Maa Shakumbhari University, SAHARANPUR U.P.

माँ शाकुम्भरी विश्वविद्यालय, सहारनपुर, उत्तर प्रदेश

Syllabus

of

M.Sc. (Physics)

(For fourth and fifth years of Higher education)

(As per guidelines of U.P. Government according to National Education Policy-2020 w.e.f. the session 2024-2025)

Members of the Board of Studies:

S. No.	Name	Signature
1.	Prof. Garima Jain, Dean Science faculty, Convener	Sd/-
2.	Prof. Ashok kumar Dimri	Sd/-
3.	Dr. Sanjay Kumar Singh	
4.	Prof. Beer Pal Singh, External Expert	
5.	Prof. R S Singh, External Expert	

Program prerequisites

To study this course, a student must have the subject Physics at B.Sc. IIIrd Year of NEP-2020.

Program Structure

The program (course) will be based on Choice Based Credit System (CBCS) developed by the University. There will be four compulsory or elective (Optional) core courses of Physics in each semester. In addition, one minor elective course of other faculty is to be selected by a student in the IVth Year of NEP-2020 i.e., first year of M.Sc. There will be one 4-credit research project in each semester.

LIST OF PAPERS IN ALL FOUR SEMESTERS

Year	Semester	Course Code	Course Title	Core Compulsory/ Elective/Value Added	Theory/ Practical/ Project	Credits	Internal Marks	External Marks (Min Marks)	Total Marks	Minimum Marks (Int+Ext)	Teaching Hours
Year-4 as per NEP-2020/ Year-I	Semester- VII as per NEP-2020/ Semester-I	0720101	Mathematical Physics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0720102	Classical Mechanics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0720103	Quantum Mechanics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0720104	Electronic Devices	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0720180	Lab Work (Based on the contents of Theory Courses)	Core Compulsory	Practical	4		100	100	40	60
	Semester- VIII as per NEP-2020/ Semester-II	0820101	Statistical Mechanics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0820102	Electrodynamics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0820103	Atomic and Molecular Physics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0820104	Nuclear Physics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0820180	Lab Work	Core Compulsory	Practical	4		100	100	40	60

Year-5 as per NEP-2020/ Year-II	Semester-IX as per NEP-2020/ Semester-III	0920101	Numerical Methods with Programming	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0920102	Condensed Matter Physics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		Any one of the Followings:									
		(1) Electronics Specialization- -									
		0920103	Operational Amplifier & Digital Circuits	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0920180	Lab Work (based on the contents of Theory Courses)	Core Compulsory	Practical	4		100	100	40	60
		0920165	Research Project	Core Compulsory	Project	4		100	100	40	60
		(2) Nuclear Physics Specialization -									
		0920104	Nuclear Physics Special Paper I	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		0920181	Lab Work (based on the contents of Theory Courses)	Core Compulsory	Practical	4		100	100	40	60
		0920166	Research Project	Core Compulsory	Project	4		100	100	40	60
	Semester-X as per NEP-2020/ Semester-IV	1020101	Advanced Quantum Mechanics	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		1020102	Physics of Nanomaterials	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		Any one of the Followings:									
		(1) Electronics Specialization-									
		1020103	Electronic Communication Systems	Elective	Theory	4	25	75 (25)	100	40	60
		1020180	Lab Work (based on the contents of Theory Courses)	Core Compulsory	Practical	4	25	100	100	40	60
		1020165	Research Project	Core Compulsory	Project	4	25	100	100	40	60
		(2) Nuclear Physics Specialization -									
		1020105	Nuclear Physics Special Paper II	Core Compulsory	Theory	4	25	75 (25)	100	40	60
		1020181	Lab Work (based on the contents of Theory Courses)	Core Compulsory	Practical	4	25	100	100	40	60
		1020166	Research Project	Core Compulsory	Project	4	25	100	100	40	60

Programme/Class: M.Sc. (Degree)	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **0720101**	Course Title: **MATHEMATICAL PHYSICS**	

Course outcomes:

- Students will be able to solve the research problems based on the complex variables and integral of complex functions.
- Students will learn the solution of various mathematical equations using Laplace transformation.
- Students will be able to use of Fourier series and transformation in some spectroscopic analysis.
- The content given in 'Special functions and polynomials of this course will impart skills for direct employability.
- Students will understand the use of mathematical methods in their various branches of physics and engineering.

Credits: **4**	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Special functions and polynomials** Legendre, Hermite and Laguerre polynomials and their generating functions. Recurrence relations and special properties of $P_n(x)$ as solution of Legendre differential equation, Rodrigues formula, orthogonality of $P_n(x)$, associated Legendre polynomials (Introduction only). Bessel function of first kind, generating function, recurrence relations, $J_n(x)$ as solution of Bessel differential equation, Expansion of $J_n(x)$ when n is half and odd integer, Integral representation	20
II	**Complex Analysis:** Complex Variables, Function of a complex variable, Analytic Function, Cauchy Riemann conditions, Complex Integration, Cauchy's integral theorem Cauchy's integral formula, Taylor's and Laurent's Series (without derivation) Singularities, zeros and residue of complex function, Cauchy's Residue theorem, Evaluation of definite integrals of the type: $\int_{UD}^{UD} f(Sin\theta, Cos\theta)\, d\theta$, $\int_{UD}^{UD} f(x)\, dx$ and $\int_{UD}^{UD} f(x)e^{[illegible]}\, dx$	15
III	**Fourier Series and Fourier Integral:** Fourier series, Even and Odd function, Half range expansion, Function of arbitrary period, Physical applications of Fourier Series analysis, Fourier integral, Fourier integral for even and odd functions and its application.	10
IV	**Integral Transforms:**	15

	Laplace Transform, First and second shifting theorems, Inverse LT by partial fractions, LT of derivative and integral of a function, Solution of initial value problems by using LT Fourier Transform, Fourier Cosine Transform, Fourier Sine Transform, two dimensional and three-dimensional Fourier transform, Fourier Transform of delta and Gaussian function	

Suggested Readings:

1. Kreyszig, E, "Advanced Engineering Mathematics" John Wiley & Sons.

2. Rajput, B.S., "Mathematical Physics" Pragati Prakashan, Meerut.

3. Das,H.K., "Mathematical Physics"

Suggestive digital platforms web links-

1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous Internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: M.Sc. (Degree)	Year: 4	Semester: 7
Subject: PHYSICS		
Course Code: **0720102**	Course Title: **CLASSICAL MECHANICS**	

Course outcomes:

On the successful completion of classical mechanics, the students will be able to learn and understand the fundamental concepts of dynamics of the system of particles, related conservation theorems, equations of motion for mechanical systems using the Lagrangian and Hamiltonian formulation. The main course outcomes are as follows:

- Able to solve the mechanics of dynamical systems using Lagrange's equations of motion for conservative and non-conservative systems through Lagrangian formulation.
- Able to understand the variational principle and its application to solve mechanical problems using Lagrangian formulation.
- Able to deal with the problem of two bodies moving under the influence of a mutual central force motion.
- Able to understand the theory of small oscillations applied in many physical applications.
- Able to solve mechanical problems using Hamilton's equations of motion by Hamiltonian formulation.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Preliminaries:** Newtonian mechanics of a particle, Mechanics of a system of particles, Constraints; their classification, D'Alembert's principle, Virtual work, generalized coordinates and derivation of Lagrange's equations, Velocity-dependent potentials and the Dissipation function, Applications of Lagrangian formulation, Generalized velocity, momentum and energy, Cyclic coordinates, Symmetries of space and time with conservation laws.	15
II	**Variational Principles and Hamilton Formalism:** Hamilton's principle, some techniques of the calculus of variations, Derivation of Lagrange's equation from Hamilton's principle, advantages of variational principle formulation, Principle of least action, Legendre transformations and Hamilton equations of motion, Cyclic coordinates and conservation theorems, Canonical transformation generating functions, Properties, Poisson bracket, Poisson theorem, Relation of Poisson brackets, Hamilton Jacobi method.	15
III	**Two Body Central Force Problem:** Reduction to the equivalent one-body problem, Motion in a central force field, The Virial theorem, The inverse square law of force, The motion in central force in the Kepler problem.	15

IV	**Rigid Body Dynamics and Small oscillations:** Rotational motion, Moment of Inertia, Euler's theorem, Euler's Angles, Symmetric top, Concept of small oscillations, Expression of kinetic energy and potential energy for the problem of small oscillations, Frequencies of free vibration, and Normal coordinates.	15

Suggested Readings:

1. Goldstein, H., "Classical Mechanics"
2. Rana, N.C. & Joag P.S., "Classical Mechanics"
3. Sommerfield A., "Physics"
4. Perceival & Richards D., "Introduction to Dynamics"

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Programme/Class: **M.Sc. (Degree)**		Year: 4	Semester: 7
Subject: **PHYSICS**			
Course Code: **0720103**	Course Title: **QUANTUM MECHANICS - I**		

Course Outcomes:

- Students will be able to understand the physical and mathematical basis of quantum mechanics for non-relativistic systems.
- Students will be able to learn mathematical tools needed to develop the formal theory of quantum mechanics.
- Students will be able to understand the measurement process in quantum mechanics.
- Students will be able to understand the connection between measurement of results and the uncertainty relation.
- Students will be able to understand the application of wave function theory in quantum mechanics.
- Students will be able to appreciate the amazing power and surprises of quantum mechanics in problems like free particles and particles in a potential.
- Students will be able to recognize the applicability of angular momenta in several branches of physics.
- Students will be able to appreciate the profound strength of approximate methods in problems like Stark effect, Zeeman effect, etc.

Credits: **4**	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Fundamental Concepts:** Schrodinger equations : Time dependent and time independent, Operators, Probability density, Expectation values, Principle of Superposition, Motion of wave packets, Eigen values and eigen vectors, Bound and continuum states, Postulates of Quantum mechanics, Coordinate and momentum representation, Hermitian operators, Degeneracy, Orthonormality and Completeness, Unitary Operators, Change of basis, Infinitesimal and finite unitary transformations, Commutator Algebra, Uncertainty relation between two operators, Free particle radial wave function, Spherical well, Cylindrical well, Charge particle in a magnetic field and Hydrogen atom.	20
II	**Representation and Transformations:** Hilbert Spaces, Vector and Bases, Dirac notation, Matrix representations of Kets, Bras and Operators, Matrix representation of Eigen value problem, Linear harmonic oscillator in matrix formulation, Space and time displacements, Rotation generators, Symmetry and conservation laws, Symmetric and anti-symmetric wave-functions and Pauli Exclusion Principle.	12
III	**Approximate Methods:** Time independent first and second order perturbation theory for non-degenerate and degenerate levels, Variational method, and its application for Helium atom,	14

	WKB Approximation. Application of electric field (Stark effect), normal and anomalous Zeeman Effect.	
IV	**Theory of Angular momentum:** Commutation relations involving angular momentum operators, the eigenvalue spectrum, Infinitesimal and finite rotations, Matrix representation of J, Addition of angular momentum, Clebsch- Gordon coefficients, Spin angular momentum, Spin wave functions, Pauli matrices, Precession of an electron in magnetic field, Addition of spin and orbital angular momentum.	14

Suggested Readings:

1. Liboff, R.L., "Introductory Quantum Mechanics".
2. Tyagi, I.S., "Principle of Quantum Mechanics".
3. Khare, S.P., "Quantum Mechanics and Atomic Physics".
4. Schiff, L.I., "Quantum Mechanics".
5. Zettili, N., "Quantum Mechanics: Concepts and Applications".
6. Griffiths, D.J., "Introduction to Quantum Mechanics".

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Programme/Class: **M.Sc. (Degree)**		Year: 4	Semester: 7
Subject: **PHYSICS**			
Course Code: **0720104**	Course Title: **ELECTRONIC DEVICES**		

Course Outcomes:

- To understand the conduction mechanism of elemental and compound semiconductors for designing the electronic components and circuits.
- Understanding the basic phenomenon of semiconductors, it can be used for the fabrication of modern devices
- Having the knowledge of semiconductors, junction diodes, transistor biasing, feedback in amplifiers, students may perform better in competitive exams as well as may understand semiconductor and microelectronic Industries and find job opportunities in communication and telecommunication sectors also.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Conduction Mechanism in Semiconductors:** Classification of semiconductors -Elemental and compound semiconductors, Direct band and indirect band gap semiconductors, The Fermi Level, Carrier concentrations; electron and hole concentrations at equilibrium, temperature dependence of carrier concentrations, degenerate semiconductors, drift of carriers in electric and magnetic fields; The Hall effect, conductivity and mobility, effect of temperature and doping on mobility,, Diffusion of carriers in semiconductors; generation and recombination, The continuity equation.	10
II	**Junction-diode and Bipolar Junction Transistors:** The Contact Potential and space charge region, Band diagram of P-N junction, Reverse bias breakdown, Zener diode, Tunnel diode. Metal semiconductor junction, Schottky diode. Transistor current components and parameters, Transistor CB, CE, CC configurations, Input output characteristics, Early Effect and base width modulation, Transistor load lines, Transistor as an amplifier, Graphical analysis of the CE configuration. Transistor biasing and thermal stabilization.	15
III	**Field Effect Transistors:** Construction and characteristics of JFET, transfer characteristics, The FET small signal model, Measurement of gm and rd, JFET fixed-bias, Self-bias and voltage divider configurations, JFET source follower (common-Drain configuration), JFET Common–Gate configuration, Depletion and enhancement type MOSFETs. Idea of NMOS, PMOS and CMOS.	15
IV	**Feedback in Amplifiers and Basics of Operational Amplifiers:** Feedback concept, Effect of negative feedback, Voltage-series feedback,	20

	Current-series feedback, Voltage-shunt feedback, Current-shunt feedback. Differential amplifier and its configurations, Op-Amp Block diagram, Schematic symbol and terminals of 741, D.C. power supplies for an Op-Amp, Ideal Op-Amp, Equivalent circuit of an Op-Amp, Important characteristics of an ideal Op-Amp, Practical Op-Amp characteristics, Ideal voltage transfer curve, Open loop operation of an Op-Amp. Op-Amp with negative feedback (closed loop configuration), concept of virtual short and virtual ground. Inverting and non-inverting amplifiers.	

Suggested Readings:

1. Sze, S.M. & Kwok, K. Ng, "Physics of Semiconductor Devices".
2. Streetman, B.G., "Solid State Electronic Devices".
3. Boylestad, R.L. & Nashelsky, L., "Electronic Devices and Circuit Theory".
4. Millman, J. & Halkias, C.C., "Integrated Electronics".
5. Chattopadhyay, D & Rakshit, P. C., "Electronics Fundamental and Application".
6. Kumar, Balbir & Jain, S.B., "Electronic Devices and Circuits".

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Suggested Continuous Evaluation Methods:

Continuous Internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **M.Sc. (Degree)**	Year: 4	Semester: 7
Subject: **PHYSICS**		
Course Code: **0720180**	Course Title: **PHYSICS LAB I**	

Course Outcomes:

- At the end of the laboratory course, each student is expected to understand the basic concepts of electronics/nuclear physics through experiments.
- The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
- The student will gain practical knowledge of designing, assembling, and testing electronics circuits as well as understanding troubleshooting.
- The student would be equipped with an in-depth knowledge of Physics that can be applied in higher studies in every field of Physics.

Credits: 4	Core Compulsory / Elective: Core Compulsory
Max. Marks: 100	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-18

List of Experiments-

Choose any six experiments from the given list.

1. To study the frequency response and to calculate the various parameters such as input Impedance, output impedance, current gain and voltage gain of the emitter follower.
2. To study the Drain characteristics and Mutual characteristics of a N/P channel MOSFET
3. To study the characteristics of a junction field effect transistor and to calculate the various parameters as

   (a) drain dynamic resistance (b) mutual conductance (c) amplification factor
4. To study and compare the following transistor biasing techniques and calculate the Bias voltage and transistor currents in-

   (a) Single battery biasing (b) Two battery biasing (c) Voltage divider bias (d)Collector to base bias
5. To study the forward and reverse bias characteristics of the following diodes-

   (a) Germanium diode (b) Silicon diode (c) Zener diode (d) Light emitting diode
6. To study the characteristics of a P-N junction and determine –

   (a) Reverse saturation current (b) Material constant

   (c) Determination of temperature coefficient of the Junction (d) Junction voltage and energy band gap.
7. To study the diffraction pattern of a semiconductor laser and –

   (a) Determine the width of the single slit from the diffraction pattern.

   (b) Measure the thickness of the wire/obstacle.

(c) Determine the wavelength of the laser light using diffraction grating.

8. To study the absorption spectrum of iodine vapour and to obtain –
   (a) Energy level diagram for iodine molecule
   (b) Deducing the electronic excitation energy for iodine molecule
   (c) Deducing force constant for iodine molecule
9. To study the characteristics of a LED and –
   (a) Determination of Plank's constant (b) Determine the material constant
   (c) Determine the temperature coefficient
10. To study the characteristics of a Photocell and –
   (a) Determination of Plank's constant (b) Determine the material constant
   (c) Determine the temperature coefficient
11. To study a single stage R-C coupled amplifier cum feedback amplifier and draw its frequency Response curve and measure –
   (a) Voltage/Power gain (b) Variation of gain (c) Input/Output Impedance
   (d) Phase relationship between input and output waveforms
12. To study a single stage L-C coupled amplifier cum feedback amplifier and draw its frequency response curve and measure –
   (a) Voltage/Power gain (b)Variation of gain (c) Input/Output Impedance
   (d) Phase relationship between input and output waveforms
13. To study the dielectric constant and determine the Curie temperature of the ferroelectric ceramics.
14. To demonstrate the concept of quantization of energy levels in accordance with the Bohr model of atoms by Frank Hertz experiment.
15. To trace a B-H curve for a ferro-magnetic material using CRO and to find magnetic parameters from The B-H curve
16. To calculate the resistivity of a semiconductor by Four-Probe method at different temperatures.

Suggested Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15).

Programme/Class: **M.Sc. (Degree)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: 0820101	Course Title: **STATISTICAL MECHANICS**	

Course Outcomes:

- After completion of the course, the students will have the basic knowledge of statistical mechanics.
- Students will be able to calculate the statistical quantities of various systems.
- Students will be able to explain the ensemble theory required for macroscopic properties of the matter in bulk in terms of its constituents.
- Students will understand the analysis of properties of ideal Bose gas, Bose- Einstein condensation, liquid helium and electron gas.
- Students will be able to understand the various theories and models of cluster expansion and fluctuations of thermodynamic variables.
- Students will have knowledge to explain theoretical aspects of order-disorder phase transition in various systems.

Credits: **4**	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Ensembles and Statistics of Ideal Gas System:** Scope and objectives of statistical mechanics. Analysis of phase space, phase points, μ - space and γ - space, concept of ensemble, density of phase points, Microstates and Macrostates. Number of accessible microstates. Detailed analysis of micro-canonical, canonical and grand canonical ensembles. Partition function formulation. Partition function of microcanonical, canonical and grand canonical ensembles. The entropy of an ideal gas using microcanonical ensemble, Gibbs paradox, Sackur-Tetrode equation	15
II	**Quantum Statistical Mechanics:** Transition from classical statistical mechanics to quantum statistical mechanics. Postulates of quantum statistical mechanics. Density matrix, Indistinguishability and quantum statistics. identical particles and symmetry of wave functions. Basic postulate and particle distribution function of Bose Einstein statistics. Energy, number of particles and pressure of B.E. gas. Bose Einstein Condensation, Thermal properties of B.E. gas, Transition in liquid ^{4}He, Superfluidity in ^{4}He. Basic postulate and particle distribution function of Fermi Dirac statistics. Energy, number of particles, temperature and pressure of F.D. gas. Properties of ideal electron gas, Thermionic Emission	20
III	**Statistical models for order-disorder phase transition:** Cluster expansion for a classical gas, virial equation of state, first and second order phase transition, Ising model, mean-field and Heigenburg theories of Ising model, Exact solutions in one-dimension, Landau theory of phase transition, Landau theory of liquid He-II, critical exponents.	15

IV	**Fluctuations:** Introduction to non-equilibrium process, mean square deviation, Energy and density fluctuations, one dimensional random walk, Random walk and Brownian motion, Langevin theory of Brownian motion and relation with diffusion equation, The Fokker-Plank equation	10

Suggested Readings:

1. Reif, F., "Statistical and Thermal Physics".
2. Huang, K., "Statistical Mechanics".
3. Pathria, R.K., "Statistical Mechanics".
4. Kubo, R., "Statistical Mechanics".
5. Landau & Lifshitz, "Statistical Physics".
6. Agarwal, B.K. & Eisner, M., "Statistical Mechanics".
7. Gopal, E.S.R., "Statistical Mechanics and properties of matter, theory and application"

Suggestive digital platforms web links-

1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
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3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: M.Sc. (Degree)	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820102**	Course Title: **ELECTRODYNAMICS**	

Course Objectives:

- To develop understanding of field produced by stationary charge distributions in free space, metals and dielectrics in students.
- To develop understanding of field produced by steady currents in free space and matter and different behavior of materials in magnetic field in students.
- To aware the students from time varying fields and fundamental equations of electromagnetism.
- To develop computational skills in students to solve basic problems of electromagnetism.
- To teach the students basic concepts in electromagnetic wave propagation in different media and at interfaces.

Course Outcomes:

After completing this course:

- Students will gain basic understanding of electrostatics, magnetostatics and electromagnetism.
- Students will become competent in solving basic problems of electromagnetism.
- Students will be in a position of critical questioning and answering in various situations of field and potential calculations.
- Students will be able to understand basic concepts of electromagnetic waves and their propagation in different media. This will, further, help them in understanding communication electronics in future.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
I	**Electrostatics:** Gauss' Law and its applications, divergence and Curl of E, Electrostatics of Conductors, Solution of electrostatic problems: Laplace's and Poisson's Equations, Methods of images, point charge near an infinite conducting plane, Point charge near a grounded conducting sphere, Electrostatic of Dielectrics: Dielectrics and Polarization, Field of polarized object, Electric field inside dielectrics, Electric displacement, Linear dielectrics.	15
II	**Magnetostatics:** Magnetic field of a Steady currents; Biot-Savart Law, Ampere's Law and elementary applications, Divergence and curl of B, Magnetic vector potential, Magnetostatic fields in Matter, Magnetization, field of a magnetized object, magnetic field inside matter, linear and nonlinear magnetic media; Ferromagnetism: Hysteresis loop.	15

III	**Time Varying Fields:** Faraday's laws of electromagnetic induction (Integral and Differential form), Maxwell's displacement current, Maxwell's equations in free space and dielectrics, Boundary conditions, Poynting theorem, Lienard Wiechert potentials due to a point charge, Field of a point charge in motion, Power radiated by accelerated charges.	15
IV	**Plane Electromagnetic Wave:** Electromagnetic waves in free space, dielectrics and conductors, Reflection and Refraction of EM Waves at an interface between dielectrics (normal and oblique incidence), transmission, absorption, Fresnel's relation of polarization by reflection and total internal reflection, Reflection from conducting surface.	15

Suggested Readings:

1. Jackson, J.D., "Classical Electrodynamics".
2. Reitz, J.R., Milford, F.J. & Christy, R.W., "Foundations of Electromagnetic Theory".
3. Griffiths, David J., "Introduction to Electrodynamics".
4. Verma, H.C., "Classical Electrodynamics".

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Suggested Continuous Evaluation Methods:

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Programme /Class: **M.Sc. (Degree)**	Year: 4	Semester: 8
Subject: **PHYSICS**		
Course Code: **0820103**	Course Title: **ATOMIC AND MOLECULAR PHYSICS**	

Course Outcomes:

On successful completion of this course, the student will:

- Develop the ability to conceptually understand the atomic spectra of Hydrogen atoms and similar valence electron atoms.
- Be able to understand and interpret the atomic spectra for many electron atoms.
- Also, can explain the change in behavior of atoms in external applied electric and magnetic field and corresponding changes in observed spectra.
- Gain sufficient understanding of rotational, vibrational, electronic and Raman spectra of molecules.
- Develop skill in important material characterization techniques like IR/FTIR, Raman, etc.
- Acquire ability to apply Nuclear Magnetic Resonance (NMR) for structure elucidation of synthesized materials.
- The knowledge of various material characterization techniques will impart skills for direct employability.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Atomic Physics -I:** Introduction to Atomic spectra, Quantum states of an electron in Hydrogen atom. Relativistic corrections for energy levels of hydrogen atom. Concept of spin and fine structure of hydrogen atom. Singlet and triplet States of Helium. Broad features of spectra of alkali elements. Fine structure in Alkali Spectra.	15
II	**Atomic Physics - II:** Many electron atoms: Central field approximation, atomic wave function, Hartree and Hartree–Fock approximations, Results of Hartree's theory, Spectroscopic Terms: LS coupling, Lande Interval rule, determination of spectral terms for atoms; with two or more Non-equivalent optical electrons, and two or more equivalent optical electrons. Breit's scheme. JJ coupling for many electron atoms. Atom in external field, Zeeman, Paschen-Bach & Stark effects.	15
III	**Molecular Physics:** Born-Oppenheimer approximation, Classification of Molecules, Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra, Raman Scattering, Classical and Quantum theory of Raman effect. Selection rules, Isotope effect, Formation of electronic spectra, fine structure of electronic bands. Intensity distribution in electronic bands: Franck-Condon principle. Explanation of intensity distribution in absorption and emission bands from Franck-Condon principle.	20
IV	**Characterization Techniques:** Infrared/FTIR Spectroscopy, General description and working of dispersive and FTIR instrument. Interpretation of FTIR spectra. Raman spectroscopy. Nuclear	10

	Magnetic Resonance, Chemical Shift, NMR Spectrometer. NMR spectrum analysis.	

Suggested Readings:

1. White, H.E., "Introduction to atomic spectra".
2. Herzberg, "Spectra of diatomic molecules".
3. Weissbluth, M., "Atoms and Molecules".
4. Slater, "Quantum theory of Atomic Structure, Vol. 1".
5. Slater, "Quantum theory of Molecules and Solids".
6. Banwell, C.B., "Fundamentals of Molecular Spectroscopy".
7. Barrow, G.M., "Introduction to Molecular Spectroscopy".
8. Brown, J.M., "Molecular Spectroscopy".
9. Larkin, Peter J., "Infrared and Raman Spectroscopy: Principles and Special Interpretation".
10. Ghatak, Ajoy & Thyagarajan, K., "Lasers: Fundamentals and Applications".

Suggestive digital platforms web links-

1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
2. Swayam Prabha - DTH Channel,

   https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: M.Sc. (Degree)	Year: 4	Semester: 8
Subject: PHYSICS		
Course Code: **0820104**	Course Title: **NUCLEAR AND PARTICLE PHYSICS**	

Course outcomes:

- Students will be more enlightened with the study of nuclear Physics and ready to go for further study.
- This course will be useful to understand different aspects of nuclear physics.
- This course will give a better insight which will be a good boost for the students.
- General introduction of nucleus with modern technology may open the Broadway of nucleus.

Credits: **4**	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**General Introduction:** Scattering of α particles, Mirror nuclei, μ meson atoms consideration, Idea of protonic charged nuclear dimensions. Nuclear mass, Nuclear angular momentum and magnetic moment, electric quadrupole moment, Parity quantum number, Statistics of nuclear particles, Isobaric spin concept, Electron capture, Partial wave analysis of n-p scattering, phase shift, single and triplet potentials	15
II	**General β decay DISINTEGRATION:** Fermi theory of allowed β decay. Non conservation of parity and Wu's experiment, Internal conversion.	05
III	**Interaction and Detection of Nuclear Radiation with matter Chemical and Biological effects of radiation:** Interaction of charged particles with matter, Stopping power of heavy charged particles, Range and straggling of electrons. Introduction of Ionization chamber , Proportional counter, G.M. counter ,scintillation counter . Radiation monitoring and Dosimeters, Physical effects of radiation, Chemical effects of radiation. Effects of radiation on water and aqueous solutions, Penetration and ionizing power of nuclear radiations in the human body.	18
IV	**Nuclear Models:** Single particle, Individual particle model, predictions of shell model and magic numbers.	05

V	**Nuclear elementary particles:** General idea of elementary particles, Conservation laws, CP and CPT invariance, introductions of hadrons, quarks, Gell-Mann Okubu mass formula, Formation of stars, Chandrashekhar limit, neutron rich matter and supernova explosion	07

Suggested Readings:

1. Srivastava, B.B., "Fundamentals of Nuclear Physics".

2. Ghoshal, S.N., "Nuclear Physics" S. Chand Publications.

3. Tayal, D.C., "Nuclear Physics" Himalaya Publications.

Suggestive digital platforms web links-

1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: M.Sc. (Degree)	Year: 4	Semester: 8
Subject: **PHYSICS**		

Course Code: **0820180**	Course Title: **PHYSICS LAB II**

Course Outcomes:

- At the end of the laboratory course, each and every student is expected to understand the basic concepts of electronics/nuclear physics through experiments.
- The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
- The student will gain practical knowledge of designing, assembling and testing electronics circuits as well as understanding troubleshooting.
- The student would be equipped with an in-depth knowledge of Physics that can be applied in higher studies in every field of Physics.

Credits: 4	Core Compulsory / Elective: Core Compulsory
Max. Marks: 100	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-18

List of Experiments-

Choose another **six** experiments from the given list.

1. To study the frequency response and to calculate the various parameters such as input Impedance, output impedance current gain and voltage gain of the emitter follower.
2. To study the Drain characteristics and Mutual characteristics of a N/P channel MOSFET
3. To study the characteristics of a junction field effect transistor and to calculate the various parameters as

   (a) drain dynamic resistance (b) mutual conductance (c) amplification factor
4. To study and compare the following transistor biasing techniques and calculate the Bias voltage and transistor currents in-

   (a) Single battery biasing (a) Two battery biasing (c) Voltage divider bias (d) Collector to base bias
5. To study the forward and reverse bias characteristics of the following diodes-

   (a) Germanium diode (b) Silicon diode (c) Zener diode (d) Light emitting diode
6. To study the characteristics of a P-N junction and determine –

   (a) Reverse saturation current (b) Material constant (c) Determination of temperature coefficient of the Junction (d) Junction voltage and energy band gap.
7. To study the diffraction pattern of a semiconductor laser and –

   (a) Determine the width of the single slit from the diffraction pattern.

   (b) Measure the thickness of the wire/obstacle.

(c) Determine the wavelength of the laser light using diffraction grating.

8. To study the absorption spectrum of iodine vapour and to obtain –
   (a) Energy level diagram for iodine molecule
   (b) Deducing the electronic excitation energy for iodine molecule
   (c) Deducing force constant for iodine molecule
9. To study the characteristics of a LED and –
   (a) Determination of Plank's constant (b) Determine the material constant
   (c) Determine the temperature coefficient
10. To study the characteristics of a Photocell and –
    (a) Determination of Plank's constant (b) Determine the material constant
    (c) Determine the temperature coefficient
11. To study a single stage R-C coupled amplifier cum feedback amplifier and draw its frequency response and measure –
    (a) Voltage/Power gain (b) Variation of gain (c) Input/Output Impedance
    (d) Phase relationship between input and output waveforms
12. To study a single stage L-C coupled amplifier cum feedback amplifier and draw its frequency response and measure –
    Voltage/Power gain (b) Variation of gain (c) Input/Output Impedance (d) Phase relationship between input and output waveforms
13. To study the dielectric constant and determine the Curie temperature of the ferroelectric ceramics.
14. To demonstrate the concept of quantization of energy levels in accordance with the Bohr model of atoms by Frank Hertz experiment.
15. To trace a B-H curve for a ferro-magnetic material using CRO and to find magnetic parameters from the B-H curve.
16. To calculate the resistivity of a semiconductor by Four-Probe method at different temperatures.

Suggested Evaluation Methods:
Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15).

Programme/Class: **M.Sc. (Degree)**	Year: 5	Semester: 9
Subject: **PHYSICS**		
Course Code: **0920101**	Course Title: **Numerical Methods with Programming**	

Course outcomes:

At the completion of the course students will be able to:

- Write arithmetic programs and perform data handling in the Python.
- Solve the linear and non-linear algebraic equations, Eigenvalue problems, curve fitting and numerical solution of ordinary differential equations.
- Solve numerical integration & differentiation, curve fitting, Numerical solution of ordinary equations.
- The course will impart skills for development of codes/programs required in software development.

Credits: **4**	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
I	**Python:** History and Application Areas of Python; Structure of Python Program; ~~Proposed Lecture~~ Identifiers and Keywords; Operators and Precedence; Basic Data Types and Type Conversion Statements and Expressions; Input/Output Statements. Conditional statements: if, if-else, if-elif-else. Introduction to files, types of files (Text file, Binary file, CSV file) Text file: opening a text file, text file open modes (r, r+, w, w+, a, a+), closing a text file, opening a file using with clause, writing/appending data to a text file using write() and write lines(), reading from a text file using read(), readline() and readlines(), seek and tell methods, manipulation of data in a text file	15
II	**Solution of Nonlinear and Linear Equations** **(i) Solution of nonlinear equations** Algebraic, Polynomial, and transcendental equations, Roots of nonlinear equations, and open-end methods: Bisection method, Newton-Raphson method. **(ii) Solution of linear system** **Direct Method:** Matrix inversion method, Gaussian elimination method, LU decomposition method, **Iterative Method:** Jacobi iterative method, Gauss-Seidel Method	15

III	**Interpolation and Curve fitting:** **Interpolation** Finite differences, Newton's formula for interpolation, Gauss Formula, Stirling formula, Divided differences, Newton's general interpolation formula, Lagrange's interpolation formula.	15
	Curve Fitting: Method of Least square curve fitting, straight line and quadratic equation fitting, curve fitting of curves $y = ax^b$, $y = ae^{bx}$, $xy^a = b$ and $y = ab^x$, curve fitting by sum of exponentials.	
IV	**Numerical differentiation, Integration and Solution of Ordinary Differential equations:** Numerical Differentiation of continuous functions, Numerical Integration: Trapezoidal rule, Simpson 1/3 and 3/8 rules, Boole's and waddles rules, Solution of ordinary differential equations: Picard Method, Euler's Method and Runge-Kutta method.	15

Suggested Readings:

1. "Programming for Computations – Python" T. J. Barth, M. Griebel, D. E. Keyes, R. M.
2. Nieminen, D. Roose, T. Schlic , Springer Open
3. "Computational Physics" Mark Newman
4. "Basics of Python Programming" Dr. Pratiyush Guleria (BPB, 2nd ed., 2024)
5. "Python Programming (Third Edition)" Reema Thareja, Oxford University Press India
6. S.S. Shastri "Introductory Methods of Numerical Analysis", PHI Pvt. Ltd. New Delhi.
7. Rajaraman "Computer Oriented Numerical Analysis" PHI Pvt. Ltd. New Delhi.
8. E. Balagurusamy "Numerical Methods", Tata McGraw Hill Pvt. Ltd. New Delhi.

Suggestive digital platforms web links-

1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: M.Sc. (Degree)	Year: 5	Semester: 9
Subject: **PHYSICS**		
Course Code: **0920102**	Course Title: **CONDENSED MATTER PHYSICS**	

Course outcomes:

After completing this course, students will

- Be able to correlate real and virtual lattice which is the key of structure property relationship of any solid.
- Develop skill in X-ray diffraction techniques and its applications.
- Gain knowledge of various crystal imperfections and their impact on properties of the material.
- Also be able to explain electronic and magnetic properties. The knowledge may help them to design new materials with desired electronic and magnetic properties.
- Learn about the basic concept of superconductivity and its application in various fields.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Crystal structure:** Lattice, primitive and nonprimitive cell, Classification of Bravais lattice, Common crystal structures: NaCl and CsCl Structure, close-packed structure, X-ray diffraction, Reciprocal lattice, and Brillouin zone; Point defects (Schottky& Frankel Defects) Imperfections, Line defects (Edge & Screw dislocations),	15
II	Different types of bonding in solids, covalent, metallic, Vander Waal, hydrogen bonding & ionic bonding, Madelung constant of ionic crystals, cohesive energy. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power.	15
III	**Electronics Properties of Solids:** Electrons in a periodic lattice: Bloch theorem, The Kronig-Penny Model, Effective mass of an electron, Tight-binding approximation, Cellular and pseudopotential methods, Fermi surface and Brillouin zones	10
IV	**Superconductivity:** Review of basic properties, Meissner effect, Type-I and Type-II superconductors, thermodynamics of superconductors, London's phenomenological theory, Flux quantization. Elements of BCS theory.	10

V	**Magnetic Properties of Solids:** Weiss theory of ferromagnetism, Heisenberg model and molecular field theory, Ferromagnetic domains, The Bloch-wall, Spin waves and Magnons, Curie- Weiss law for susceptibility, Ferri and antiferro-magnetic order	10

Suggested Readings:

1. Verma & Srivastava, "Crystallography for Solid State Physics".
2. Azaroff, "Introduction to Solids".
3. Pillai, S.O., "Solid State Physics".
4. Omar, "Elementary Solid-State Physics".
5. Aschroff & Mermin, "Solid State Physics".
6. Kittel, "Solid State Physics".
7. Chaikin & Lubensky, "Principles of Condensed Matter Physics".

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2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: M.Sc. (Degree)	Year: 5	Semester: 9
Subject: PHYSICS		
Course Code: 0920103	Course Title: **ELECTRONICS - SPECIAL PAPER - I** **OPERATIONAL AMPLIFIER AND DIGITAL CIRCUITS**	

Course outcomes:

Upon completion of this course students will be able to:

- To design various types of electronic circuits built around OP-Amp and study them experimentally.
- Learn various steps of combinational logic circuit design.
- Understand the concept of data storage and transfer.
- Understand the basics of microprocessor 8085 and writing simple assembly language programs.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Applications of Operational Amplifier:** Linear OP-Amp Circuits: Closed loop Inverting and Non-Inverting amplifier, voltage follower, Summing and Difference amplifier, Adder and Subtractor, Controlled Sources: Voltage Controlled Voltage Source, Voltage Controlled Current Source, Current Controlled Voltage Source, Current Controlled Current Source. Non-Linear OP-Amp Circuits: Rectifiers, Clippers, Clampers, Comparators and Schmitt Triggers, Integrator and Differentiator Active Filter and Oscillators: Low Pass, High Pass, Band Pass, Band Rejection Filters (with special reference to Butterworth filters), Wein Bridge and Phase Shift Oscillators.	15
II	**Logic Gates, IC Logic Families and Combinational Logic Circuits:** **Logic Gates:** symbols, truth tables and timing diagrams **IC Logic Families:** Characteristic Parameters, TTL and MOS Logic Families **Boolean Algebra:** Describing logic circuits algebraically, Implementing logic circuits for Boolean equations, Boolean Theorems, De Morgan's theorems, Universality of NAND and NOR gates. SOP and POS forms of Boolean equations, minterm and maxterm notations, converting a truth table to a POS and SOP equation. Simplifying Boolean equations: Algebraic simplification, Karnaugh Map (K-Map) up to four variables, K-Map simplification method for Boolean equations: Pair, Quad, Octet. Implementing Dont Care conditions. Arithmetic Circuits: Half Adder, Full Adder, Half Subtractor, Full Subtractor, Data Processing Circuits: Multiplexer, Demultiplexer, Encoders and Decoders.	15

III	**Clocks and Sequential Logic Circuits:** Clock Waveform, 555 Timer IC and its application as astable and monostable multivibrator **Flip Flops:** NOR gate latch and NAND gate latch, Level Clocked and Edge-triggered Flip-Flops, R-S Flip-Flop, D-Flip Flop, J-K Flip-Flop, T-Flip Flop, Excitation Table of Flip-Flops, Flip-Flop timing considerations, Master/Slave Flip-Flops. **Counters:** Asynchronous (Ripple) counters, Up and Down Counter, Asynchronous counter with Mod Number<2N, Synchronous counter, Synchronous counter design. **Register:** Serial-in-serial out, Serial-in-parallel out, Parallel-in-serial out, Parallel-in parallel out, Shift Register, Shift Register counter (Ring Counter and Johnson Counter).	15
IV	**Analog/Digital Interfacing Memories and Microprocessor:** **Digital to Analog conversion:** DAC specifications, Binary Weighted Register DAC, R/2R Ladder DAC. **Analog to Digital Conversion:** ADC specifications, Counter Type ADC, Successive Approximation ADC, Dual Slope ADC and Flash ADC. Basic Terms and Idea of Memory Devices. **Microprocessor- 8085:** Architecture and its operations, Memory and I/O interfacing devices, Writing Assembly language Programs (Simple Cases of data transfer and arithmetic operations).	15

Suggested Readings:

1. Gayakwad, R.A., "Op-Amp and Linear Integrated Circuit".
2. Tocci, Ronald J., "Digital Systems, Principles and Applications".
3. Malvino, A.P. & Leach, D.P., "Digital Principles and Applications".
4. Maini, Anil K., "Digital Electronics, Principles and Integrated Circuits".
5. Gaonkar, Ramesh, "Microprocessor Architecture, Programming and Applications with the 8085".

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2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **M.Sc. (Degree)**	Year: 5	Semester: 9
Subject: **PHYSICS**		

Course Code: **0920180**	Course Title: **ELECTRONICS LAB I**

Course Outcomes:

- At the end of the laboratory course, each student is expected to understand the basic concepts of electronics through experiments.
- The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
- The student will gain practical knowledge of designing, assembling, and testing electronics circuits as well as understanding troubleshooting.
- The student would be equipped with an in-depth knowledge of Electronics that can be applied in higher studies in every field of Electronics.

Credits: 4	Core Compulsory / Elective: Core Compulsory
Max. Marks: 100	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-18

List of Experiments-

Choose any **six** experiments from the given list.

1. To study the various logic gates, Half Adder, Full Adder, Half Subtractor and Full Subtractor by using digital IC's.
2. To study the performance characteristics of various optical transducers, such as
   (a) photovoltaic cell (b) photoconductive cells (c) Characteristics of photo diode
   (d) phototransistors.
3. To study the features of an IC 555 timer and to set up and operate is as a –
   (a) free running multivibrator (b) monostable multivibrator
4. To study the operational amplifier as –
   (a) inverting amplifier (b) non-inverting amplifier (c) Voltage follower amplifier
5. To study the operational amplifier as –
   (a) adder or summing amplifier (b) subtractor (c) integrator (d) differentiator
6. To study the active filters of first and second stage using operational amplifier as –
   (a) As low pass filter (b) High pass filter (c) Band pass filter
7. To study the R-S flip flop circuits –
   (a) By using NOR gates only. (b) By using a combination of AND and NOR gates.

(c) Clocked R-S flip flop (d) T flip flop.

8. To study the transmission line characteristics and calculate the various parameters like

   (i) Attenuation coefficient (ii) Phase shift coefficient (iii) Characteristic impedance

9. To study the amplitude modulation and demodulation and calculate the modulation index.

10. To study the frequency modulation and demodulation and calculate modulation index

11. To study the Hall effect and to calculate the Hall coefficient of the given semiconductor material by using Four Probe method.

12. To study the digital to analog conversion by using a R-2R ladder circuit.

13. To study the analog to digital conversion by using the IC ADC0808.

14. To construct any desired circuit on a digital breadboard using the digital /analog trainer kit.

15. To stimulate the given circuit by the computer simulation software LT Spice.t

16. To study and calculate the magneto resistance of a given semiconductor material.

Suggested Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15).

Programme/Class: **Master of Science/M.Sc.**	Year: 5	Semester: 9
Subject: **PHYSICS**		Credits: **04**
Course Code: 0920165	Course Title: **RESEARCH PROJECT**	
Max. Marks: **75+25** (75 for Research Project and 25 for Paper Publication)		

Course Outcomes:

- The students will be able to develop a positive outlook on learning with deepen understanding of subjects.
- Engagement in research projects will improve the critical thinking, problem solving and communication skills in student's.
- Students learn to collect information from reliable sources and carry out research.
- They get the benefit of Research Experience in graduate programs when applying for advanced studies.

Steps to proceed may include

1.Selection of topic for research.

2.Preparation of Research Proposal.

3.Methodology Literature survey & Review writing.

4.Data collection, data treatment & data analysis.

5.Review paper writing to publish.

6.Data collection and its comparison with previously reported data in literature.

7.Research paper writing to publish.

8.Presentation of paper in seminar/conference/workshop.

9.Project Report writing.

10. Presentation of project Report.

11. Submission of the Report.

Suggestive Teaching Learning Process: Class discussion, demonstrations, Power point presentations, using e-content, Class activities/ assignments, etc.

Suggested Readings:

1. **Research Methodology: Methods and Techniques** – C.R. Kothari & Gaurav Garg
2. **Research Design: Qualitative, Quantitative, and Mixed Methods Approaches** – John W. Creswell & J. David Creswell
3. **Scientific Research Methodology** – Jean-Luc Lebrun
   Good for planning and structuring scientific projects, including reporting results.

Programme/Class: **M.Sc. (Degree)**	Year: 5	Semester: 9
Subject: **PHYSICS**		
Course Code: 0920104	Course Title: **NUCLEAR PHYSICS - SPECIAL PAPER - I**	

Course outcomes:	
• Students will be able to learn about Quark theory. Quarks are basic building blocks. Quark theory explains the entire structure of the Universe. • Students will learn about why the excited state of deuteron doesn't exist? • Students will be able to calculate the stopping power of nuclear particles which may be performed experimentally also. • The basic theory of alpha, beta particles will help to perform GM Counter related experiments.	
Credits: 4	Core Compulsory / Elective: Elective
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
I	**Nuclear Structure** Quarks and Leptons – Lepton number conservation, Baryon number conservation, Quarks as the basic building block of hadrons, Isospin of nucleon, antiparticles and Quarks, Quark wave function of pions, Strangeness, Charm beauty and color. Static quark model of hadrons, Magnetic dipole moment of the baryon octet, Hadron mass and quark-quark interaction.	20
II	**Nuclear force and two-nucleon systems** The deuteron – Binding energy, parity, spin and isospin, Deuteron magnetic dipole moment-contribution from $^3S_1$-state, Admixture of $^3D_1$-state, electric quadrupole moment, Tensor force and the deuteron D-state, symmetry and Nuclear force - Charge independence and isospin invariance, Isospin operators.	10
III	General form of nuclear potential, Yukawa theory of nuclear interaction, Nucleon-nucleon scattering, phase shifts, spin polarization in nucleon-nucleon scattering, Low energy scattering parameters – Effective range theory, Neutron scattering of hydrogen molecules, Neutron scattering length, Nuclear potential.	10
IV	**Interaction of Nuclear Radiations with Matter:** Stopping power and range for charged nuclear particles, Stopping power and range of electrons, Absorption of gamma rays – Photo-electric absorption, Compton scattering and pair production, Stopping of neutrons.	10
V	**Nuclear Decay:** α-decay, its properties, range, range-energy relation, Geiger-Nuttall law, theory of α-decay, β-decay and its classification (basic only), Gamma-decay, range, properties, pair production, energy spectra and nuclear energy levels.	10

Suggested Readings:

1. Samuel S.M. Wong, "Introductory Nuclear Physics"
2. Harald A. Enge, "Introduction to Nuclear Physics"
3. Roy & Nigam, "Nuclear Physics"
4. Blatt & Weisskopf, "Theoretical Nuclear Physics"

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1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **M.Sc. (Degree)**	Year: 5	Semester: 9
Subject: **PHYSICS**		
Course Code: **0920181**	Course Title: **NUCLEAR PHYSICS LAB I**	

Course Outcomes:

- At the end of the laboratory course, each student is expected to understand the basic concepts of nuclear physics through experiments.
- The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
- The student will gain practical knowledge of designing, assembling, and testing electronics circuits as well as understanding troubleshooting.
- The student would be equipped with an in-depth knowledge of Nuclear Physics that can be applied in higher studies in every field of Nuclear Physics.

Credits: 4	Core Compulsory / Elective: Core Compulsory
Max. Marks: 100	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-18

List of Experiments

(1) To determine the g– factor by using NMR Spectroscopy
(2) To Plot the characteristics curve of beta particles with range and maximum energy by G.M. counter
(3) Efficiency calculation by using Alpha counting System.
(4) To determine the Lande's g factor and Lande's Spitting factor by using ESR
(5) Nuclear magnetic Resonance on protons and fluorine in solid samples
(6) To verify the inverse square relationship between the distance and intensity of radiation
(7) To study the diode applications in a Clipping & Clamping circuit
(8) To Study the Transistor Bias stability.

Suggested Readings:

1. Roy, R.R. & Nigam, B.P., "Nuclear Physics".

2. Kapoor, S.S. & Ramamurthy, V.S., "Nuclear Radiation Detectors".

3. Tait, W.H., "Radiation Detection".

4. Price, W.J., "Nuclear Radiation Detection".

Suggested Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15).

Programme/Class: **Master of Science/M.Sc.**	Year: 5	Semester: 9
Subject: **PHYSICS**		Credits: **04**
Course Code: **0920166**	Course Title: **RESEARCH PROJECT**	
Max. Marks: 75+25 (75 for Research Project and 25 for Paper Publication)		
Course Outcomes: • The students will be able to develop a positive outlook on learning with deepen understanding of subjects. • Engagement in research projects will improve the critical thinking, problem solving and communication skills in student's. • Students learn to collect information from reliable sources and carry out research. • They get the benefit of Research Experience in graduate programs when applying for advanced studies.		

Programme/Class: M.Sc. (Degree)	Year: 5	Semester: 10
Subject: PHYSICS		
Course Code: 1020101	Course Title: **ADVANCED QUANTUM MECHANICS**	
Course outcomes: • Students will be able to understand the scattering processes in atomic, subatomic, and molecular systems. • Students will be able to understand the time-dependent Schrodinger wave approach and its applications in real life, transition probabilities. • Students will be able to understand quantum theory of radiations. • Students will be able to understand relativistic quantum theory.		
Credits: 4	Core Compulsory / Elective: Core compulsory	
Max. Marks: 75 + 25	Min. Passing Marks: 40	
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0		

Unit	Topics	No. of Lectures
I	**Scattering Theory:** Laboratory and center-of-mass systems, scattering by potential field, scattering amplitude, differential and total cross sections, partial wave analysis, phase shift, Lippmann-Schwinger equation, and First Born approximation.	15

II	**Time Dependent Perturbation Theory:** First order perturbation, Harmonic Perturbation, Interaction of an atom with an electromagnetic field, Transition probabilities, Fermi Golden rule, Dipole approximation. Einstein's coefficients based on quantum mechanics, Induced and spontaneous emissions of radiations, adiabatic and sudden approximation.	15
III	**Quantum Theory of Radiation:** Classical radiation field, Fourier decomposition and electromagnetic radiation field, dipole approximation, Creation, annihilation and number operators,	15
	Photon states, Basic matrix elements for emission and absorption, explanation of stimulated and Spontaneous emission on the bases of quantum mechanics, Plank's radiation law.	
IV	**Relativistic Quantum Theory:** Klein-Gordon equation and its plane wave solution, Probability density in KG theory, Difficulties in KG equation, Dirac equation for a free electron, Dirac matrices and spinors, Plane wave solutions, Charge and current densities, Existence of spin and magnetic moment from Dirac equation of electron in an electromagnetic field. Dirac equation for central field with spin orbit interaction, Energy levels of Hydrogen atom from the solution of Dirac equation, covariant form of Dirac equation.	15

Suggested Readings:

1. Khare, S.P., "Quantum Mechanics and Atomic Physics".
2. Schiff, L.I., "Quantum Mechanics".
3. Sakurai J.J., "Advanced Quantum Mechanics".
4. Zettili, N., "Quantum Mechanics: Concepts and Applications".
5. Chaddha, G.S., "Quantum Mechanics".

Suggestive digital platforms web links-

1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: M.Sc. (Degree)	Year: 5	Semester: 10
Subject: PHYSICS		
Course Code: **1020102**	Course Title: **PHYSICS OF NANOMATERIALS**	

Course outcomes:

- Students may understand the basics of nano science and fundamental concepts behind size reduction in various properties of materials.
- Students may understand the phenomena of size dependence of physical properties.
- Students may understand Quantum Confinement in different dimensions.
- Students will be able to synthesize the nanomaterials using Top down and bottom-up approaches.
- Students will be able to understand the characterization techniques of nano structures.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Introduction to Nanostructure Materials:** Nanoscience & nanotechnology, Size dependence of properties, Moore's law, Surface energy and Melting point depression of nanoparticles, Free electron theory (qualitative idea) and band theory of solids, Idea of band structure of insulators, semiconductors and conductors, E-K Diagram, Effective masses and Fermi surfaces, Localized particles, Donors, Acceptors and Deep traps, Mobility, Excitons and its types, Density of states, variation of density of states with energy and dimensions of the crystal.	20
II	**Quantum Size Effect:** Quantum confinement and its effects, Nano structures, Quantum well, Quantum wire and Quantum dot, Fabrication techniques of Quantum wire.	10
III	**Characterization techniques of Nanomaterials:** Determination of particle size using XRD, (Derivation of Scherrer's formula), Diffraction under non ideal conditions, Increase in width of XRD peaks of nanoparticles, Shift in absorption spectra of nanoparticles and their correlation with energy band gap, shift in photoluminescence peaks, Electron microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe microscopy (SPM), Scanning Tunneling Electron Microscopy (STEM) and Atomic Force Microscopy (AFM).	20
IV	**Synthesis of Nanomaterials:** Key issues in the synthesis of Nanomaterials, Different approaches of synthesis, Top down and Bottom up approaches, capping agents, Ball Milling, Cluster beam evaporation, R-F Plasma, Chemical method, Pulsed Laser method, Carbon nanotubes (CNT)- Synthesis, Properties and Application	10

Suggested Readings:

1. Charles P. Poole, Jr. Frank J. Owens, "Introduction to Nanotechnology" John Wiley & Sons Inc.

2. Pradeep T. "A textbook of Nanoscience & Technology" Tata McGraw Hill 2012.

3. Guozhong Cao "Nanostructures & Nanomaterials, Synthesis, Properties & Applications" Imperial College Press.

4. Wilson, M., "Nanotechnology: Basic Science and Emerging Technologies"

Suggestive digital platforms web links-

1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **M.Sc. (Degree)**	Year: 5	Semester: 10
Subject: **PHYSICS**		
Course Code: **1020103**	Course Title: **ELECTRONICS - SPECIAL PAPER ELECTRONIC COMMUNICATION SYSTEM**	

Course outcomes:
On completion, the student will be able to

- Analyze analog communication signals in time domain and frequency domain.
- Distinguish between different analog modulation techniques.
- Analog signal generation techniques.
- Discuss the fundamental concepts of wave propagation in Transmission Lines.
- Analyze the line parameters and various losses in transmission lines.
- Apply smith chart for line parameter and impedance calculations.
- The study of analog communication systems, their transmission media and optical fiber communication systems are directly or indirectly useful for employment.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 75 + 25	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	**Amplitude Modulation Systems:** Principles of Amplitude Modulation: AM envelope and Equation of AM wave, Modulation index and Percent Modulation, Frequency Spectrum and Bandwidth, AM Power Distribution, AM by Multiple Sine waves, Transmission efficiency, Double Side-Band Suppressed Carrier (DSB-SC), AM Modulator Circuits; Low-level AM Modulator, Medium Power AM Modulator	20
II	**Single- Sideband Techniques:** Evolution and Description of Single Sideband Modulation (SSB); Suppression of Carrier, Balanced Modulator, Suppression of Unwanted Sideband, The filter. System, The phase-shift method, System evaluation and comparison, Extensions of SSB, Vestigial-sideband Modulation.	10
III	**Frequency Modulation Systems:** Theory of Frequency and Phase Modulation, Relationship between phase and frequency modulation, Mathematical Representation of FM, Phase and frequency deviation, Spectrum of an FM signal, Sinusoidal modulation, Bandwidth of a sinusoidally modulated FM signal, Generation of FM signal, Direct and Indirect Methods	15
IV	**Transmission Line Theory & Optical Fiber Communication Systems:** Fundamental of Transmission lines, Different types of Transmission lines, Primary line constants, phase velocity and line wavelength, Characteristic impedance, Propagation Coefficient. Phase and group velocities, Standing waves, Lossless line at radio frequencies, Voltage standing wave ratio, Slotted line measurements at radio frequencies, Transmission lines as circuit elements, Drawbacks of Radio	15

	communication, Introduction to Optical Communication, Fiber index profiles, Modes of Propagation, Number of Propagated modes in Step-index Fibers, Losses in Fibers.	

Suggested Readings:

1. Miller, Gary M., "Modern Electronic Communication - 6th edition".
2. Kennedy, George & Davis, Bernard, "Electronic Communication Systems – 4th edition".
3. Taub, H. & Schilling, Donald L., "Principles of Communication Systems".
4. Roddy, Dennis & Coolen, John, "Electronic Communications".
5. Tomasi, Wayne, "Electronic Communication Systems - Fundamentals through Advanced – 4th edition".

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2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc. as per revised NEP guidelines.

Programme/Class: **M.Sc. (Degree)**	Year: 5	Semester: 10
Subject: **PHYSICS**		
Course Code: **1020180**	Course Title: **ELECTRONICS LAB II**	

Course Outcomes:

- At the end of the laboratory course, every student is expected to understand the basic concepts of electronics through experiments.
- The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
- The student will gain practical knowledge of designing, assembling, and testing electronics circuits as well as understanding troubleshooting.
- The student would be equipped with an in-depth knowledge of Electronics that can be applied in higher studies in every field of Electronics.

Credits: **4**	Core Compulsory / Elective: Core Compulsory
Max. Marks: 100	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-18	

List of Experiments-

Choose another **six** experiments from the given list.

1. To study the various logic gates, Half Adder, Full Adder, Half Subtractor and Full Subtractor by using digital IC's.
2. To study the performance characteristics of various optical transducers, such as (a) photovoltaic cell (b) photoconductive cells (c) Characteristics of photo diode (d) phototransistors.
3. To study the features of an IC 555 timer and to set up and operate is as a –
   (a) free running multivibrator (b) monostable multivibrator
4. To study the operational amplifier as –
   (a) inverting amplifier (b) non-inverting amplifier (c) Voltage follower amplifier
5. To study the operational amplifier as –
   (a) adder or summing amplifier (b) subtractor (c) integrator (d) differentiator
6. To study the active filters of first and second stage using operational amplifier as –
   (a) As low pass filter (b) High pass filter (c) Band pass filter
7. To study the R-S flip flop circuits –

(a) By using NOR gates only. (b) By using a combination of AND and NOR gates.

(c) Clocked R-S flip flop (d) T flip flop.

8. To study the transmission line characteristics and calculate the various parameters like

(i) Attenuation coefficient (ii) Phase shift coefficient (iii) Characteristic impedance

9. To study the amplitude modulation and demodulation and calculate the modulation index.

10. To study the frequency modulation and demodulation and calculate modulation index

11. To study the Hall effect and to calculate the Hall coefficient of the given semiconductor material by using the Four Probe method.

12. To study the digital to analog conversion by using a R-2R ladder circuit.

13. To study the analog to digital conversion by using the IC ADC0808.

14. To construct any desired circuit on a digital breadboard using the digital /analog trainer kit.

15. To stimulate the given circuit by the computer simulation software LT Spice.

16. To study and calculate the magneto resistance of a given semiconductor material.

Suggested Evaluation Methods:
Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15).

Programme/Class: **Master of Science/M.Sc.**	Year: 5	Semester: 10
Subject: **PHYSICS**		Credits: **04**
Course Code: **1020165**	Course Title: **RESEARCH PROJECT**	
Max. Marks: 75+25 (75 for Research Project and 25 for Paper Publication)		

Course Outcomes:

- The students will be able to develop a positive outlook on learning with deepen understanding of subjects.
- Engagement in research projects will improve the critical thinking, problem solving and communication skills in student's.
- Students learn to collect information from reliable sources and carry out research.
- They get the benefit of Research Experience in graduate programs when applying for advanced studies.

Programme/Class: **M.Sc. (Degree)**	Year: 5	Semester: 10
Subject: **PHYSICS**		
Course Code: **1020105**	Course Title: **NUCLEAR PHYSICS – SPECIAL PAPER - II**	

Course outcomes:

- Students will be benefited with high energy Physics which will be very helpful for research purposes.
- Students will learn about various accelerators which will help them to go for research.

Credits: **4**	Core Compulsory / Elective: Elective
Max. Marks: 75 + 25	Min. Passing Marks: 40
Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 4-0-0	

Unit	Topics	No. of Lectures
I	**Nuclear Reactions and Nuclear Energy:** Nuclear reaction cross section, Theories of nuclear reactions, Compound nucleus formations, Ghosal experiment, Direct reactions, Statistical theory of nuclear reactions, Direct reactions, Statistical theory of nuclear reactions, (Fermi gas model of the nucleus) Nuclear temperature. Partial wave analysis of nuclear reaction cross sections. Derivation and discussion of Briet Wigner resonance formula. Nuclear fission and extended Liquid drop model. Statistical theory of nuclear reactions, Evaporation probability and cross sections for specific reactions.	20
II	**Direct Reactions:** Kinematics of the stripping and pick-up reactions, Plane wave theory of the stripping and pick-up reactions, Nuclear reactions at high energies, spectroscopic factors, transfer reactions.	10

III	**Acceleration of charged particle:** a. **Linear Electrostatics Accelerators:** Cock-croft Walton, Van-de Graff, Tandem Van-de-Graff Accelerator (Palletron). b. **Linear Radio-Frequency Accelerators:** Linear accelerator (LINAC) c. **Circular Accelerators:** Cyclotron, Frequency modulated cyclotron or Synchrocyclotron, AVF Cyclotron, Alternating-gradient accelerators.	20
IV	**Optical Potentials and Heavy-ion Reactions:** Theory of average cross sections, Properties of optical potentials, Heavy-ion collisions, Features of medium and low energy heavy-ion elastic scattering, Diffraction models.	10

Suggested Readings:

1. Harald A. Enge, "Introduction to Nuclear Physics"
2. Roy, R.R. & Nigam, B.P., "Nuclear Physics"
3. Livingood, John J., "Principles of Cyclic Particle Accelerators"
4. Livingston, M.S. & Blewett J.P., "Particle Accelerators"
5. Lee, S.Y., "Accelerators Physics"
6. Muraleedhara Varier, K., Jodrph, A., Pradyumnan, P.P., "Advanced Experimental Techniques in Modern Physics", Pragati Prakashan.

Suggestive digital platforms web links-

1. Uttar Pradesh Higher Education Digital Library, http://heecontent.upsdc.gov.in/SearchContent.aspx
2. Swayam Prabha - DTH Channel, https://www.swayamprabha.gov.in/index.php/program/current_he/8
3. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd

Suggested Continuous Evaluation Methods:

Continuous internal evaluation (CIE) of 25 marks shall be based on Class tests, assignments, presentations, etc as per revised NEP guidelines.

Programme/Class **M.Sc. (Degree)**	Year: 5	Semester: 10
Subject: **PHYSICS**		
Course Code: **1020181**	Course Title: **NUCLEAR PHYSICS – Lab II**	

Learning outcomes:

- At the end of the laboratory course, each and every student is expected to understand the basic concepts of nuclear physics through experiments.
- The students will get a better understanding of the concepts studied by them in the theory course and correlate with experimental observations.
- The student will gain practical knowledge of designing, assembling and testing electronics circuits as well as understanding troubleshooting.
- The student would be equipped with an in-depth knowledge of Nuclear Physics that can be applied in higher studies in every field of Nuclear Physics.

Credits: 4	Core Compulsory / Elective: Core compulsory
Max. Marks: 100	Min. Passing Marks: 40

Total No. of Lectures-Tutorials-Practical (in hours per week): L-T-P: 0-0-18

List of Experiments-

(1) To study the radioactive decay of a nucleus by detecting gamma rays using the Gamma Ray Spectrometer.

(2) To plot the characteristics curve of emitted beta particle by half thickness method

(3) To determine the no. of alpha particle by using alpha Absorption System

(4) To study the comparison of different efficiencies at different preset times using Alpha counting System.

(5) Nuclear magnetic Resonance on protons and fluorine in liquid samples.

(6) To determine the plateau of the Geiger Muller Counter.

(7) To determine Optimal operating voltage of Geiger Muller Counter.

(8) To study the charging and discharging of capacitors in RC circuit and to determine the time constant.

Suggested Evaluation Methods:

Evaluation of 100 marks shall be based on the experiments performed, viva-voce and lab records as per revised NEP guidelines (60+25+15).

Programme/Class: **Master of Science/M.Sc.**	Year: 5	Semester: 10
Subject: **PHYSICS**		Credits: **04**
Course Code: **1020166**	Course Title: **RESEARCH PROJECT**	
Max. Marks: 75+25 (75 for Research Project and 25 for Paper Publication)		

Course Outcomes:

- The students will be able to develop a positive outlook on learning with deepen understanding of subjects.
- Engagement in research projects will improve the critical thinking, problem solving and communication skills in student's.
- Students learn to collect information from reliable sources and carry out research.
- They get the benefit of Research Experience in graduate programs when applying for advanced studies.