6	3	2	3	-	2	1	1	2	3	1



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Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

### Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	A text book of Quantum Mechanics	P.M. Mathews and Venkatesan	2 <sup>nd</sup> Edition 2010	TMH Publication
2	Introduction to Quantum Mechanics	D J Griffiths	3 <sup>rd</sup> Edition 2018	Cambridge Uni Press
3	Quantum Mechanics: Concepts and Applications	Nouredine Zettili	3 <sup>rd</sup> Edition 2022	John Wiley & Sons Inc
4	Quantum Mechanics	G. Aruldas	2 <sup>nd</sup> Edition 2008	PHI Learning
5	Introduction to Solid State Physics	Charles Kittel	Eight edition/2015	Wiley
6	Elements of Solid State Physics	J. P. Srivastava	2009	Prentice Hall of India
7	Solid State Physics: Structure and Properties of Materials	M. A. Wahab	Second edition/2008	Narosa Publishers
8	Elementary Solid State Physics: Principles and Applications	M. A. Omar	1975	Addison-Wesley
9	Solid State Physics	N.W. Ashcroft and N.D. Mermin	1976	Brooks/Cole

### Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	MIT Open Course Ware: Time Independent Perturbation Theory	<a href="https://ocw.mit.edu/courses/8-06-quantum-physics-iii-spring-2018/resources/mit8_06s18_lec01/">https://ocw.mit.edu/courses/8-06-quantum-physics-iii-spring-2018/resources/mit8_06s18_lec01/</a>
2	NPTEL: Variational Method	<a href="https://www.youtube.com/watch?v=T-wXwgS7MuI">https://www.youtube.com/watch?v=T-wXwgS7MuI</a>



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### M.Sc. (Physics) Semester – II

3	MIT Open CourseWare: WKB Approximation	<a href="https://ocw.mit.edu/courses/8-06-quantum-physics-iii-spring-2018/resources/17-1/">https://ocw.mit.edu/courses/8-06-quantum-physics-iii-spring-2018/resources/17-1/</a>
4	MIT OCW: Time Dependent Perturbation Theory	<a href="https://ocw.mit.edu/courses/8-06-quantum-physics-iii-spring-2018/pages/video-lectures/time-dependent-perturbation-theory/">https://ocw.mit.edu/courses/8-06-quantum-physics-iii-spring-2018/pages/video-lectures/time-dependent-perturbation-theory/</a>
5	Alternate Pictures of Time Evolution	<a href="https://www.youtube.com/watch?v=EPT_qwvIHKs">https://www.youtube.com/watch?v=EPT_qwvIHKs</a>
6	MIT OpenCourseWare – Lecture notes and videos on Solid State Physics, Band Theory, Bloch theorem, Kronig–Penny model	<a href="https://ocw.mit.edu">https://ocw.mit.edu</a>
7	NPTEL – Complete courses on Condensed Matter Physics, Electronic Properties of Materials, and Semiconductor Physics	<a href="https://nptel.ac.in">https://nptel.ac.in</a>
8	HyperPhysics – Conceptual explanations of band theory, Fermi energy, Brillouin zones, etc.	<a href="http://hyperphysics.phy-astr.gsu.edu">http://hyperphysics.phy-astr.gsu.edu</a>
9	SWAYAM – UGC-approved courses on Condensed Matter Physics and Electronics	<a href="https://swayam.gov.in">https://swayam.gov.in</a>



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## M.Sc. (Physics) Semester – II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCPHY04	Practical I	0-8-0	120	04

### Course Learning Outcomes (CLOs)

After completing the lab, students will be able to:

CLO1 Evaluate principles of experimental optics, semiconductor devices, and electronic circuits.

CLO2 Perform experiments to determine physical parameters viz. wavelength, band gap and transducer response

CLO3 Design, implement and analyse electronic circuits like multivibrators, Schmitt trigger and Analog-to-Digital and Digital-to-Analog conversion

CLO4 Apply numerical and computational techniques to employ variational method, multidimensional integration for physics problems

CLO5 Present experimental results with clarity, accuracy, and scientific reasoning.

Sr. No.	List of Practicals	CLO(s)
1	Laser: Slit Width & Wavelength	CLO1, CLO5
2	Multivibrators	CLO3, CLO5
3	e/k Power Transistor	CLO2, CLO5
4	Schmitt Trigger using IC 741	CLO3, CLO5
5	Temperature Transducers	CLO2, CLO5
6	Eg of Junction Diode	CLO2, CLO5
7	Variational Method / Multidimensional Numerical Integration	CLO4, CLO5

### Assessment Methodologies/Tools

**(G) Internal Assessment [Total: 50 Marks]**

**a. Internal Formative assessment [25]**

- (j) Preparation of Journal
- (k) Viva Voce
- (l) Attendance



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### b. Internal Summative Assessment [25]

- (g) Mid-term tests
- (h) Laboratory performance

### (H) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Practical	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
1	1, 5	17	1	1	5	7
2	3, 5	17	1	1	5	7
3	2, 5	17	1	1	5	7
4	3, 5	17	1	1	5	7
5	2, 5	17	1	1	5	7
6	2, 5	17	1	1	5	7
7	4, 5	18	1	1	6	8
		<b>120</b>	<b>07</b>	<b>07</b>	<b>36</b>	<b>50</b>

### Assessment and Evaluation:

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Internal Practical Exam	50
2	End-Semester Examination	External Practical Exam	50

### CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	2	2	2	1	2	2	1	2	1
2	3	1	3	3	3	2	1	1	2	1
3	3	2	3	3	2	1	3	2	1	1
4	2	3	3	1	2	1	2	3	2	1
5	2	1	3	2	3	1	1	1	2	1



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Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

### Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Practical Physics	A. Srivastava, R. K. Shukla	2018	New age publisher
2	B.Sc. Practical Physics	C. L Arora	2016	S Chand
3	Electronic: Vol I & II	K. A. Navas	5th Edition 2015	PHI Learning Pvt. Ltd.
4	Digital Electronics: A Comprehensive Lab Manual	Cherry Bhargava	2019	BSP Books
5	Numerical Methods	Balagurusamy	1999	McGrew Hill
6	Computational Physics: An Introduction	R C Verma, P K Ahluwalia, K C Sharma	2014	New Age International
7	Electronics Practical	A K Sawhney	19 <sup>th</sup> Edition 2015	Dhanpat Rai & Co. (Pvt.) Ltd.



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## M.Sc. (Physics) Semester – II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCPHY05	Practical II	0-8-0	120	04

### Course Learning Outcomes (CLOs)

After completing the lab, students will be able to:

CLO1 Determine efficiency of GM Counter and analyze absorption coefficients for transmission of beta and gamma radiation.

CLO2 Apply the fundamental concepts of atomic and molecular physics and spectroscopy in cases of I<sub>2</sub> molecule, Rydberg's constant and Hartmann Formula.

CLO3 Examine temperature dependence of properties of semiconductor materials.

CLO4 Apply numerical and computational techniques to employ diagonalization methods for computing band structure.

CLO5 Study applications of ICs in Analog-to-Digital and Digital-to-Analog Conversion.

Sr. No.	List of Practical	CLO(s)
1	G. M. Counter II	CLO1
2	Hartmann Formula	CLO2
3	Dissociation of I <sub>2</sub> Molecule	CLO2
4	Rydberg Constant	CLO2
5	Transport Properties of Semiconductor (different temperature)	CLO3
6	A/D and D/A Converters	CLO5
7	Empty Lattice Method / Jacobi's Method	CLO4

### Assessment Methodologies/Tools

(I) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment [25]

(m) Preparation of Journal

(n) Viva Voce

(o) Laboratory Attendance



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### b. Internal Summative Assessment [25]

- (i) Mid-term tests
- (j) Laboratory Performance

### (J) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Practical	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
1	1	17	1	1	5	7
2	2	17	1	1	5	7
3	2	17	1	1	5	7
4	2	17	1	1	5	7
5	3	17	1	1	5	7
6	5	17	1	1	5	7
7	4	18	1	1	6	8
		<b>120</b>	<b>07</b>	<b>07</b>	<b>36</b>	<b>50</b>

### Assessment and Evaluation:

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Internal Practical Exam	50
2	End-Semester Examination	External Practical Exam	50

### CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	1	3	3	3	1	1	1	2	1
2	3	2	2	2	2	1	1	1	3	1
3	3	2	3	3	3	3	2	1	2	2
4	3	3	3	1	2	2	3	3	2	1
5	3	2	3	3	2	1	3	2	1	1

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-



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## M.Sc. (Physics) Semester – II

Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Practical Physics	A. Srivastava, R. K. Shukla	2018	New age publisher
2	B.Sc. Practical Physics	C. L Arora	2016	S Chand
3	Electronic: Vol I & II	K. A. Navas	5th Edition 2015	PHI Learning Pvt. Ltd.
4	Digital Electronics: A Comprehensive Lab Manual	Cherry Bhargava	2019	BSP Books
5	Numerical Methods	Balagurusamy	1999	McGraw Hill
6	Computational Physics: An Introduction	R C Verma, P K Ahluwalia, K C Sharma	2014	New Age International
7	Electronics Practical	A K Sawhney	19 <sup>th</sup> Edition 2015	Dhanpat Rai & Co. (Pvt.) Ltd.



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## M.Sc. (Physics) Semester – II

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S02NCPHY06	Analog & Digital ICs	1-2-0	60	02

### Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Describe the operating principles of common integrated circuits and analyse the functionality of IC-based circuits such as comparator, waveform generator and memory devices.

CLO2: Explain the types and characteristics of digital memory devices and analyse their potential applications in electronic systems.

CLO3: Explain the principles of Digital to Analog and Analog to Digital convertors and Box-car integrator circuits and analyse their characteristics for applications.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<p><b>Integrated Circuits:</b></p> <p>Block diagram of Operational Amplifier IC 741, Characteristics and parameters of Op-Amp, Applications of Op-Amp- Comparator, Schmitt Trigger, UTP and LTP adjustments, Voltage Controlled Oscillator using IC-741, Timer IC 555 block diagram, Timing waveform generators using IC 555 Astable multivibrator and Monostable multivibrator. Phase Locked Loop PLL IC-LM-565- Block diagram and Operating principle, lock range and capture range.</p>	ICL, SM, CBL, PBL, ICT, EL, IBL, SDL	Explain IC 741, IC 555, IC 565 and their applications
II	<p><b>Applications of Digital Circuits:</b></p> <p>Semiconductor Memories: Read Only Memory, Programmable Read Only Memory, Erasable Programmable Read Only Memory &amp; Random Access Memory, Expanding memory size. Digital to Analog Convertor-Resistive divider, Binary ladder, Analog to Digital Convertor using OPAMP, Specifications, Parallel Comparators, Counter method and Successive Approximation method, Box-car Integrator.</p>	ICL, SM, CBL, PBL, ICT, EL, IBL, SDL	Discuss different memories, convertors and their applications



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### (\* Learning Pedagogies/Methods

- (u) CL: Classroom Lecture
- (v) CBL: Case-Based Learning
- (w) PBL: Problem-Based Learning
- (x) EL: Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (y) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (z) IBL: Inquiry-Based Learning
- (aa) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

### Assessment Methodologies/Tools

#### (K) Internal Assessment [Total: 25 Marks]

##### a. Internal Formative assessment [10]

- (p) Assignment, Self-learning and Terms work
- (q) Seminar/Presentation
- (r) Viva Voce
- (s) Laboratory / class regularity

##### b. Internal Summative Assessment [15]

- (k) Mid-term tests

#### (L) Weightage of Learning Efforts for External Assessment [Total: 25 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1,2	30	2	3	7	12
II	2,3	30	2	3	8	13
		<b>60</b>	<b>4</b>	<b>6</b>	<b>15</b>	<b>25</b>

### Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Internal Practical Examination	Seminars, Assignments, Quizzes, Regularity, Practicals.	50
2	End-Semester Examination	Written Exam/Practical Exam & viva	50



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### CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	1	2	3	-	-	1	2	-	-
2	3	1	2	3	-	-	1	2	-	-
3	3	1	2	3	-	-	1	2	-	-

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

### Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Op-Amps and Linear Integrated Circuits	Ramakant Gayakwad	Fourth/ 2016	PHI Learning Pvt. Ltd.
2	Fundamental of Digital Circuits	A Anand Kumar	Fourth/ 2016	PHI Learning Pvt. Ltd.
3	Digital Principles and Applications	D P Leach, A P Malvino and G Saha	Eight/ 2015	Tata McGraw Hill Education Pvt. Ltd.
	Microelectronics: Digital and Analog	K. R. Botkar	1991	Khanna Publishers

### Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Introduction and configuration of IC 741	<a href="https://how2electronics.com/op-amp-ic-lm741-basics-characteristics-pins-applications/">https://how2electronics.com/op-amp-ic-lm741-basics-characteristics-pins-applications/</a>
2	Timer IC and different applications	<a href="https://www.youtube.com/watch?v=OdI4WtTmuuk">https://www.youtube.com/watch?v=OdI4WtTmuuk</a>
3	IC 565 and its understanding	<a href="https://www.youtube.com/watch?v=IX-u3Rtkm9g">https://www.youtube.com/watch?v=IX-u3Rtkm9g</a>
4	Semiconductor memories	<a href="https://www.youtube.com/watch?v=oBMj77ONeH8">https://www.youtube.com/watch?v=oBMj77ONeH8</a>



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