SYLLABI OF EXAMINATIONS
FOR

M.Sc. Physics

(Based on Curriculum and Credit Framework for PG Programs under NEP)

WITH EFFECT FROM
THE
SESSION 2024-25

CHAUDHARY RANBIR SINGH
UNIVERSITY
JIND (HARYANA)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. (Physics)		
Semester	1^{st}		
Name of the Course	Mathematical Physics		
Course Code	24-PHY-101		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 101.1:** Students will be equipped to understand and apply series expansion and integral transforms to various applications. **CLO 101.2:** Students will gain the ability to solve problems involving differential equations. **CLO 101.3:** The study of special functions will prepare students to effectively address specific problems. **CLO 101.4:** Students will gain the knowledge about the complex variables.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Fourier Series and Integral Transform:** Fourier series, Evaluation of coefficients of Fourier series, Cosine and Sine series, Applications of Fourier Series, Fourier Transforms, Fourier sine Transforms, Fourier cosine Transforms, Fourier transform of derivatives, Applications of Fourier Transforms, Laplace transform, Properties of Laplace transforms such as first and second shifting property, Laplace Transform of Periodic Functions, Laplace transform of derivatives, Laplace Transform of integrals, Inverse Laplace Transform by partial fractions method,	15
II	**Second order linear differential equation with variable coefficients**: Ordinary point, Singular point, Series solution around an ordinary point, Series solution around a regular singular point; the method of Frobenius, Wronskin and getting a second solution, Solution of Legendre's equation, Solution of Bessel's equation, Solutions of Hermite's equation and Solutions of Laguerre's equation.	15

III	**Special functions**: Generating functions for Bessel function of integral order $J_n(x)$, Recurrence relations, Integral representation, orthogonality of Bessel function; Legendre polynomials $P_n(x)$, Generating functions for $P_n(x)$, Recurrence relations, orthogonality, Rodrigue's Relation, Hermite Polynomials; Generating functions, Rodrigue's relation & orthogonality for Hermite polynomials, Laguerre polynomials, Generating function and Recurrence relations, Orthogonality, Rodrigue's Relation.	15
IV	**Complex variables:** Analyticity and Cauchy-Riemann Conditions, Cauchy's integral theorem and formula, Taylor's series and Laurent's series expansion, Cauchy's residue theorem, Singular points and evaluation of residues, Jordan's Lemma, Evaluation of infinite integrals using Cauchy's residue theorem and Jordan's Lemma	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Group Theory and Quantum Mechanics by M. Tinkam.
2. Mathematical Methods for Physicists (4th edition) by G. Arfken.
3. Mathematical Methods for Physicists (6th edition) by Arfken and Weber.
4. Mathematical Physics for Physicists and Engineers by L. Pipes.
5. Introduction to Mathematical Physics by C. Harper.

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. (Physics)		
Semester	1^{st}		
Name of the Course	Classical Mechanics		
Course Code	24-PHY-102		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 102.1:** Student would be able to describe and understand the motion of a mechanical system using Lagrange **CLO 102.2:** Students would become able to understand the concepts of central force motion and moving co-ordinate systems. **CLO 102.3:** Student would get basic ideas about the Legendre transformation & Hamilton equations. **CLO 102.4:** This unit will provide students with a deep understanding of canonical transformations, Poisson brackets, equilibrium concepts, and the theory of small oscillations, essential for analyzing complex mechanical systems and coupled oscillators.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Lagrangian Formulation:** Newtonian mechanics of one and many particle systems, Conservation laws, Constraints and their classification, Generalized coordinates and momenta, Principle of virtual work, D' Alembert's principle and Lagrange's equation, Velocity dependent potentials and dissipation function, Simple applications of Lagrangian formulation, Cyclic coordinates, Symmetries of space and time and conservation laws, Invariance of Lagrangian under Galilean transformation	15

II	**Hamiltonian Formulation:** Legendre Transformation and Hamilton's equations of motion, Some techniques of calculus of variation, Variational principle, Hamilton's principle from D'Alembert's principle, Lagrange's equation from Hamilton's principle, Hamilton's equations from variational principle, variation and end points, Principle of least action and its forms, Hamilton-Jacobi equation and their solutions, Use of Hamilton-Jacobi method for the solution of Harmonic oscillator problem, Hamilton's principle function, Hamilton's characteristic function and their properties	15
III	**Motion in a Central Force Field:** Rotating frames, inertial forces, terrestrial applications of Coriolis force, Two body problem: Reduction to equivalent one body problem, Central force definition and characteristics, the equation of motion and first integrals, differential equation for the orbit, general analysis of orbits, condition for closure and stability of circular orbits, Kepler's laws and equations, Virial theorem, Rutherford scattering.	15
IV	**Canonical Transformations and Small Oscillations:** Canonical transformations, Generating functions, Properties of Poisson bracket, Equation of motion in Poisson bracket, Angular momentum and Poisson bracket relations, Jacobi identity, Invariance of Poisson brackets using canonical transformations, Potential Energy and equilibrium: Stable, unstable and neutral equilibrium, One-dimensional Oscillator, Two coupled oscillators: Solution of differential equation to find normal coordinates and normal modes, Theory of small oscillations, Examples of coupled oscillators: Two coupled pendulum, double pendulum, Free vibrations of a linear triatomic molecule.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Classical Mechanics (3rd ed., 2002) by H. Goldstein, C. Poole and J. Safko, Pearson Edition
2. Classical Mechanics by John R Taylor.
3. Chaos and Integrability in nonlinear dynamics: An introduction (1989) by Michael Tabor.
4. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajasekar.
5. Classical Mechanics, J.C. Upadhyaya, Himalaya Publishing House.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Physics		
Semester	1^{st}		
Name of the Course	Quantum Mechanics-I		
Course Code	24-PHY-103		
CourseType	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 103.1:** This unit will help students understand the foundational formalism of quantum mechanics, including states, operators, commutation relations, and the solution of the linear harmonic oscillator, essential for advanced study in quantum theory. **CLO 103.2:** This unit will provide students with a thorough understanding of Pauli spin matrices & angular momentum operators and their properties, including commutation relations and matrix representations. **CLO 103.3:** Students can understand the solutions of the Schrödinger equation for 3D problems, including eigenvalues, eigenfunctions, and degeneracies of the harmonic oscillator and hydrogen atom. **CLO 103.4:** students can understand time-independent perturbation theory, including non-degenerate and degenerate cases, anharmonic perturbations, and applications like the Stark effect in hydrogen		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Schrodinger Formulation:** States and operators; Representation of States and dynamical variables; Linear vector space; Bra Ket notation, Linear operators; Orthonormal set of vectors, Completeness relation; Hermitian operators, their eigenvalues and eigenvectors, The fundamental commutation relation; Commutation rule and the	15

	uncertainty relation; Simultaneous eigenstates of commuting operators; The unitary transformation; Dirac delta function; Relation between kets and wave functions; Matrix representation of operators; Solution of linear harmonic oscillator problem by operator methods	
II	**Applications of Schrodinger Equation:** The one dimensional harmonic oscillator, The three-dimensional harmonic oscillator in both Cartesian and spherical polar coordinates, Eigen values, Eigen functions and the degeneracy of the states; Solution of the hydrogen atom problem, the eigenvalues, Eigen functions and the degeneracy	15
III	**Theory of Angular Momentum:** Angular momentum operators and their representation in spherical polar co-ordinates; Eigenvalues and eigenvectors of L^2, spherical harmonics; Commutation relations among L_x L_y L_z ; Rotational symmetry and conservation of angular momentum; Eigenvalues of J^2 and J_z and their matrix representation; Pauli spin matrices; Addition of angular momentum, Clebsch-Gordan coefficient for $J_1=J_2=J_3=1/2$, J_1,$J_2=2$, $J_1=1/2$ & $J_2=1$.	15
IV	**Approximation Methods-I:** Time independent perturbation theory; Non degenerate case, the energies and wave functions in first order & the energy in second order; Anharmonic perturbations of the form λx^3 and λx^4; Degenerate perturbation theory; Stark effect of the first excited state of hydrogen.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Quantum Mechanics (3^{rd} edition) by L. I. Schiff
2. Quantum Mechanics (2^{nd} edition) by B. H. Bransden and Joachain
3. Quantum Mechanics (3^{rd} edition) by S. Gasiorowicz
4. Quantum Mechanics (3^{rd} edition) by E. Merzbacher
5. Quantum Mechanics by John L. Powell and B. Crasemann
6. Quantum Mechanics by A. K. Ghatak and S. Loknathan
7. Introductory Quantum Mechanics (4^{rd} edition) by Richard L. Liboff
8. Quantum Mechanics: Concepts and Applications (2^{nd} edition) by N. Zettili
9. Quantum Mechanics by Y. B. Band and Y. Avishai

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc.(Physics)		
Semester	**1st**		
Name of the Course	Electronics-I		
Course Code	24-PHY-104		
Course Type	DEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 104.1:** To Understand the types and behaviors of semiconductors. **CLO 104.2:** Students will be able to understand the basic principles of different Junction transistor with some negative resistor devices. **CLO 104.3:** To gain an understanding of fundamental circuit laws, key network theorems, transistor models, amplifier design and analysis, enabling effective analysis and design of electronic circuits **CLO 104.4:** To understand circuit analysis and implementation of operational amplifiers for various applications such as comparators, A/D and D/A converters, oscillators, and more.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Semiconductor Physics:** Intrinsic and extrinsic semiconductors, Charge carriers in semiconductors, Direct and indirect band gap semiconductors, Current flow due to drift and diffusion of carriers, p-n junction diode: Basic structure, Energy band diagram, Built-in potential, Qualitative description of current flow in forward and reverse bias, Zener diode as voltage regulator, clipping and clamping circuits, Junction, Solar cell, Light emitting diode (LED)	15
II	**Transistors:** Bipolar junction Transistor (BJT) Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, Field Effect Transistors: Junction Field Effect Transistor (JFET), Metal Oxide Semiconductor Field Effect Transistor (MOSFET,	15

	Concept of AC load line, Biasing methods of BJT and FETs, Negative Resistance devices: Uni-junction Transistor and Silicon Controlled Rectifier its characteristics	
III	**Network theorems and Amplifiers:** Kirchhoff's current and voltage law, Thevenin theorem, Norton theorem, maximum power transfer theorem, Transistor models and parameters, Equivalent circuits, Analysis and comparison of different configurations of Transistor Amplifier Circuits, Linear Analysis of a Transistor Circuit, classification of amplifiers, frequency response, RC coupled amplifier and its low frequency response	15
IV	**Operational Amplifier,:** CMRR, circuit configuration, emitter coupled supplied with constant current, transfer characteristics, block diagram of Op. Amp. Inverting and non-inverting amplifier, basic applications-summing, scaling, current to voltage and voltage to current signal conversion, differential dc amplifier, voltage follower, bridge amplifier, AC-coupled amplifier, Integration, differentiation, analog computation, Digital to analog conversion–ladder and weighted resistor types, analog to digital conversion- counter type	15
	Total Contact hours	60

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Integrated electronics by J Millman & CC Halkias.
2. Micro Electronics by J Millman&AGrabel.
3. Electronic communications by D Roddy and J Coolen.
4. Electronic Communications: Modulation and Transmission by RJ Schoenbeck
5. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
6. Electronic fundamentals and applications (5th ed.) by J D Ryder
7. Electronic Devices & Circuit Theory by Robert L Boylestad& Louis Nashelsky
8. Microelectronic Circuits: Theory and Applications (6th ed.) by Adel S Sedra and Kenneth C Smith

Session: 2024-25			
Part A- Introduction			
Name of the Programme	M.Sc. (Physics)		
Semester	1st		
Name of the Course	Practical: General Physics-I		
Course Code	24-PHY-105		
Course Type	PC		
Level of the course	400-499		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 105.1:** Develop the understanding of sound in different liquid and study different aspect of charge carriers in semiconductor **CLO 105.2**: Evaluation of e/m ratio using helical method and numerical aperture of optical fiber **CLO 105.3:** Demonstration of calibration of prism and evaluation of Cauchy constant **CLO 105.4:** Development of experimental approach by evaluating Boltzmann constant and Planck constant		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals	Contact Hours
Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination. 1. To study the velocity of sound and its variation with temperature using Ultrasonic interferometer. 2. Measurement of Hall Coefficient of given semiconductor, Identification of charge carrier type and estimation of carrier concentration. 3. To determine e/m ratio of electron using Helical Method. 4. To determine numerical aperture of a optical fiber and size of Lycopodium Powder using semiconductor laser. 5. Determination of wavelength of He-Ne laser using engraved scale as a diffraction grating and measurement of thickness of thin wire. 6. To calibrate a prism spectrometer with mercury lamp and hence to find the Cauchy’s constants. 7. Determination of Boltzmann Constant from forward I – V characteristics of Si-diode. 8. Determination of Planck's constant (h) by measuring the voltage drop across light-emitting diodes (LEDs) of different colors.	120

	9. To determine refractive indices of liquids, transparent and translucent solutions and solids using Abbe-refractometer. 10. To determine the wavelength of a laser using the Michelson interferometer.	

<table>
<tr><td colspan="4">Suggested Evaluation Methods</td></tr>
<tr><td colspan="2">Internal Assessment: 30</td><td colspan="2">End Term Examination: 70</td></tr>
<tr><td>➢ Practicum</td><td>30</td><td>➢ Practicum</td><td>70</td></tr>
<tr><td>• Class Participation:</td><td>5</td><td colspan="2" rowspan="2">Lab record, Viva-Voce, write-up and execution of the practical</td></tr>
<tr><td>• Seminar/Demonstration/Viva-voce/Lab records etc.:</td><td>25</td></tr>
</table>

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Integrated Electronics by J. Millman and C. C. Halkias
2. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajasekar
3. Introduction to Solid State Physics (7^{th} edition) by Charles Kittel
4. Modern Physics by Arthur Beiser
5. Elements of Nuclear Physics by W. E. Meyerhof.
6. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy

<table>
<tr><th colspan="5">Session: 2024-25</th></tr>
<tr><th colspan="5">Part A - Introduction</th></tr>
<tr><td>Name of the Programme</td><td colspan="4">M.Sc. (Physics)</td></tr>
<tr><td>Semester</td><td colspan="4">1st</td></tr>
<tr><td>Name of the Course</td><td colspan="4">Practical: Electronics-I</td></tr>
<tr><td>Course Code</td><td colspan="4">24-PHY-106</td></tr>
<tr><td>Course Type</td><td colspan="4">PC</td></tr>
<tr><td>Level of the course</td><td colspan="4">400-499</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="4">--</td></tr>
<tr><td>Course Learning Outcomes (CLO)
After completing this course, the learner will be able to:</td><td colspan="4">CLO 106.1: Design and understand the operations of clipping, clamping circuits, differentiating and integrating circuits.
CLO 106.2: Measure the sensitivities of X and Y plates of a CRO and determine frequency and phase-difference using a CRO.
CLO 106.3: Design and draw load characteristics of a amplifier.
CLO 106.4: Design the different LOGIC GATES.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td colspan="2">Practical</td><td>Total</td></tr>
<tr><td>0</td><td colspan="2">4</td><td>4</td></tr>
<tr><td>Teaching Hours per week</td><td>0</td><td colspan="2">8</td><td>8</td></tr>
<tr><td>Internal Assessment Marks</td><td>0</td><td colspan="2">30</td><td>30</td></tr>
<tr><td>End Term Exam Marks</td><td>0</td><td colspan="2">70</td><td>70</td></tr>
<tr><td>Max. Marks</td><td>0</td><td colspan="2">100</td><td>100</td></tr>
<tr><td>Examination Time</td><td>0</td><td colspan="3">4 hours</td></tr>
<tr><th colspan="5">Part B- Contents of the Course</th></tr>
<tr><th colspan="4">Practicals</th><th>Contact Hours</th></tr>
<tr><td colspan="4">Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.
1. Find the frequency and amplitude of given electrical signal using C.R.O.
2. To design a power supply of ± 12 V using regulator ICs.
3. To design a voltage regulator circuit using Zener diode.
4. To design and study of clipping and clamping circuits.
5. To design common emitter amplifier and study its frequency response.
6. To design and implement the following LOGIC GATES using different discrete components: OR, AND, NAND and NOR.
7. To study and validate Network theorems.
8. To study the output and transfer characteristics of a JFET and find its drain resistance, trans-conductance and amplification factor.
9. To study rectifier and filter circuits and draw wave shapes.
10. To study frequency response of RC coupled Amplifier.</td><td>120</td></tr>
<tr><th colspan="5">Suggested Evaluation Methods</th></tr>
<tr><th colspan="2">Internal Assessment: 30</th><th colspan="3">End Term Examination: 70</th></tr>
<tr><td>➢ Practicum</td><td>30</td><td colspan="2">➢ Practicum</td><td>70</td></tr>
</table>

• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical
• Seminar/Demonstration/Viva-voce/Lab records etc.:	25	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

7. Integrated Electronics by J. Millman and C. C. Halkias
8. Pulse, digital and switching waveforms by J. Millman and H. Taub
9. Electronic devices and circuits by Y. N. Bapat
10. Microwave devices and circuits by Samuel Y. Liao
11. Physics of semiconductor Devices by S. M. Sze
12. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick
13. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
14. Electronics for Scientists and Engineers: Devices, Circuits and Systems by TV Viswanathan, GK Mehta and V Rajaraman

Session: 2024-25			
Part A - Introduction			
Subject	Physics		
Semester	1st		
Name of the Course	Seminar		
Course Code	24-PHY-107		
CourseType: (CC/MCC/MDC/CC-M/ DSEC /VOC/DSE/PC/AEC/VAC)	Seminar		
Level of the course (As per Annexure-I	400-499		
Pre-requisite for the course (if any)	NA		
Course Learning Outcomes(CLO):	**CLO 107.1:** Achieve effective communication skills and understand the concepts involved in the topic of seminar. **CLO 107.2:** Acquire skills for working in team and develop confidence for facing audience. **CLO 107.3:** Learn to write effectively a report on a particular topic and know the techniques of responding to the questions posed by audience. **CLO 107.4:** Enhance the presentation abilities and improve interpersonal skills.		
Credits	Theory	Practical	Total
	2	0	2
Contact Hours	2	0	2

Session: 2024-25			
Part A - Introduction			
Name of Programme	M. Sc. Physics		
Semester	2^{nd}		
Name of the Course	Nuclear and Particle Physics		
Course Code	24-PHY-201		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 201.1:** This unit offers fundamental insights into nuclear forces through the use of common potentials. It delves into the ground state of the deuteron, nucleon-nucleon scattering, meson theory of nuclear force, and various types of nuclear reactions, providing a thorough understanding of nuclear physics principles. **CLO 201.2:** Students will gain proficiency in analyzing nuclear structure through the liquid drop model and shell model, understanding their implications for nuclear stability, mass calculations, shell structure, magic numbers, and the role of spin-orbit coupling. **CLO 201.3:** Describe certain properties associated This unit offers a thorough understanding of nuclear decay phenomena, including alpha, beta, and gamma decay, as well as internal conversion. It covers their theoretical foundations, selection rules, detection methods, and their implications in nuclear science. **CLO 201.4:** This unit will enhance understanding of elementary particle physics by examining particle classifications, interactions, conservation laws, and the quark model. It provides foundational knowledge for studying fundamental particles and forces.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B- Contents of the Course			

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Two Nucleon Problem:** The ground state of deuteron, Square well solution for the deuteron, Qualitative features of Nucleon – nucleon scattering, Effective range theory in n – p scattering and Significance of sign of scattering length; Meson theory of nuclear force (Qualitative discussion);Types of nuclear reactions: compound and direct nuclear reactions, Reaction cross – section, Reaction cross-section in terms of partial wave treatment, Balance of mass and energy in nuclear reactions, Q equation and its solution.	15
II	**Nuclear Models:** Liquid drop model: Similarities between liquid drop and nucleus, Semi-empirical mass formula, Mass Parabolas (Prediction of stability against β-decay for members of an Isobaric family), Stability limits against spontaneous fission, Merits and limitations of Liquid drop model; Shell model: Experiment evidences for shell effect, Magic numbers, Main assumptions of the single particle shell model, Spin-orbit coupling in single particle shell model, Estimation of spin, parities and magnetic moments of nuclei by single particle shell model.	15
III	**Nuclear Decays:** Alpha (α) decay, α- disintegration energy, Range of α-particles, Range – energy relationship for α-particles and Geiger – Nuttall law; Beta decay, Pauli's neutrino hypothesis, Fermi theory of beta decay, Curie plot, selection rules for beta decay, Fermi and Gamow-Teller Transitions, Detection and properties of neutrino; Gamma decay , Multipole transitions in nuclei, Angular momentum and parity selection rules; Internal conversion, Nuclear isomerism.	15
IV	**Elementary Particle Physics:** Classifications of elementary particles: fermions and bosons, particles and antiparticles; Fundamental interactions in nature; Type of interaction between elementary particles: Symmetry and conservation laws; Classification of hadrons: Strangeness, Hypercharge, Gelleman - Nishijima formula, Elementary ideas of CP and CPT invariance; Quark model, Baryon Octet, Meson Octet, Baryon Decuplet, Gell-Mann-Okubo formula for octet and decuplet, the necessity of introducing the colour quantum number, SU (2) and SU (3) multiples (qualitative only).	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Experimental Nuclear Physics by R. M. Singru.

2. Elements of Nuclear Physics by W. E. Meyerhof.
3. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy
4. Introduction to High Energy Physics (2nd edition) by D. H. Perkins.
5. Radiation Detection and Measurement by G. F. Knoll.
6. Nuclear Physics Theory and Experiment, by R. R. Roy and B. P. Nigam.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Physics		
Semester	2nd		
Name of the Course	Solid State Physics		
Course Code	24-PHY-202		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 202.1:** Students will gain knowledge of various lattice types and understand the concept of reciprocal lattices, applying them to comprehend crystal diffraction phenomena using X-rays **CLO 202.2:** This unit explores the motion of electrons in periodic lattices of solids under various binding conditions, introduces the concept of energy bands, and examines their impact on electrical properties **CLO 202.3:** This unit equips students with knowledge of lattice vibrations in solids and the identification of various types of defects in crystals. **CLO 202.4:** This unit explores various types of magnetic phenomena, superconductivity, the underlying physics, and their potential applications		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Crystalline Solids:** Lattice, The basis, Lattice translation vectors, Direct lattice, Two and three dimensional Bravais lattice, Conventional units cells of FCC, BCC, NaCl, CsCl, Diamond and cubic ZnS, Primitive lattice cell of FCC, BCC and HCP, Packing fraction: Simple Cubic, BCC, FCC, HCP and diamond structures, Interaction of x-rays with matter, Absorption of x-rays, elastic scattering from a perfect lattice, The reciprocal lattice and its	15

	application to diffraction techniques, Ewald's construction, The Laue, Powder and rotating crystal methods, Atomic form factor, Crystal structure factor and intensity of diffraction maxima, Crystal structure factors of BCC, FCC, monatomic diamond lattice, polyatomic CuZn.	
II	**Lattice Vibrations:** Vibration of one-dimensional mono and diatomic chains, Phonon momentum, Density of normal modes in one and three dimensions, Quantization of lattice vibrations, Measurement of phonon dispersion using inelastic neutron scattering, Point defects, Line defects and planer (stacking) faults, Fundamental ideas of the role of dislocation in plastic deformation and crystal growth, Observation of imperfection in crystals, X-rays and electron microscopic techniques.	15
III	**Band Theory of Solids:** Electron in periodic lattice, Block theorem, Kronig-Penny model and band theory, Classification of solids, Effective mass, Weak-binding method and its application to linear lattice, Tight-binding method and its application to Simple cubic, BCC and FCC crystals, Concepts of holes, Fermi surface: Construction of Fermi surface in two-dimension, de Hass van Alfen effect, Cyclotron resonance, Magneto-resistance.	15
IV	**Ferromagnetism and Magnons:** Weiss Theory of Ferromagnetism Heisenberg model and molecular field theory of ferromagnetism of spin waves and Magnons, Curie-Weiss law for susceptibility. Ferri and Anti Ferro-magnetic order, Domains and Block wall energy, Occurrence of superconductivity, Meissner effect, Type-I and Type-II superconductors, Heat capacity, Energy gap, Isotope effect, London equation, Coherence length, Postulates of BCS theory of superconductivity, BCS ground state, Persistent current. High temperature oxide super conductors (introduction and discovery).	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Solid State Physics (7^{th} edition) by Charles Kittel
2. Solid State Physics by Neil W. Ashcroft and N. David Mermin
3. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
4. Principles of the Theory of Solids (2^{nd} edition) by J. M. Ziman
5. Condensed Matter Physics by Michael P. Marder
6. Applied Solid State Physics by Rajnikant

Session: 2024-25			
Part A - Introduction			
Name of Programme	M. Sc. Physics		
Semester	2^{nd}		
Name of the Course	Quantum Mechanics-II		
Course Code	24-PHY-203		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 203.1:** Students will gain essential insights into variational methods, perturbation theory, and approximation techniques crucial for solving complex quantum mechanical problems **CLO 203.2:** This unit equips students with the knowledge of semi-classical radiation theory, essential for analyzing transition probabilities, dipole transitions, and selection rules in atomic and molecular systems **CLO 203.3:** This unit equips students with the knowledge of three-dimensional collision and scattering theory, essential for analyzing scattering amplitudes, cross sections, and the Born approximation in various physical systems. **CLO 203.4:** By studying identical particles, students will develop proficiency in applying quantum mechanics principles to analyze spin states, collision dynamics, and the behavior of complex atomic systems		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Approximation Methods-II:** Variational method, Ground state of Helium by both variational and perturbation methods, WKB	15

	approximation: General, Validity, connection formula, Application of WKB: Bound states in a potential well, Time dependent perturbation theory; Constant perturbation; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximation.	
II	**Semi-classical Theory of Radiation:** Transition probability for absorption and induced emission; Electric dipole transition and selection rules; Magnetic dipole transitions; Forbidden transitions; Higher order transitions; Einstein's coefficients.	15
III	**Scattering Theory:** Scattering angle in Lab and C.M frame, scattering: Laboratory and C.M. reference frames; scattering amplitude; Differential scattering cross section and total scattering cross section; The optical theorem; Scattering by spherically symmetric potentials; Partial waves and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; The Born approximation.	15
IV	**Identical Particles:** The principle of indistinguishability; Symmetric and antisymmetric wave functions; Spin and statistics of identical particles; The Slater determinant; The Pauli exclusion principle; Spin states of a two-electron system, States of the helium atom, Collision of identical particles.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Quantum Mechanics (3rd edition) by L. I. Schiff
2. Quantum Mechanics (2nd edition) by B. H. Bransden and Joachain
3. Introduction to Quantum Mechanics (2nd edition) by David J. Griffiths
4. Quantum Mechanics by A. K. Ghatak and S. Loknathan
5. A Textbook of Quantum Mechanics by P. M. Mathews and K. Venkatesan
6. Quantum Mechanics by John L. Powell and B. Crasemann
7. Quantum Mechanics: Concepts and Applications (2nd edition) by N. Zettili

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. (Physics)		
Semester	2nd		
Name of the Course	Electronics – II		
Course Code	24-PHY-204		
Course Type	CC		
Level of the course	400-499		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	CLO 204.1: Implementation of Boolean expression with basic gates and design circuits to achieve desired output. CLO 204.2: Develop various building blocks for MOSFET as MOS devices and study electronic opertions flip flop, serial to parallel convertor etc. CLO 204.3: Understand the various types of modulation and microwave devices CLO 204.4: Designing of basic building blocks of ICs for different electronics operations such as addition, subtraction, code generation, data register, counting etc.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Binary operation of a system:** Different logic gates: Symbols, truth table and their realization using diodes/ transistors; De Morgan's law, logic symbol of NAND and NOR using diode transistor logic; Decoder/Demultiplexer: BCD system, BCD to decimal decoder, conversion of decoder to demultiplexer, 4-to-16 line decoder/demultiplexer; Data selector/multiplexer: parallel to serial conversion, sequential data selection; Encoders; Seven segment display; Digital comparator and parity checker	15
II	**Combinational & Sequential circuits :** A sequential system, 1-bit storage cell; Flip flops: SR flip flop, clocked SR flip flop, Preset and Clear, Race	15

	around condition, JK flip flop, Master-slave JK flip flop, D and T Flip flop; Shift Registers: Serial-to-Parallel converter, Parallel-to-serial converter, Parallel in parallel out, serial in serial out, Right and left shift register, Digital MOSFET circuits: Inverter, NAND and NOR operation using MOSFET, CMOS, Dynamic and static MOS Shift Register	
III	**Modulation and Demodulation:** Fundamentals of modulation, Frequency spectra in AM modulation, power in AM modulated class C amplifier, Efficiency modulation, linear demodulation of AM waves, frequency conversion, Pulse modulation: PAM, PTM, PWM, PPM, PCM; Resonant Cavity, Klystrons and Magnetron – velocity modulation, basic principle of two cavity klystron and reflex klystron, principle of operation of magnetron, Hot electrons, Transferred electron devices, Gunn effect	15
IV	**Integrated Circuits and their Fabrication:** Types of Integrated Circuits, Analog and Digital Integrated Circuits, Semiconductor Device Fabrication: Crystal Growth, Epitaxial Growth, Photolithography, Impurity Doping: Thermal Diffusion and Ion Implantation, Process Flow for the Fabrication of Monolithic Transistor, Monolithic Diodes, Integrated Resistors, and Integrated Capacitors	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Integrated Electronics by J. Millman and C. C. Halkias
2. Pulse, digital and switching waveforms by J. Millman and H. Taub
3. Electronic devices and circuits by Y. N. Bapat
4. Microwave devices and circuits by Samuel Y. Liao
5. Physics of semiconductor Devices by S. M. Sze
6. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick
7. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
8. Electronics for Scientists and Engineers: Devices, Circuits and Systems by TV Viswanathan, GK Mehta and V Rajaraman

<table>
<tr><th colspan="4">Session: 2024-25</th></tr>
<tr><th colspan="4">Part A - Introduction</th></tr>
<tr><td>Name of the Programme</td><td colspan="3">M.Sc. (Physics)</td></tr>
<tr><td>Semester</td><td colspan="3">2nd</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Practical: General Physics-II</td></tr>
<tr><td>Course Code</td><td colspan="3">24-PHY-205</td></tr>
<tr><td>Course Type</td><td colspan="3">PC</td></tr>
<tr><td>Level of the course</td><td colspan="3">400-499</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">--</td></tr>
<tr><td>Course Learning Outcomes (CLO)
After completing this course, the learner will be able to:</td><td colspan="3">CLO 205.1: Evaluation of band gap of semiconductor using four probe and p-n junction diode
CLO 205.2: Determination of lande g factor, stefann constant and dielectric constant
CLO 205.3: Understand the solar cell characteristics and energy level of argon using frank hertz experiment
CLO 205.4: Draw B-H curve and evaluation of energy loss</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>0</td><td>4</td><td>4</td></tr>
<tr><td>Teaching Hours per week</td><td>0</td><td>8</td><td>8</td></tr>
<tr><td>Internal Assessment Marks</td><td>0</td><td>30</td><td>30</td></tr>
<tr><td>End Term Exam Marks</td><td>0</td><td>70</td><td>70</td></tr>
<tr><td>Max. Marks</td><td>0</td><td>100</td><td>100</td></tr>
<tr><td>Examination Time</td><td>0</td><td colspan="2">4 hours</td></tr>
<tr><th colspan="4">Part B-Contents of the Course</th></tr>
<tr><th colspan="3">Practicals</th><th>Contact Hours</th></tr>
<tr><td colspan="3">Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.
1. To measure the resistivity of a Ge crystal using four probe method at different temperatures and find its energy band gap.
2. Lattice dynamic kit:
(i) To study the dispersion relation of monoatomic lattice and to find the cut off frequency.
(ii) To study the dispersion relation of diatomic lattice: acoustical, optical branches, Energy gap and comparison of experimental and theoretical values.
3. Determination of Lande g-factor of DPPH using ESR spectrometer.
4. To study the band gap of a semiconductor material using p-n junction diode and find the diffusion potential of the diode.
5. To study B-H curve of a given sample and find the energy loss in ferromagnetic material.</td><td>120</td></tr>
</table>

	6. To determine the dielectric constant of polar and non-polar liquids. 7. Determination of ionization potential of mercury. 8. To determine Stefan's constant using black body radiations from copper plates (Electrical Method). 9. To study the characteristics (illumination, I-V, Power-load, Areal and Spectral characteristics) of a Solar cell. 10. To study the energy levels of Ar using Frank-Hertz experiment.	

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	25		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. The First Three Minutes: A Modern View of the Origin of the Universe, Steven Weinberg, Basic Books (1993).
2. Principles of Modern Physics, A.K. Saxena, Narosa publications (2010). Chapter 17, Pages 1-4, pages 35-37.
3. The Feynman Lectures on Physics: Feynman, Leighton, Sands. Volume I. Narosa Publishing House (India) (2008). Chapters 1, 3, 5.
4. Understanding Physics: Cassidy, Holton, Rutherford. Springer International Edition (2002).
5. University Physics: Sears, Zemansky, Young. Narosa Publishing Co., New Delhi (1998).
6. Integrated Electronics by J. Millman and C. C. Halkias

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc. (Physics)		
Semester	2^{nd}		
Name of the Course	Practical: Electronics-II		
Course Code	24-PHY-206		
Course Type	PC		
Level of the course	400-499		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 206.1:** Determine the frequency for different oscillators. **CLO 206.2:** To study the modulation and demodulation. **CLO 206.3:** Implication of seven segment display. **CLO 206.4:** Draw V-I characteristics of an UJT and also able to design and able to determine the frequency of saw-tooth waves using UJT.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals	Contact Hours
Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination. 1. To study the frequency response of a single stage negative feedback amplifier for voltage series and shunt feedback. 2. To study the frequency variation in RC phase shift, Colpitt and Hartley Oscillators. 3. To study the applications of operational amplifier as summer, astable multivibrator, Schmitt trigger, integrator and differentiator. 4. To study the frequency/amplitude modulation and demodulation. 5. To study the analog to digital conversion and digital to analog conversion circuits. 6. To study analog comparator circuit. 7. To study the binary module-6 and 8 decade decoder and shift register. 8. To study the BCD to seven segment display. 9. To study the I-V characteristics of uni-junction transistor and its application as saw tooth wave generator.	120

	10. To study the I-V characteristics of silicon-controlled rectifier and its applications.	

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	25		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Integrated Electronics by J. Millman and C. C. Halkias
2. Pulse, digital and switching waveforms by J. Millman and H. Taub
3. Electronic devices and circuits by Y. N. Bapat
4. Microwave devices and circuits by Samuel Y. Liao
5. Physics of semiconductor Devices by S. M. Sze
6. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick
7. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
8. Electronics for Scientists and Engineers: Devices, Circuits and Systems by TV Viswanathan, GK Mehta and V Rajaraman

Session: 2024-25			
Part A - Introduction			
Name of the Programme	Common to all PG Programmes		
Semester	2nd		
Name of the Course	Constitutional, Human and Moral Values, and IPR		
Course Code	24-CHM-201		
Course Type	CHM		
Level of the course	400-499		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 201.1:** Learn the different Constitutional Values, Fundamental rights and duties enshrined in the India Constitution. **CLO 201.2:** Understand humanism, human virtues and values, and idea of International peace. **CLO 201.3:** Grasp the basic concepts of Moral Values and Professional Conduct which are required to become a part of the civil society and for developing professionalism. **CLO 201.4:** Understand concepts of Intellectual Property Rights, Copyright, Patent, Trademark etc., and about threats of Plagiarism.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Constitutional Values:** Historical Perspective of Indian Constitution; Basic Values enshrined in the Preamble of the Indian Constitution; Concept of Constitutional Morality; Patriotic Values and Ingredients Nation Building; Fundamental Rights and Duties ; Directive Principles of the State Policy.	8
II	**Humanistic Values:** Humanism, Human Virtues and Civic Sense; Social Responsibilities of Human Beings; Ethical ways to deal with human aspirations; Harmony with society and nature; Idea of International Peace and Brotherhood (Vasudhaiv Kutumbkam).	7

III	**Moral Values and Professional Conduct:** Understanding Morality and Moral Values; Moral Education and Character Building; Ethics of Relations: Personal, Social and Professional; Introduction to Gender Sensitization; Affirmative approach towards Weaker Sections (SCs, STs, OBCs, EWS& DAs); Ethical Conduct in Higher Education Institutions; Professional Ethics.	8
IV	**Intellectual Property Rights:** Meaning, Origins and Nature of Intellectual Property Rights (IPRs);Different Kinds of IPRs – Copyright, Patent, Trademark, Trade Secret/Dress, Design, Traditional Knowledge; Infringement and Offences of IPRs – Remedies and Penalties; Basics of Plagiarism policy of UGC.	7
	Note: Scope of the syllabus shall be restricted to generic and introductory level of mentioned topics.	
	Total Contact Hours	30

Suggested Evaluation Methods

Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Ahuja, V K. (2017). *Law relating to Intellectual Property Rights*, India, IN: Lexis Nexis.
2. Bajpai, B. L., *Indian Ethos and Modern Management*, New Royal Book Co., Lucknow, 2004.
3. Basu, D.D., *Introduction to the Constitution of India* (Students Edition) Prentice Hall of India Pvt. Ltd., New Delhi, 20th ed., 2008.
4. Dhar, P.L. & R.R. Gaur, *Science and Humanism*, Commonwealth Publishers, New Delhi, 1990.
5. George, Sussan, *How the Other Half Dies*, Penguin Press, 1976.
6. Govindarajan, M., S. Natarajan, V.S. Sendilkumar (eds.), *Engineering Ethics (Including Human Values)*, Prentice Hall of India Private Ltd, New Delhi, 2004.
7. Harries, Charles E., Michael S. Pritchard & Michael J. Robins, *Engineering Ethics*, Thompson Asia, New Delhi, 2003.
8. Illich, Ivan, *Energy & Equity*, Trinity Press, Worcester, 1974.
9. Meadows, Donella H., Dennis L. Meadows, Jorgen Randers & William W. Behrens, *Limits to Growth: Club of Rome's Report*, Universe Books, 1972.
10. Myneni, S.R, Law of Intellectual Property, Asian Law House.
11. Narayanan, P, *IPRs*.
12. Neeraj, P., & Khusdeep, D. (2014). *Intellectual Property Rights*, India, IN: PHI learning Private Limited.
13. Nithyananda, K V. (2019). *Intellectual Property Rights: Protectionand Management*. India, IN: Cengage Learning India Private Limited.
14. Palekar, Subhas, *How to practice Natural Farming*, Pracheen (Vaidik) KrishiTantra Shodh, Amravati, 2000.
15. Phaneesh, K.R., *Constitution of India and Professional Ethics*, New Delhi.

16. Pylee, M.V., *An Introduction to Constitution of India*, Vikas Publishing, New Delhi, 2002.
17. Raman, B.S., *Constitution of India*, New Delhi, 2002.
18. Reddy, B., Intellectual Property Rights and the Law, Gogia Law Agency.
19. Reddy, N.H., Santosh Ajmera, *Ethics, Integrity and Aptitude*, McGraw Hill, New Delhi.
20. Sharma, Brij Kishore, *Introduction to the Constitution of India*, New Delhi,
21. Schumacher, E.F., *Small is Beautiful: A Study of Economics as if People Mattered*, Blond & Briggs, Britain, 1973.
22. Singles, Shubham et. al., *Constitution of India and Professional Ethics*, Cengage Learning India Pvt. Ltd., Latest Edition, New Delhi, 2018.
23. Tripathy, A.N., *Human Values*, New Age International Publishers, New Delhi, 2003.
24. Wadehra, B.L., Law relating to Intellectual Property, Universal Law Publishing Co.

Relevant Websites, Movies and Documentaries:

25. *Value Education Websites*, http://uhv.ac.in, http://www.uptu.ac.in.
26. *Story of Stuff*, http://www.storyofstuff.com
27. Cell for IPR Promotion and Management: http://cipam.gov.in/.
28. World Intellectual Property Organization: https://www.wipo.int/about-ip/en/
29. Office of the Controller General of Patents, Designs & Trademarks: http://www.ipindia.nic.in/
30. Al Gore, *An Inconvenient Truth*, Paramount Classics, USA.
31. Charlie Chaplin, *Modern Times*, United Artists, USA.
32. *Modern Technology – The Untold Story*, IIT, Delhi.
33. A. Gandhi, *Right Here Right Now*, Cycle wala Productions.

Session: 2024-25

Part A– Introduction

Name of Programme	M. Sc. Physics
Semester	3^{rd}
Name of the Course	Electrodynamics and Wave propagation
Course Code	24-PHY-301
Course Type	CC
Level of the course	500-599
Pre-requisite for the course (if any)	--
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 301.1:** Students will be able to formulate and solve electrodynamic problems related to basic formalism. **CLO 301.2:** Students will gain knowledge about the electrostatic and magnetic fields produced by static and moving charges in various simple configurations. **CLO 301.3:** Development of understanding of basic of electromagnetic induction and various guazes. **CLO 301.4:** Students will be able to analyze the fundamentals of transmission line and waveguide theory.

Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Electrostatics and Magnetostatics:** Introduction, Coulomb's Law, Gauss Law, Scalar potential, Laplace and Poisson's equations, Electrostatic potentials, energy and energy density of the electromagnetic field, Multipole expansion, Dipole moment, quadrupole moment; Biot-Savart Law, Ampere's theorem, Magnetic Vector potential, magnetic field of a localized current distribution, Magnetic moment, force and torque on a current distribution in an external field, Magnetostatic energy	15
II	**Polarization and Method of Images:** Static fields in material media, Polarization vector macroscopic equations, Molecular polarizability and	15

	electric susceptibility, Claussius-Mossotti relations, Models of Molecular Polarizability. Energy of charges in dielectric media, Uniqueness Theorem, Dirichlet and Neumann Boundary conditions, Green's Theorem, Formal solution of Electrostatic Boundary value problem with Green function Method of images with examples, Magnetostatic Boundary value problems	
III	**Maxwell's Equations and Electromagnetic Waves:** Electromagnetic induction, Faraday's Law of induction, Displacement current, Maxwell equations, Scalar and vector potentials, Gauge transformation, Lorentz and Coulomb gauges, General Expression for the electromagnetic fields energy, conservation of energy, Poynting's Theorem, Conservation of momentum Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, Waves in conducting media, skin depth.	15
IV	**Electromagnetic Boundary Interactions & Waveguides:** Reflection and Refraction of EM waves at plane dielectrics interface, Fresnel's amplitude relations. Reflection and transmission coefficients, Polarization by reflection, Brewster's angle, Total internal reflection, Parallel plate transmission lines, Wave guides, TE and TM waves, Rectangular wave guides and cavity resonators, Solutions of the inhomogeneous wave equation in the absence of boundaries, Fields and Radiation of a localized oscillating source. Electric dipole and electric quadrupole fields	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Classical Electrodynamics by J.D. Jackson.
2. Introduction to Electrodynamics by D. J. Griffiths.
3. Introduction to Electrodynamics by A. Z. Capri and P. V. Panat.
4. Electrodynamics by S. P. Puri.
5. Introduction to Plasma Physics by F. F. Chen.
6. Introduction to Plasma Theory by D. R. Nicholson.

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Physics		
Semester	**3rd**		
Name of the Course	Statistical Mechanics		
Course Code	24-PHY-302		
Course Type	CC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 302.1:** Students will develop an appreciation for how phase space operates and how Statistical Mechanics intersects with Thermodynamics. **CLO 302.2:** Understanding ensemble theory provides deeper insights into solving complex problems across diverse fields **CLO 302.3:** Students will gain the ability to analyze the distinctive behaviors of gases and apply this knowledge to address complex challenges **CLO 302.4:** Students will be equipped to investigate the practical applications of the Ising Model and comprehend different approximation approaches.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Fundamentals of Statistical Mechanics:** Phase space, Ensembles, Liouville theorem, conservation of extension, Equation of motion, Equal a priori probability, Statistical equilibrium, Micro-canonical ensemble, Quantization of phase space, classical limit, symmetry of wave functions effect of symmetry on counting, Various distributions using micro canonical ensemble Entropy of an ideal gas, Equilibrium Conditions, Quasi – Static Process, Entropy of an ideal gas using Micro-canonical Ensemble, Gibbs paradox	15
II	**Ensemble Theory:** Entropy of a system in contact with a reservoir, Canonical	15

	ensemble, Ideal gas in a canonical ensemble, Equipartition of energy, Third law of thermodynamics, Photons, Grand canonical ensemble, Ideal gas in Grand Canonical ensemble, Comparison of various ensembles, Quantum distribution using other ensembles	
III	**Classical & Quantum Statistics**: Transition from classical statistical mechanics to quantum statistical mechanics, Indistinguishability and quantum statistics, identical particles and symmetry requirements, Bose Einstein statistics, Fermi Dirac statistics, Maxwell Boltzmann statistics.	15
IV	**Cluster Expansion & Phase Transitions:** Cluster expansion for a classical gas, Virial equation of state, Van der Waals gas, Phase transition of second kind, Ising Model, Bragg Williams Approximation, Ising Model in one and two dimensions, One dimensional random walk, Brownian motion.	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Statistical Mechanics by R. K. Pathria (2nd Ed.)
2. Statistical Mechanics by R. K. Pathria and P. D. Beale (3rd edition)
3. Statistical and Thermal Physics by F. Reif
4. Statistical Mechanics by K. Huang
5. Statistical Mechanics by L. D. Landau and I. M. Lifshitz
6. Statistical Mechanics by R. Kubo

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Physics		
Semester	**3rd**		
Name of the Course	Radiation Physics-I		
Course Code	24-PHY-303		
Course Type	DEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 303.1:** Understand the principles and applications of nuclear structure and radioactivity, including atomic structure, binding energy, isotopes, nuclear size, radioactive decay, half-life, radioactive equilibrium, and the uses of radio-isotopes. **CLO 303.2:** Understand the various sources of radiation, including the characteristics and clinical applications of X-rays, the nature and effects of cosmic rays, and the properties and measurement of terrestrial radiations and radiation quantities. **CLO 303.3:** Understand the various modes of interaction between radiation and matter, including ionization, excitation, scattering, and specific processes such as Bremsstrahlung and Cerenkov radiation, as well as the interactions of charged particles and electromagnetic radiations with matter, and the principles of gamma radiation attenuation. **CLO 303.4:** Understand the fundamental concepts of neutron physics, including the discovery, properties, and classification of neutrons, neutron sources and collimators, and the principles and types of neutron detection and measurement, as well as neutron monochromators and the process of nuclear fission.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours

I	**The Nucleus and Radioactivity:** Atomic structure, Nuclear mass, Binding energy, binding energy curve and its interpretation, Isotopes, Isotones, Isobars, Nuclear size, Radioactivity, Modes of radioactive disintegration, Nature and properties of radioactive radiations, Radioactive decay, Half life time, Radioactive growth and decay, Radioactive equilibrium, Radioactive series, Radioactive branching, Radioactive dating, Artificial radioactivity, and Uses of radio-isotopes	15
II	**Other Sources of Radiations:** X-rays: Characteristic X-rays, Bremsstrahlung (continuous) X-rays, X ray targets, and Clinical X ray beams; Cosmic rays: Discovery, Nature of a cosmic rays, soft and hard component, and Geometric effects on cosmic rays; Terrestrial radiations: Radon gas and Radioactive isotopes of lighter elements, Radiation quantities and units: Activity, KERMA, Exposure, Dose, Equivalent Dose, Effective Dose, Annual Limit on Intake (ALI), and Derived Air Concentration (DAC)	15
III	**Interaction of Radiation with Matter:** Modes of interaction: ionization, excitation, elastic and inelastic scattering, Bremsstrahlung, Cerenkov radiation, concepts of specific ionization, mean free path; Interaction of Light Charged Particles with matter; Interaction of Heavy Charged Particles with matter; Interaction of Electromagnetic Radiations with matter: Photoelectric effect, Compton Scattering, and Pair production; Attenuation of Gamma Radiation: Linear and mass attenuation coefficient	15
IV	**Neutron Physics:** Discovery of neutrons, Neutron sources, Neutron collimators, Properties of neutrons, Classification of neutrons according to energy, Neutron detectors: Slow neutron detectors (Boron trifluride proportional counter, Boron coated proportional counter, Helium-3 proportional counter) Intermediate neutrons detectors, and Fast neutrons detectors	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. G.F. Knoll,*Radiation Detection and Measurement* (John Wiley & Sons, Inc, 2010).
2. A. Beiser, S. Mahajan, S. Rai Choudhury,*Concepts of Modern Physics* (McGraw Hill Education, 2015).
3. E.B. Podgorsak, Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, (IAEA Library Cataloguing in Publication Data, 2005)
4. Dr. Claus Grupen, *Practical knowledge for Handling Radioactive Sources,* (Springer-Verlag Berlin Heidelberg, 2010)

5. F.H.Attlx, *Introduction to Radiological Physics and Radiation Dosimetry(*John Wiley & Sons, Inc., 1986)
6. S.L. Kakani, ShubhraKakani, *Nuclear and Particle Physics*(Wiley India, 1988)

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Physics		
Semester	3rd		
Name of the Course	Nuclear Physics-I		
Course Code	24-PHY-304		
Course Type	DEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 304.1:** This unit offers the understanding of principles of ΔE-E detector telescopes and modern gas detectors, including particle identification methods, event-by-event analysis, and neutron-gamma discrimination. **CLO 304.2:** Unnderstand the principles and applications of various preamplifiers, pulse shaping circuits, coincidence techniques, and data acquisition systems, including single and multi-channel analyzers. **CLO 304.3:** This unit offers a thorough understanding of ion sources (RF ion source, Duoplasmatron, SNICS), ion accelerators (Tandem, Pelletron), and ion-solid interactions, including ion penetration, stopping, channeling, ion implantation, radiation damage, sputtering, and ion beam mixing. **CLO 304.4:** This unit will enhance understanding of fission, fusion and reactors.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B –Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Nuclear Detectors:** Basic principle of ΔE-E detector telescopes, short range charged particles ΔE-E telescope, methods of particle identification using semiconductor and gaseous detectors, ΔE-E time of flight spectroscopy; Event by event particle identification system for heavy ion	15

	induced reaction analysis; neutron-gamma discrimination; Modem Gas Detectors: basic principle and operation of split anode ionization chamber, position sensitive ionization chamber, position sensitive proportional counter & multi wire proportional counter	
II	**Types of preamplifiers:** basic idea of voltage sensitive and current sensitive pre-amplifiers, details of charge sensitive preamplifier and its applications; Amplifier Pulse Shaping Circuits: RC, Gaussian, delay-line, bipolar and zero cross-over timing circuits, pole zero cancellation and base line restorer; Coincidence Techniques: basic idea of coincidence circuit and its resolving time, basic principle of slow coincidence, slow fast coincidence and sum coincidence techniques	15
III	**Ion Accelerators:** Ion sources- basic features of RF ion source, direct extraction negative ions source (Duoplasmatron) and source of negative ions by Cs sputtering (SNICS); Basic principle and working of Tandom accelerator and Pelletron accelerator and its applications; Ion Beam Interaction in Soilds: Basic ion bombardment processes in solids- general phenomenon, ion penetration and stopping, ion range parameters, channeling, components of an ion implanter, energy deposition during radiation damage, sputtering process and ion beam mixing	15
IV	**Nuclear Reactors:** Nuclear stability, fission, prompt and delayed neutrons, fissile and fertile materials- characteristics and production, classification of neutrons on the basis of their energy, four factor formula, control of reactors, reactors using natural uranium, principle of breeder reactors, fast breeder reactor & doubling time, calculation of critical size and mass of reactor	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy
2. Introduction to Experimental Nuclear Physics by R. M. Singru
3. Techniques for Nuclear and Particle Physics Experiments by W. R. Leo
4. Radiation Detection and Measurement by G. F. Knoll
5. The Physics of Nuclear Reactions by W. M. Gibson
6. VLSI Technology by S. M. Sze

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Physics		
Semester	3^{rd}		
Name of the Course	Computational Physics-I		
Course Code	24-PHY-305		
Course Type	DEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 305.1:** Students will be able to recognize the nature of specific numerical problems and develop the ability to choose an appropriate numerical technique to find their solutions. **CLO 305.2:** Students will gain an understanding of interpolation techniques. **CLO 305.3:** Students would be able to understand the numerical solution to first order differential. **CLO 305.4:** Students will gain an understanding of the use of computers in research perspectives.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Numerical Integration** : Newton-cotes formulae : Trapezoidal rule, Simpson's 1/3 rule, error estimates in Trapezoidal rule and Simpson 1/3 rule using Richardson deferred limit approach ; Gauss-Legendre quadrature method; **Numerical Differentiation:** Taylor Series method; Generalized numerical differentiation: truncation errors. Roots of Linear, Non-linear Algebraic and Transcendental equations: Newton-Raphson method; convergence of solutions. **Curve Fitting:** Principle of least square; linear regression; Polynomial regression; Exponential and Geometric regression	15
II	**Interpolation:** Finite differences; Interpolation with equally spaced points; Gregory - Newton's Interpolation formula for forward and	15

<table>
<tr><td></td><td>backward interpolation; Interpolation with unequally spaced points: Lagragian interpolation,
Solution of Simultaneous Linear Equations: Gaussian elimination method, Pivoting; Gauss- Jordan elimination method; Matrix inversion .Eigen values and Eigen vectors: Jacobi's method for symmetric matrix</td><td></td></tr>
<tr><td>III</td><td>Numerical Solution of First Order Differential Equations: First order Taylor Series method; Euler's method; Modified Euler's method, Runge-Kutta methods; Predictor corrector method.
Numerical Solutions of Second Order Differential Equation: Initial and boundary value problems: shooting methods</td><td>15</td></tr>
<tr><td>IV</td><td>Computer basics and operating system: Elementary information about digital computer principles; basic ideas of operating system, DOS and its use (using various commands of DOS); Compilers; interpreters; Directory structure; File operators.
Introduction to FORTRAN 77: Data types: Integer and Floating point arithmetic; Fortran variables; Real and Integer variables; Input and Output statements; Formats; Expressions; Built in functions; Executable and non-executable statements; Control statements; Go To statement; Arithmetic IF and logical IF statements; Flow charts; Truncation errors, Round off errors; Propagation of errors, Block IF statement; Do statement; Character DATA management; Arrays and subscripted variables; Subprograms: Function and SUBROUTINE.</td><td>15</td></tr>
<tr><td colspan="2" align="right">Total Contact Hours</td><td>60</td></tr>
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<table>
<tr><th colspan="4">Suggested Evaluation Methods</th></tr>
<tr><th colspan="2">Internal Assessment: 30</th><th colspan="2">End Term Examination: 70</th></tr>
<tr><td>➢ Theory</td><td>30</td><td>➢ Theory:</td><td>70</td></tr>
<tr><td>• Class Participation:</td><td>5</td><td colspan="2" rowspan="3">Written Examination</td></tr>
<tr><td>• Seminar/presentation/assignment/quiz/class test etc.:</td><td>10</td></tr>
<tr><td>• Mid-Term Exam:</td><td>15</td></tr>
</table>

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Sastry, Introductory methods of Numerical Analysis (Prentice Hall India Learning Private Limited; Fifth edition, 2012)
2. Rajaraman, Numerical Analysis (Prentice Hall India Learning Private Limited; 3rd edition, 1993)
3. Ram Kumar, Programming with FORTRAN 77 (McGraw-Hill Professional 1988)
4. Teukolsky, Vellerling, Flannery, Numerical Recipes in FORTRAN (2nd Edition, The Art of Scientific Computing, 1992)
5. Desai, FORTRAN programming and Numerical methods(Tata Mcgraw Hill Publishing Co Ltd, 1989)
6. McCalla, Introduction to Numerical methods and FORTRAN programming (Journal of the American Statistical Association, 2014).
7. R.C, Verma, Computation Physics: An Introduction (NEW AGE INI, 2005)

Session: 2024-25			
Part A–Introduction			
Name of Programme	M. Sc. Physics		
Semester	3rd		
Name of the Course	Material Science-I		
Course Code	24-PHY-306		
Course Type	DEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 306.1:** Understand the basic concepts and properties of Materials and describe how and why defects (point, line and planar) in materials greatly affect engineering properties and limit their use in service **CLO 306.2:** Understand the Langevin diamagnetism equation, quantum theories of diamagnetism and paramagnetism (including rare earth and iron group ions), crystal field effects, cooling methods like isentropic demagnetization and nuclear demagnetization, and the paramagnetic behavior of conduction electrons. **CLO 306.3:** Understand the ferromagnetic behavior of materials through different theories. .**CLO 306.4:** Understand the phenomenon of superconductivity.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Crystals of Inert Gases:** Van der Waals-London Interaction,RepulsiveInteraction,Equilibrium Lattice Constants; Cohesive	15

	Energy; Ionic crystals: Electrostatic or Madelung energy, Evaluation of the Madelung constant; Covalent crystals;Metals;Hydrogen bonds, Atomic radii, Ionic crystal radii,Lattice vacancies; Diffusion; Color centers: F centers, Other centers in alkali halides; Frenkel defects; Schottky vacancies	
II	**Langevin diamagnetism equation:** Quantum theory of diamagnetism of mononuclear systems Paramagnetism: Quantum theory of paramagnetism, Rare earth ions, Hund rules, Iron group ions Crystal field splitting, Quenching of the orbital angular momentum, Spectroscopic splitting factor, Van Vleck temperature-independent paramagnetism; Cooling by isentropic demagnetization; Nuclear demagnetization; Paramagnetic susceptibility of Conduction electrons	15
III	**Ferromagnetic Order:** Curie point and the exchange integral, Temperature dependence of the saturation magnetization, Saturation magnetization at absolute zero; Magnons: Quantization of spin waves, Thermal excitation of Magnons; Ferri-magnetic order: Curie temperature and susceptibility of ferri-magnets, Iron garnets; Anti-ferromagnetic order: Susceptibility below the Neel temperature, Anti-ferromagnetic Magnons; Ferromagnetic domains: Anisotropy energy, Transition region between domains, Origin of domains, Coercivity and hysteresis	15
IV	**Superconductivity:** Occurrence of superconductivity, Destruction of superconductivity by magnetic fields; Meissner effect; Heat capacity; Energy gap; Microwave and infrared properties; Isotope effect; Thermodynamics of the superconducting transition; London equation; Coherence length BCS theory of superconductivity; BCS ground state; Flux quantization in a superconducting ring Duration of persistent currents; Type-II superconductors; Vortex state; Estimation of H_{C1} and H_{C2}; Single particle tunneling; Josephson superconductor tunneling; Dc and Ac Josephson effect; Macroscopic quantum interference	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. C. Kittle, Introduction to Solid State Physics (8th edition Wiley, 2005)
2. J.P. Srivastava, Elements of Solid State Physics (PHI, 2006)
3. A.J. Dekker,Solid State Physics (Macmillan, 2000)
4. Ashcroft and Mermin, Solid State Physics (Cengage Learning, 1976)

5. Ali Omar, Elementary Solid State Physics (Pearson, 2002)
6. M.A. Wahab, Solid State Physics (Narosa, 2015)

Session: 2024-25			
Part A – Introduction			
Name of Programme	M. Sc. Physics		
Semester	3rd		
Name of the Course	Practical: Computational Physics-I or Practical: Material Science-I		
Course Code	24-PHY-307		
Course Type	PC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		

NOTE: Unlike the M. Sc. First Year Laboratory, experiments in the Final Year Laboratories are based upon six different discipline elective courses (DECs). In this course, students shall complete at least six experiments from the DEC allotted. Besides continuous assessment of students through internal viva-voce examination of the experiments performed, there shall be end-semester laboratory examination wherein each student will be required to perform at least one experiment as per paper setting by a duly appointed panel of examiners. The evaluation will be made on the basis of performance of students in (i) experiment, (ii) report and analysis of the experiment and (iii) viva-voce examination.

DEC: Computational Physics-I

Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 307.1:** Students would develop an understanding of programming concepts. **CLO 307.2:** Students would learn the practical implementation of programming languages for carrying numerical calculations. **CLO 307.3:** Students would benefit from their enhanced computational skills in the context of higher studies in physics or business purposes as well.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course	Contact Hours
Practicals 1. Numerical Integration using (a) Simpson 1/3 and (b) Gauss quadrature methods for one and two-dimensional integrals. Application: Show that the function $f(x) = (n/\pi)(1/(1+n^2x^2))$ behaves like the Dirac delta function for large n. 2. Least Square fitting (Linear). 3. Solution of second-order differential equation using Runge-Kutta method. Application: Eigenvalues and eigenfunctions of a linear harmonic oscillator using	120

Runge-Kutta method.
4. To find roots of an equation of degree 1, 2 and 3 by using Bisection method.
5. Solution of Simultaneous Linear Algebraic equations by Gauss-Jordan elimination method.
Application: Illustration of Kirchhoff's laws for simple electric circuits.
6. Interpretation and Extrapolation by using Lagrangian method.
7. Finding eigenvalues and eigenvectors of square matrices.

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Numerical Python by Robert Johnsson.
2. Learn Python programming by Fabrizio Romano.
3. Introduction to computing and problem solving using Python by Balaguruswamy.
4. Introductory methods of Numerical Analysis by S. S. Sastry.
5. Computer Oriented Numerical Method by V. Rajamana.
6. Numerical Computational Methods by P B Patil and U. P. Verma.

DEC: Material science-I

Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 307.1:** Have understanding of X-ray diffractometer and use it to record and analyze the XRD pattern of a crystalline substance. Further use of this technique to compute particle size and lattice strain. **CLO 307.2:** Ascertain the magnetic nature of a given material by measuring its magnetic susceptibility. **CLO 307.3:** Grasp the concept of ferroelectricity and study the variation of dielectric constant with temperature for given ferroelectric material. Learn about solar cell and understand the effect of light intensity and temperature on its I-V characteristics. **CLO 307.4:** Learn and measure the characteristics of a thermo-luminescent material. Understand thermal properties of materials. Compute the chemical states and chemical shift from XPS spectra

Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course	
Practicals	**Contact Hours**
1. Band Gap of a given semiconductor material using Four-Probe method. 2. Study of Hall effect and estimation of Hall coefficient R, carrier density (n) and carrier mobility of Semiconductor material. 3. Lattice parameter and Miller Indices using XRD. 4. Dielectric constant of a given material. 5. Solar cell characteristics. 6. Study of the phenomenon of magneto-resistance. 7. Ultrasonic Interferometer – Young's modulus and elastic constant of solids 8. Determining the elements and its composition by XRF measurement of a sample.	120

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings
2. Mechanical Metallurgy by G. E. Dieter
3. Ion Implantation by G. Dearnally.
4. Fundamentals of Surface and Thin Film Analysis by L. C. Feldman and J. W. Mayer
5. Surface Analysis Methods in Material Science by D. J. O'Connor, B. A. Sexton and R. St. C. Smart (Eds), Springer Series in Surface Sciences 2023.

Session: 2024-25			
Part A – Introduction			
Name of Programme	M. Sc. Physics		
Semester	3rd		
Name of the Course	Practical: Radiation Physics-I or Practical: Nuclear Physics-I		
Course Code	24-PHY-308		
Course Type	PC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		

NOTE: Unlike the M. Sc. First Year Laboratory, experiments in the Final Year Laboratories are based upon six different discipline elective courses (DECs). In this course, students shall complete at least six experiments from the DEC allotted. Besides continuous assessment of students through internal viva-voce examination of the experiments performed, there shall be end-semester laboratory examination wherein each student will be required to perform at least one experiment as per paper setting by a duly appointed panel of examiners. The evaluation will be made on the basis of performance of students in (i) experiment, (ii) report and analysis of the experiment and (iii) viva-voce examination.

DEC: Radiation Physics Physics-I

Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 308.1**		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course	**Contact Hours**
Practicals 1. Investigation of the plateau of a Geiger-Muller counter. 2. To investigate the relationship between absorber materials (atomic number), and backscattering. 3. To Estimation of efficiency of the G..M. .detector 4. Production and attenuation of bremsstrahlung 5. Measurement of short half-life of radioactive sources 6. Study of the attenuation coefficients of the γ rays for Al using NaI scintillation detector 7. Energy calibration and resolution of scintillation detector 8. To find end point of energy of beta particles. 9. Detection efficiency of NaI scintillator detector	120

Part C-Learning Resources
Recommended Books/e-resources/LMS: 1. G.F. Knoll,Radiation Detection and Measurement (John Wiley & Sons, Inc, 2010). 2. A. Beiser, S. Mahajan, S. Rai Choudhury,Concepts of Modern Physics (McGraw Hill Education, 2015). 3. E.B. Podgorsak, Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, (IAEA Library Cataloguing in Publication Data, 2005) 4. Dr. Claus Grupen, Practical knowledge for Handling Radioactive Sources, (Springer-Verlag Berlin Heidelberg, 2010)

DEC: Nuclear Physics-I

Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 308.1:** Learn the concept of simulation and simulate the response of different detectors. **CLO 308.2:** Calibrating a gamma detector and identifying different gamma emitters from an unknown source. **CLO 308.3:** Calibrate an alpha spectrometer and find the energy resolution of the spectrometer. **CLO 308.4:** Find efficiency of a given detector and study gamma attenuation in an absorber.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals	Contact Hours
1. To determine the thickness of Al Sheet using G. M. Counter. 2. Mass attenuation coefficient of Gamma Rays in lead with G. M. Counter 3. Estimating the Efficiency of NaI (Tl) Detector. 4. Simulating the response of Geiger Muller counter to radiations. 5. Simulating the response of a scintillator to radioactive sources after incorporating all three gamma interactions. 6. Simulating the response of ΔE-E detector telescope and calculation of energy loss of incident particles. 7. Study of alpha spectrum for shape properties of an alpha spectrometer. 8. Study of alpha spectrum for energy calibration of an alpha spectrometer. 9. Identification of different gamma emitters from an unknown sample. 10. Resolving Time of a Fast Coincidence Circuit.	120

Part C-Learning Resources
Recommended Books/e-resources/LMS: 7. 1. Introduction to Experimental Nuclear Physics by R. M. Singru

8. Techniques for Nuclear and Particle Physics Experiments by W. R. Leo 9. Radiation Detection and Measurement by G. F. Knoll

• Seminar/Demonstration/Viva-voce/Lab records etc.:	25	

Session: 2024-25			
Part A – Introduction			
Name of the Programme	M.Sc. (Physics)		
Semester	**3rd**		
Name of the Course	Sources of Energy		
Course Code	24-PHY-339		
Course Type	OEC		
Level of the course (As per Annexure-I	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 339.1**: Understand the basics of conventional and non- conventional energy resources **CLO 339.2**: Describe the various techniques to fabricate solar cells, solar thermal power plant. **CLO 339.3**: Comprehend the principles and working of characterization tools for analyses of nanostructure. **CLO 339.4**: Grasp the concepts of various physical properties of nanostructures.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Conventional and Non-Conventional Energy Sources** Limitation of conventional energy sources, need and growth of alternative energy sources, basic scheme and application of direct energy conservation, Theory of solar cells, Solar cell materials, solar drying, solar furnaces, Solar cooking, solar greenhouse technology	8

II	**Solar Energy** Solar Thermal Energy: Solar radiations, flat plate collectors and their materials, applications and performance, focusing of collectors and their materials, applications and performance	8
III	**Geothermal Energy** Geothermal Energy: Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, applications of geothermal energy, Geothermal power plant	7
IV	**Wind Energy** Wind Energy: Wind power and its sources: Principle of working of Wind Energy, performance and limitations of energy conversion systems	7
	Total Contact Hours	30

Suggested Evaluation Methods

Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. John Twideu, Tony Weir, Renewal Energy Resources (BSP Publications, 2005).
2. M.V.R. Koteswara Rao, Energy Resources: Conventional & Non-Conventional (BSP Publications, 2004)
3. D.S. Chauhan, Non-Conventional Energy Resources(New Age International, 2012)
4. C.S. Solanki, Renewal Energy Technologies: A Practical Guide for Beginners (PHI Learning, 2008)
5. Peter Auer, Advances in energy system and Technology Vol I & II (Academic Press, 1978)
6. G.D. Rai, Non-conventional Energy sources (Khanna Publishers, 2004)

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc. (Physics)		
Semester	**4th**		
Name of the Course	Physics of Nano-materials		
Course Code	24-PHY-401		
Course Type	CC		
Level of the course (As per Annexure-I	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 401.1**: Students would be able to explain the properties of nanomaterials and nanostructures. **CLO 401.2**: Students will be enabled to analyze the density of states in various nanostructures and its effects on optical properties. **CLO 401.3**: Students will become acquainted with important techniques for the preparation of nanomaterials and nanostructures. **CLO 401.4**: Quantitatively understanding the experimental results of X-ray diffraction, photoluminescence, and Raman spectra of nanomaterials opens up avenues for future research.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours

I	**Free Electron Theory:** qualitative idea of free electron theory and its features, Idea of band structure: Kronig Penny model, Metals, insulators and semiconductors, Concept of effective mass, Derivation of density of states in 3D, 2D, 1D and 0D systems, Density of states in bands, Variation of density of states with energy, Variation of density of states and band gap energy with size of crystal, Electronic structure from Bulk to quantum dot, Excitons: Frenkel and Mott-Wannier excitons.	7
II	**Physics of reduced dimensional systems and devices:** Quantum confinement, Electron confinement in one, two and three dimensional infinitely deep square well potentials, Various low dimensional systems: Quantum well structure; Idea of quantum well structure, Electron wave function and energy in quantum well structure (infinite well approximation), Density of states and optical absorption in quantum well, Quantum wires: Electron wave function and energy, Density of states, Quantum dots: Electron wave function and energy, Density of states, idea of hetero-junction LED, Quantum well laser and quantum dot laser, Coulomb blockade and Single electron transistor.	8
III	**Synthesis of Nanomaterials/Nanostructures:** Bottom up and top down approaches for synthesis of nano materials, Synthesis of zero-dimensional nanostructures (Nanoparticles): Sol-Gel Process, Epitaxial core-shell nanoparticles, Ball milling, One-dimensional nanostructures (Nanowires, Nanorods, Nanotubes): Electrochemical deposition, Lithography, Two-dimensional nanostructures (Thin Films & Quantum wells): Molecular beam epitaxy (MBE), MOCVD, Cluster beam evaporation, Ion beam deposition, Chemical bath deposition technique.	8
IV	**Characterization of Nanomaterials/Nanostructures:** Effect of particle size and Strain on width of XRD peaks of nanomaterials, Determination of crystallite/particle size and strain in nanomaterials using Debye Scherer's formula and Williamson–Hall's plot, Transmission electron microscopy: Basic principle, Brief idea of set up, Sample preparation, Imaging modes (Dark & Bright Field), Photoluminescence (PL) spectroscopy: Basic principle and idea of instrumentation, Shift in PL peaks with particle Size, Determination of alloy composition in thin films of compound semiconductors, Estimation for width of quantum wells, Raman spectroscopy: Basic principle and idea of instrumentation, Variations in Raman spectra of nanomaterials with particle size, Study of Raman spectra of carbon nanotubes and graphene.	7
	Total Contact Hours	30

Suggested Evaluation Methods

Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Nanotechnology – Charles P. Poole Jr. and Frank J. Owens, Wiley India Pvt. Ltd., 2007.
2. Nanomaterials – Guozhong Cao, Imperial College Press, 2004.

Session: 2024-25			
Part A – Introduction			
Name of Programme	M. Sc. Physics		
Semester	**4th**		
Name of the Course	Atomic and Molecular Physics		
Course Code	24-PHY-402		
Course Type	CC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 402.1:** Students will explore the atomic spectra of one and two-electron atoms, gaining insights into quantum states. **CLO 402.2:** This unit equips students with the knowledge of how external fields influence atomic spectra, covering the Zeeman effect, Paschen-Back effect, Stark effect, and qualitative aspects of hyperfine structure, essential for analyzing complex atomic interactions **CLO 402.3:** Students will gain a comprehensive understanding of diatomic molecules and their rotational spectra, covering various types and energy levels, essential for interpreting molecular structures and analyzing spectroscopic data. **CLO 402.4:** This unit equips students with essential knowledge of diatomic molecules' vibrational and rotational-vibrational spectra, crucial for understanding molecular energy transitions, potential energy curves, and interpreting spectroscopic features		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B-Contents of the Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The			

compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**One Electron systems and Pauli principle:** Quantum states of one electron atoms, atomic orbitals, Hydrogen spectrum, Pauli principle, spectra of alkali elements, spin orbit interaction and fine structure in alkali spectra, Spectra of two electron systems, equivalent and non-equivalent electrons	15
II	**Hyperfine Structure:** The influence of external fields, Hyperfine structure and Line broadening, Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Two electron systems, interaction energy in LS and JJ coupling.	15
III	**Rotational spectra:** Types of molecules, Diatomic linear symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotator, energy levels and spectra of non-rigid rotor, intensity of rotational lines	15
IV	**Vibrational Spectra:** Vibration and Rotational Vibration spectra of Diatomic molecules: Vibrational energy of diatomic molecule, Diatomic molecules as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrating rotator, vibration spectrum of diatomic molecules, PQR Branches	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987).
2. Atomic spectra & atomic structure, Gerhard Hertzberg: Dover publication, New York.
3. Molecular structure & spectroscopy, G. Aruldhas; Prentice – Hall of India, New Delhi.
4. Fundamentals of molecular spectroscopy, Colin N. Banwell& Elaine M. McCash, Tata McGraw –Hill publishing company limited.
5. Introduction to Atomic spectra by H.E. White.
6. Spectra of diatomic molecules by Gerhard Herzberg.
7. Principles of fluorescence spectroscopy by Joseph R. Lakowicz.

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc.(Physics)		
Semester	**4th**		
Name of the Course	Nuclear Physics-II		
Course Code	24-PHY-403		
Course Type	DEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 403.1** Learn basics of nuclear shell model to predict various nuclear properties using shell model. **CLO 403.2** Learn basics of nuclear collective model and to predict various nuclear properties using this model. **CLO 403.3** Acquire conceptual understanding of the general theory of nuclear scattering and reactions and analysis of the cross sections for compound and direct nuclear reactions. **CLO 403.4** Understand the key features of nuclear reactions involving weakly bound nuclei and heavy ion induced reactions.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
Part B-Contents of the Course			

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Deuteron Problem & Low Energy Scattering:** Qualitative features and phenomenological potentials, Exchange forces, generalized Pauli principle. The ground state of deuteron, Range-depth relationship for square well potential, Neutron-Proton scattering at low energies (below 10 MeV), Concept of scattering length and its interpretation, Spin dependence of neutron-proton scattering, Effective range theory of n-p scattering, Coherent scattering of neutrons on ortho and para hydrogen, Magnetic moment and its importance in the determination of exact ground state of deuteron	15

II	**Nuclear Reactions and Cross Sections:** Nuclear reactions and cross sections, Resonance : Breit-Wigner dispersion formula for ℓ= 0, Breit-Wigner dispersion formula for all values of ℓ, The compound nucleus, Continuum theory of cross section σ_C, Statistical theory of nuclear reactions, Evaporation probability and cross sections for specific reactions, Kinematics of the stripping and pick-up reactions, Theory of stripping and pick-up reactions	15
III	**Liquid Drop Model & Magic Numbers**: Liquid drop model, Outlines of Bohr and Wheeler theory of nuclear fission, Concept of magic numbers, The properties of magic nucleus, Nuclear Shell Model, Predictions of shell closure on the basis of harmonic oscillator potential, Need of introducing spin-orbit coupling to reproduce magic numbers. Extreme single particle model and its predictions regarding ground state spin parity, magnetic moment and electric quadrupole moments	15
IV	**Nuclear Surface Deformations & Oscillators:** Nuclear surface deformations, General parameterization, Types of multipole deformations, Quadrupole deformations, Symmetries in collective space, Surface vibrations, Vibrations of a classical liquid drop, The Harmonic quadrupole oscillator, The collective angular momentum operator, The collective quadrupole operator, Quadrupole vibrational spectrum, Rotating nuclei, The rigid rotor, The symmetric rotor, The asymmetric rotor	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. R. R. Roy and B. P. Nigam, "Nuclear Physics: Theory and Experiment", Wiley Eastern Limited, 1993.
2. M. K. Pal, "Theory of Nuclear Structure", Affiliated East-West Press, New Delhi.
3. W. Greiner and J. A. Maruhn, "Nuclear Models", Springer, 1996
4. R. A. Broglia and A. Winther, "Heavy Ion Reactions (Lecture Notes)", Benjamin/Cummings Publishing Company, Inc., 1981
5. Ford and Wheeler, Annals of Physics, Vol. 7 (1959) 259.
6. C. A. Bertulani, M. Hussein and G Muenzenberg, "Physics of Radioactive Beams", Nova Science, NY, 2002.
7. L. F. Canto et al., Physics Reports, Vol. 424 (2006) 1.

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Physics		
Semester	**4th**		
Name of the Course	Radiation Physics-II		
Course Code	24-PHY-404		
Course Type	DEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 404.1**: Students will gain the knowledge about the basic principles of detectors. **CLO 404.2:** Understand the effects of radiations on ecological system and humans. **CLO 404.3:** Understand the principle of radiological protection **CLO 404.4:** Students will understand the basic knowledge of radiation hazards and their precautions.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B- Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Principles of radiation detection;** Gas filled radiation detectors: ionization chambers, proportion counters, GM counters, and Spark counter. Scintillation (organic/inorganic) counter; Solid State Detector: Crystal detector, Semiconductor Detectors (Junction type detector, Lithium drift Germanium detector, and HPGe), Thermo – Luminescent Dosimeters (TLD)	15
II	**Biological Effects of Ionizing Radiation:** Introduction, Cell Biology: Structure and function of living cell, cell division-mitosis, meiosis and differentiation, central dogma of molecular biology, genetic codes-DNA, RNA and Proteins; Effect of Radiation on Cell: inhibition of cell division, chromosome aberrations, genes mutation, and cell death; Biological effects of Radiation on Human: Somatic Effects (Early effect) and Stochastic effect (Late effect)	15

III	**Principles of Radiological Protection:** Justification of Practice, Optimization of Practice, and Dose Limitations; Internal Exposure, Dose Limit for (i) Radiation Workers (ii) Public, Occupational Exposure of Women, Apprentices and Students; Production of Radioisotopes and Labeled Compounds: Introduction, Separation of Isotopes, Production of labeled compounds, Specific Activity of labeled compounds, Storage, Quality, and Purity of Radio-labeled compounds	15
IV	**Radiation Hazard:** Internal Hazards and External Hazards; Evaluation and Control of Radiation Hazard, Radiation Shield, Monitoring of External Radiation, Control of Internal Hazard: (i) Containment of Source (ii) Control of Environment (iii) Contamination (iv) Air Contamination Monitoring (v) Personal Contamination Monitoring (vi) Decontamination Procedures; Radiation Emergency and Preparedness	15
	Total Contact hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Glenn F. Knoll, Radiation Detection and Measurement (John Wiley & Sons, Inc, 2017)
2. Arthur Beiser, S Mahajan, and S RaiChoudhury, Concepts of Modern Physics (McGraw Hill Education, 2015)
3. E.B. Podgorsak, Radiation Oncology Physics: a handbook for teachers and students (International Atomic Energy Agency Vienna, 2005)
4. Dr. Claus Grupen, Practical knowledge for Handling Radioactive Sources (Springer, 2010)
5. Frank Herbert Attlx, Introduction to Radiological Physics and Radiation Dosimetry (1ed Wiley-VCH, 2004)
6. Radiation Biology: a handbook for teachers and students (International Atomic Energy Agency Vienna, 2010)

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Physics		
Semester	4^{th}		
Name of the Course	Computational Physics-II		
Course Code	24-PHY-405		
Course Type	DEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 405.1:** Students would be able to understand framework of computer languages **CLO 405.2:** Students would be able to solve various physical problems numerically **CLO 405.3:** Students would acquire fundamental proficiency in applying MATLAB for problem-solving purposes. **CLO 405.4:** Students would acquire fundamental proficiency in applying MATLAB for problem-solving purposes.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Random Numbers:** Random number generators, Mid-square methods, Multiplicative congruential method, mixed multiplicative congruential methods, modeling of radioactive decay. Hit and Miss Monte-Carlo methods, Monte-Carlo calculation of π, Monte-Carlo evaluation of integration, Evaluation of multidimensional integrals, chaotic dynamics: Some definitions, the simple pendulum, Potential energy of a dynamical system, Un-damped motion, Damped motion, Driven and damped oscillator.	15
II	**Solutions of Some Models Using Numerical Methods:** Numerical solution of Radial Schrodinger equation for Hydrogen atom using Forth-order Runge-Kutta method(when Eigen value is given), Numerical	15

	Solutions of Partial Differential Equations using Finite Difference Method, Algorithms to simulate interference and diffraction of light, Simulation of charging and discharging of a capacitor, current in LR and LCR circuits, Computer models of LR and LCR circuits driven by sine and square functions, Computer model of Rutherford scattering experiment, Simulation of electron orbit in H_2 ion.	
III	**MATLAB – I:** Introduction, working with arrays, creating and printing plots, Interacting Computations: Matrices and Vectors, Matrices and Array Operations, built in functions, saving and loading data, plotting simple graphs Programming in MATLAB: Script files, function files, Compiled files, p-code, variables, loops, branches, and control flow, Input/ Output, Advanced data objects, structures, cells	15
IV	**MATLAB – II:** Linear Algebra; solving a linear system, Gaussian elimination, finding eigenvalues and Eigen vectors, matrix factorization, Curve fitting and Interpolation; polynomial curve fitting, least square curve fitting, interpolation, Data analysis and statistics, Numerical integration; double integration, Ordinary differential equation; first order linear ODE, second order nonlinear ODE, tolerance, ODE suite, event location, Non-linear algebraic equations	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. P. B. Patil and U. P. Verma, Numerical Computational Methods, Narosa Publishing House
2. M. L. De Jong, Introduction to Computation Physics, Addison-Wesley publishing company.
3. R. C. Verma, P K Ahluwalia and K C Sharma, Computational Physics an Introduction, New Age International Publisher.
4. S. S. Sastry Introductory methods of numerical Analysis, Prentice Hall of India Pvt. Ltd.
5. C. BalachandraRao and C K Santha, Numerical Methods, University Press
6. K. E. Atkinson, An introduction to numerical analysis, John Wiley and Sons.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Physics		
Semester	4^{th}		
Name of the Course	Material Science-II		
Course Code	24-PHY-406		
Course Type	DEC		
Level of the course	500-599		
Pre-requisite for the course (if any)	---		
Course Learning Outcomes (CLOs) After completing this course, the learner will to:	**CLO 406.1:** understand of dielectric functions of electron gas, various properties of plasmons **CLO 406.2:** Understand magnetic processes, Diamagnetism, Paramagnetism, density of states curves for a metal; and Grasp the concepts of Ferromagnetism, exchange interactions, domain structure; Antiferromagnetism, Ferrimagnetism and Ferrites **CLO 406.3:** Elucidate the physics describing dielectrics and ferroelectric materials, with focus on the piezoelectric & pyroelectric properties and Describe the optical properties of insulators **CLO 406.4:** Understanding of the surface and concepts of salvage depth and Grasp the concept, working and development of isomorphous alloys.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Dielectric Function of The Electron Gas:** Definitions of the dielectric function, Plasma optics, Dispersion relation for electromagnetic waves, Transverse optical modes in a plasma Transparency of metals in the ultraviolet, longitudinal plasma oscillations; Plasmons; Electrostatic screening: Screened coulomb potential, Pseudopotential component U(0), Mott metal-insulator transition, Screening and phonons in metals;	15

	Polaritons; Electron-electron interaction: Fermi liquid, Electron-electron collisions; Electron-phonon interaction. Polarons; Optical reflectance: Kramers-Kronig relations, conductivity of collisionless electron gas, Electronic interband transitions	
II	**Excitons:** Frenkel excitons, Alkali halides, Molecular crystals weakly bound (Mott-Wannier) excitons; Exciton condensation into electron-hole drops (EHD); Maxwell equations; Polarization; Macroscopic electric field: Depolarization field; Local electric field at an atom: Lorentz field, Field of dipoles inside cavity, Dielectric constant and polarizability: Electronic polarizability, Classical theory, some examples, Structural phase transitions; Ferroelectric crystals and their classification, Displacive transitions: Soft optical phonons, Landau theory of the phase transition, Second-order transition, First-order transition, Anti-ferroelectricity, Ferroelectric domains, Piezoelectricity	15
III	**Electron Transport and Band Theory of Solids:** Band gap, Equations of motion: Physical derivation of, Holes, Effective mass, Physical interpretation of the effective mass, Effective masses in semiconductors; Intrinsic carrier concentration; law of mass action; intrinsic mobility; Impurity conductivity: Donor states, Acceptor states, Thermal ionization of donors and acceptors; Energy bands in Silicon, Germanium and GaAs; Cyclotron resonance in semiconductors; Carrier lifetime and recombination; thermoelectric effects; Semimetals	15
IV	**Microstructure:** Description of solubility limit, Phases, Microstructure, Phase equilibria, Unary phase diagrams Binary phase diagrams: Binary Isomorphous systems,Interpretation of phasediagrams, Development of microstructure inIsomorphous alloys, Mechanical properties of Isomorphous alloys, Binary eutectic systems, Materials of Importance-Lead-Free Solders, Development of microstructure in eutectic alloys, Equilibrium diagrams having intermediate phases or compounds, Eutectoid and Peritectic Reactions, Congruent phase transformations, Ceramic and ternary phase diagrams, The Gibbs Phase Rule, The iron–carbon system	15
	Total Contact Hours	60

Suggested Evaluation Methods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Material Science, J.C. Anderson, K.D. Leaver, J. M. Alexander and R. D. Rawlings
2. Mechanical Metallurgy, G.E. Dieter.
3. Electronic Processes in Materials, L. V. Azaroff and J. J. Brophy
4. Fundamentals of Surface and Thin Film Analysis, L.C. Feldman and J. W. Mayer
5. Surface Analysis Methods in Material Science, D. J. O'Connor, B. A. Sexton and R. St. CSmart (Eds), Springer Series in Surface Sciences 23
6. Solid State Physics – A J Dekker (McMillan, 1971)
7. Materials Science and Engineering by William D. Callister

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<tr><td>Name of Programme</td><td colspan="3">M. Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="3">4th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Practical: Computational Physics-II or Practical: Material Science-II</td></tr>
<tr><td>Course Code</td><td colspan="3">24-PHY-407</td></tr>
<tr><td>Course Type</td><td colspan="3">PC</td></tr>
<tr><td>Level of the course</td><td colspan="3">500-599</td></tr>
<tr><td>Pre-requisite for the course (if any)</td><td colspan="3">--</td></tr>
<tr><td colspan="4">NOTE: Unlike the M. Sc. First Year Laboratory, experiments in the Final Year Laboratories are based upon six different discipline elective courses (DECs). In this course, students shall complete at least six experiments from the DEC allotted. Besides continuous assessment of students through internal viva-voce examination of the experiments performed, there shall be end-semester laboratory examination wherein each student will be required to perform at least one experiment as per paper setting by a duly appointed panel of examiners. The evaluation will be made on the basis of performance of students in (i) experiment, (ii) report and analysis of the experiment and (iii) viva-voce examination.</td></tr>
<tr><td colspan="4">DEC: Computational Physics-II</td></tr>
<tr><td>Course Learning Outcomes (CLOs)
After completing this course, the learner will be able to:</td><td colspan="3">CLO 407.1: Students would develop an understanding of programming concepts.
CLO 407.2: Students would learn the practical implementation of programming languages for carrying numerical calculations.
CLO 407.3: Students would benefit from theirenhanced computational skills in the context of higher studies in physics or business purposes as well.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>0</td><td>4</td><td>4</td></tr>
<tr><td>Teaching Hours per week</td><td>0</td><td>8</td><td>8</td></tr>
<tr><td>Internal Assessment Marks</td><td>0</td><td>30</td><td>30</td></tr>
<tr><td>End Term Exam Marks</td><td>0</td><td>70</td><td>70</td></tr>
<tr><td>Max. Marks</td><td>0</td><td>100</td><td>100</td></tr>
<tr><td>Examination Time</td><td>0</td><td colspan="2">4 hours</td></tr>
</table>

Part B- Contents of the Course	Contact Hours
Practicals 1. Numerical Integration 2. Least square fitting 3. Numerical solutions of equations (single variable) 4. Solution of H-atom problem 5. Solution of RL circuits 6. Numerical solution of simultaneous linear algebraic equations	120

7. Numerical solution of ordinary differential equation 8. Simulation of chaotic pendulum 9. Motion of Projectile thrown at an angle 10. Simulation of Planetary Motion 11. Charging and discharging of Capacitor 12. Solution of LCR circuit	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Numerical Python by Robert Johnsson.
2. Learn Python programming by Fabrizio Romano.
3. Introduction to computing and problem solving using Python by Balaguruswamy.
4. Introductory methods of Numerical Analysis by S. S. Sastry.
5. Computer Oriented Numerical Method by V. Rajamana.
6. Numerical Computational Methods by P B Patil and U. P. Verma.

DEC: Material science-II

Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 407.1:** Have understanding of X-ray diffractometer and use it to record and analyze the XRD pattern of a crystalline substance. Further use of this technique to compute particle size and lattice strain. **CLO 407.2:** Ascertain the magnetic nature of a given material by measuring its magnetic susceptibility. **CLO 407.3:** Grasp the concept of ferroelectricity and study the variation of dielectric constant with temperature for given ferroelectric material. Learn about solar cell and understand the effect of light intensity and temperature on its I-V characteristics. **CLO 407.4:** Learn and measure the characteristics of a thermo-luminescent material. Understand thermal properties of materials. Compute the chemical states and chemical shift from XPS spectra		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals	Contact Hours
1. To study the B-H curve of a ferrite with temperature and find the ferromagnetic transition temperature of the material. 2. To determine the dielectric constant of PZT material with temperature variation and find its Curie temperature. 3. To study the magneto-resistance of bismuth crystal. 4.To measure the magnetic susceptibility of a paramagnetic material using Gouy's method. 7. To study thermo-luminescence of F-centers in alkali halide crystals. 8. To simulate X-Ray Diffraction Experiment 9. To determine the crystallite size and lattice strain using Williamson's Halls Plot from a given x-ray diffraction data. 10. Indexing and determination of lattice parameter of a Simple cubic crystal for a given x-ray diffraction data. 11. To study hysteresis in the electrical polarization of a TGS crystal and measure the Curie temperature. 12. To study the lead tin phase diagram.	120

Part C-Learning Resources
Recommended Books/e-resources/LMS: 1.Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings 2.Mechanical Metallurgy by G. E. Dieter 3.Ion Implantation by G. Dearnally. 4.Fundamentals of Surface and Thin Film Analysis by L. C. Feldman and J. W. Mayer 5.Surface Analysis Methods in Material Science by D. J. O'Connor, B. A. Sexton and R. St. C. Smart (Eds), Springer Series in Surface Sciences 2023.

Session: 2024-25			
Part A – Introduction			
Name of Programme	M. Sc. Physics		
Semester	4^{th}		
Name of the Course	Practical: Radiation Physics-II or Practical: Nuclear Physics-II		
Course Code	24-PHY-408		
Course Type	PC		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		

NOTE: Unlike the M. Sc. First Year Laboratory, experiments in the Final Year Laboratories are based upon six different discipline elective courses (DECs). In this course, students shall complete at least six experiments from the DEC allotted. Besides continuous assessment of students through internal viva-voce examination of the experiments performed, there shall be end-semester laboratory examination wherein each student will be required to perform at least one experiment as per paper setting by a duly appointed panel of examiners. The evaluation will be made on the basis of performance of students in (i) experiment, (ii) report and analysis of the experiment and (iii) viva-voce examination.

DEC: Radiation Physics Physics-II

Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	**CLO 408.1**		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course	**Contact Hours**
Practicals 1. Investigation of the optimal operating voltage of a Geiger-Muller counter. 2. Investigation of statistical nature of counting rate. 3. To determine the resolving time of a GM counter. 4. To investigate the relationship between absorber materials (atomic number), absorption thickness. 5. To verify the inverse square relationship between the distance and intensity of radiation. 6. To investigate the attenuation of radiation via the absorption of beta particles. 7. To determine the maximum energy of decay of a beta particle. 8. Measurement of range of α particle range in air using a spark counter.	120

9. Study of the attenuation coefficients of the γ rays for Fe and Pb using NaI scintillation counter. 10. Measurement of γ ray energy of Cs-137 source using a NaI Scintillation detector.	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Solid State Physics (7^{th} edition) by Charles Kittel
2. Solid State Physics by Neil W. Ashcroft and N. David Mermin
3. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
4. Principles of the Theory of Solids (2^{nd} edition) by J. M. Ziman
5. Condensed Matter Physics by Michael P. Marder
6. Advanced Solid State Physics by P. Phillips

DEC: Nuclear Physics-II

Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 408.1:** Learn the concept of simulation and simulate the response of different detectors. **CLO 408.2:** Calibrating a gamma detector and identifying different gamma emitters from an unknown source. **CLO 408.3:** Calibrate an alpha spectrometer and find the energy resolution of the spectrometer. **CLO 408.4:** Find efficiency of a given detector and study gamma attenuation in an absorber.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

Part B- Contents of the Course

Practicals	Contact Hours
1. Statistics of G.M. Counter. 2. Range of Alpha Particles in air using Spark counter. 3. Resolving time of G.M. Counter set-up. 4. Thickness measurement of Al Sheet using G. M. Counter. 5. Thickness measurement of Al Sheet using Gamma Ray Absorption Experiment. 6. Study of resolving power of Gamma Ray Detector as a function of energy. 7. Efficiency Determination of NaI (Tl) Detector. 8. Study of Compton scattering experiment.	120

9.	Study of Alpha-Spectrometer.	
10.	Study of Rutherford Back Scattering Experiment.	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Experimental Nuclear Physics by R. M. Singru
2. Techniques for Nuclear and Particle Physics Experiments by W. R. Leo
3. Radiation Detection and Measurement by G. F. Knoll

• Seminar/Demonstration/Viva-voce/Lab records etc.:	25	

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc. (Physics)		
Semester	**4th**		
Name of the Course	Space Science and Sensors		
Course Code	24-PHY-409		
Course Type	EEC		
Level of the course (As per Annexure-I	500-599		
Pre-requisite for the course (if any)	--		
Course Learning Outcomes (CLO) After completing this course, the learner will be able to:	**CLO 409.1:** Understanding of Astronomical model, basic principles involved, remote sensing, GIS **CLO 409.2:** Understand the fundamentals of the astronomical gravity, Sun, Earth Moon atmosphere and basics of tidal forces **CLO 409.3:** Understand the thermodynamics of star, stellar, and able to calculate mass of white dwarf. **CLO 409.4:** Understand the basics of different sensors used in space science and principal behind them.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Introduction to Space Science:** Solar System: geocentric model; heliocentric model; Kepler's laws of planetary motions - Galileo's pioneering work - length and time measurements; Remote sensing: Definition, Principle and Physical basis; Interaction of EM radiations with earth's surface and atmosphere; Introduction to Geographical Information System (GIS), components and functions of GIS, Concept of raster and vector data.	7
II	**Sun, Earth and Moon systems:** Motion of the Moon around the Earth, Falling bodies, Halley's comet; importance of gravity as a force in astronomy; Physics of the Sun, sunspots, Babcock model of sunspot	7

	formation, solar atmosphere –chromosphere and Corona; Thermonuclear reactions; discovery of Neptune and Pluto; asteroid belt, meteors, and comets; Tidal forces and the oceanic tides; precession of equinox and change of seasons.	
III	**Stars and Stellar:** Stars—the type, structure, evolution and stability; Stellar structure and evolution- evolution of low mass stars and high mass stars; white dwarfs - structure and stability, Realms of thermodynamics, statistical mechanics and special relativity, Theory of Fowler, Chandrasekhar and Eddington for white Dwarf; Chandrasekhar's mass limit. Introduction to supernova and neutron stars; supernova explosion; pulsars.	8
IV	**Introduction to Sensors for space:** Piezoelectric MEMS sensor, thermistor sensors; Charge Coupled Detectors (CCD), Complimentary Metal-Oxide Semiconductor (CMOS) imaging sensors or CMOS Imaging Sensors (CIS), long-wave infrared detectors, X-ray Detectors for space (LWIR), Short Wave Infrared Band (SWIR) and a Modular Opto-electronic Scanner (MOS), Wide Field Sensor (WiFS), Ultraviolet sensors for space, Solar Wind Electron Energy Probe (SWEEP) and the Solar Wind lon Composition Analyzer (SWICAR).	8
	Total Contact Hours	30

Suggested Evaluation Methods

Internal Assessment: 15		**End Term Examination: 35**	
➢ **Theory**	**15**	➢ **Theory**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Astronomy, The Evolving Universe, M. Zeilik (Cambridge University Press, 2002)
2. Introduction to Astronomy & Cosmology, I. Morrison (Wiley, 2008)
3. Remote Sensing and image interpretation (John Wiley & sons). T.M. Lillesand and R.W. Kiefer
4. Remote Sensing Principles and interpretation (WH Freeman Company. F.F. Reeds
5. Remote Sensing for Earth Resources (AEG publication), D.P. Rao
6. Principles of Remote sensing (ELBS London). P. J. Kuran
7. Fundamental Astronomy, H. Karttunen et al. (Springer, 2003)
8. Solar Astrophysics, P. V. Foukal (Wiley-VCH, 2004)
9. Fundamentals of Solar Astronomy, A. Bhatnagar & W.C. Livingston (World Scientific, 2005)
10. The Physical Universe, Frank Shu (University Science Books, 1982)
11. Cosmology: The Science of the Universe, Edward Harrison (Cambridge University Press, 2000)
12. From Black Clouds to Black Holes, J. V. Narlikar (World Scientific, 1985)
13. Archeo astronomy- Introduction to the Science of Stars and Stones, Giulio Magli (Springer, 2016)
14. Universe, R. A. Freedman & W. J. Kaufmann (W. H. Freeman & Co., 2008)
15. Statistical Mechanics by R. K. Patharia
16. Micro sensors: Principles and Applications, J. W. Gardner (John Wiley, 1994)
17. Sensor Technology and Devices, L. R. Ristic (Artech House publishers, 1994)