Kurukshetra University, Kurukshetra

(Established by the State Legislature Act-XII of 1956)

(“A^{++}” Grade, NAAC Accredited)

Syllabus

For

Post Graduate Programme

M.Sc. APPLIED PHYSICS

as per NEP 2020

Curriculum and Credit Framework for Postgraduate Programme

With Multiple Entry-Exit, Internship and CBCS-LOCF

With effect from the session 2024-25 (in phased manner)

FACULTY OF SCIENCE

KURUKSHETRA UNIVERSITY, KURUKSHETRA -136119

HARYANA, INDIA

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Applied Physics		
Semester	1st		
Name of the Course	Classical Mechanics		
Course Code	M24-APHY-101		
Course Type	CC-1		
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:** Demonstrate a basic and advanced knowledge of Lagrangian and Hamiltonian Formulations and solve related problems, understand the concept of non-holonomic systems and conservation laws. **CLO 101.2:** Acquire knowledge of Two-body central forces, Virial theorem, Kepler's laws of planetary motion. Develop a deep understanding of concept of Scattering. **CLO 101.3:** Understand the foundations of Legendre transformations, Hamilton's equations, cyclic coordinates, Poisson brackets, Hamilton-Jacoby theory and action–angle variable. **CLO 101.4:** Understand the foundations of nonlinear dynamics in general and chaotic motion and fractals, in particular. Perform stability analysis of cubic anharmonic oscillator and undamped pendulum, and find chaotic trajectories.		
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	Hamilton's variational principle - Derivation of Lagrange's equations from this principle, extension of the non-holonomic systems - method of undetermined multiplier, velocity dependent forces and dissipation function, conservation laws - some illustrative applications (like simple pendulum, coplanar double pendulum, pendulum with moving support).	15

II	Two-body central forces problems - Classification of orbits, differential equations for orbits, Virial theorem, Kepler's laws of planetary motion and their derivation. Scattering: scattering in laboratory and centre of mass frames, scattering cross sections, Rutherford scattering (derivation of differential and total cross section).	15
III	Legendre transformations and Hamilton's equations, cyclic coordinates and conservation theorems, Ruth's Procedure, canonical transformations, Poisson brackets (with illustrative evaluations), Poincare invariants, Hamilton-Jacobi method and example of harmonic oscillator problem, action angle variables and its applications to harmonic oscillator problem.	15
IV	Classical Chaos: linear and nonlinear systems, periodic motion, Perturbation and KAM theorem, dynamics in phase space, phase portraits for conservative systems, attractors, classification and stability of equilibrium points, stability analysis of cubic anharmonic oscillator and undamped pendulum, chaotic trajectories and Liapunov exponent, Poincare Map, Henon-Hiels Hamiltonian, bifurcation, driven-damped harmonic oscillator, the logistic equation, Fractals and dimensionality.	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 - N.C. Rana and P.S. Jog, Tata - McGraw Hill
3. Classical Mechanics - T.L. Chow, John - Wiley.
4. Classical Mechanics - Sankara Rao, Prantice Hall
5. Mechanics - L.D. Landau and E.M. Lifshitz, Pergamon
6. Classical Mechanics by John R Taylor.
7. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajasekar.
8. Classical Mechanics, J.C. Upadhyaya, Himalaya Publishing House.

Session: 2024-25			
Part A – Introduction			
Name of Programme	M.Sc. Applied Physics		
Semester	1st		
Name of the Course	Applied Mathematics		
Course Code	M24-APHY-102		
Course Type	CC-2		
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:** Obtain explicit expressions of Hermite, Laguerre, Bessel and Legendre polynomials and to establish their recurrence relations and other properties. **CLO 102.2:** Find the Laguerre, HermitePolynomials, function of complex variables. Derive Cauchy integral theorem, Cauchy integral formula, Taylor and Laurent series expansion of functions of complex variable and to evaluate some definite integrals using the method of contour integration. **CLO 102.3:** Find the Laplace transforms of functions, analyze various types of errors and fitting of data. **CLO102.4**: Understand basics of group theory, preparation of group multiplication tables and construction of character table of symmetry groups.		
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	Bessel Functions : Bessel's functions of the first kind : Generating function, recurrence relations, Jn(x) as solution of Bessel's differential equation, expansion of Jn(x) when n is half and odd integer, orthogonality of Jn(x) (Statement only). Legendre polynomials: Generating functions for Pn(x) (n $\geq$ 0), recurrence relations and special properties, Pn(x) as solution of Legendre differential equation, Rodrigues formula, orthogonality of Pn(x), associated	15

	Legendre polynomials (Introduction only).	
II	Laguerre Polynomials: Generating function and recurrence relations. Hermite Complex Variables : Function of complex variable, Analytic functions, Cauchy-Riemann conditions for the function to be analytic, Cauchy's integral theorem, Cauchy's integral formula, Taylor's and Laurent's series, definite Integrals, Jordan's Lemma.	15
III	Laplace Transform: Definition, important properties of Laplace transforms Inverse Laplace transforms and its important properties. Error Analysis: Types of experimental errors, statistical analysis of random errors, the normal or Gaussian law of error, Propagation of Errors, method of least squares, applications of method of least squares solution of linear equations, curve fitting.	15
IV	Group Theory : Definition of a group with illustrative examples, group multiplication table, rearrangement theorem, cyclic groups, subgroups and cosets, conjugate elements and class structure, normal division and factor groups, isomorphy and homomorphy, class multiplications, group representation, reducible and irreducible representation, the great orthogonality theorem (statement only) and geometrical interpretation, character of a representation and construction of character of character table with illustrative example of symmetry groups of equilateral triangle,rectangle and square.	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. Mathematical Methods for Physicists - G. Arfken
2. Mathematical Physics for Physicists and Engineers - L. Pipes.
3. Theory and Problem of Complex Variables- M.R. Speigel,Schaum's Outlines
4. Theory and Problems of Laplace Transform - M.R.Speigel, Schaum's Outlines.
5. Group Theory and Quantum Mechanics - M. Tinkam.
6. Theory of Errors - J. Topping.
7. Numerical Methods - J.H. Mathews Prentice Hall of India.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	1^{st}		
Name of the Course	Quantum Mechanics		
Course Code	M24-APHY-103		
Course Type	CC-3		
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:** Realize basic quantum-mechanical view point, learn its wave mechanical & matrix formulations, and solve the Schrödinger equation for simple potentials, including harmonic and central potentials. **CLO 103.2:** Construct matrices for observables and wave functions in different representations, apply matrix theory to linear harmonic oscillator, and describe the time-development of a quantum system in Schrödinger, Heisenberg and Interaction pictures. **CLO 103.3:** Calculate the eigenvalues and eigen functions for the orbital and general angular momenta, learn the matrix representation of angular momentum, and perform addition of two angular momenta. **CLO 103.4:** Grasp the concepts of time independent and dependent perturbation theories and their applications; understand the concepts of identity & indistinguishability, symmetric and anti-symmetric wave functions, spin and statistics and Pauli exclusion principle.		
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 of Quantum Mechanics: Recapitulation of basic concepts: Why quantum mechanics? Two-slit experiment with *em* radiation and matter particles, Quantum-mechanical view point, The Schrödinger wave equation, Expectation values, Ehrenfest theorem; Interpretative postulates of quantum mechanics: Dynamical variables as Hermitian operators, Eigenvalues and eigenfunctions, Expansion in eigenfunctions; Illustration of postulates for energy and momentum: Orthonormality of eigenfunctions, Reality of eigenvalues, Closure property, Probability function and expectation value, Co-ordinate and momentum representations of wave function, Uncertainty principle for two arbitrary observables; Problems: A charged particle in a uniform static magnetic field (eigenfunctions and Landau levels); The Hydrogen atom (reduced mass, radial wave functions and energy eigenvalues).	15
II	Matrix formulation of Quantum Mechanics: Preliminaries: Hermitian and unitary matrices, Transformation and diagonalization of matrices, Matrices of infinite rank; Representation of observables and wave functions as matrices, Transformation theory, choice of basis, change of basis, unitary transformations, Hilbert space representation; Dirac's ket and bra notation; Time-development of quantum system: Schrödinger, Heisenberg and Interaction pictures, Link with classical equations of motion, Quantization of a classical system; Application to motion of a particle in an *em* field; Matrix theory of the harmonic oscillator: Spectrum of eigenvalues and eigenfunctions, Matrices for position, momentum and energy operators (energy representation).	15
III	Quantum theory of Angular Momentum: Orbital angular momentum operator **L**, Cartesian and spherical polar co-ordinate representation, Commutation relations, Orbital angular momentum and spatial rotations, Eigenvalues and eigenfunctions of $\mathbf{L}^2$ and L_z, Spherical harmonics; General angular momentum **J**: Eigenvalues and eigenfunctions of $\mathbf{J}^2$ and J_z, Matrix representation of angular momentum operators, Spin angular momentum, Wave function including spin (Spinor); Spin one-half: Spin eigenfunctions, Pauli spin matrices; Addition of two angular momenta, Clebsch-Gordan coefficients and their calculation for $j_1= j_2 =1/2$, $j_1=1$, $j_2 =1/2$ and $j_1= j_2 =1$.	15
IV	Time independent perturbation theory: First order and second order non- degenerate and degenerate perturbation theory. Applications: Zeeman effect without spin, He atom (ground state), Linear Stark effect in hydrogen atom. Time dependent perturbation theory: constant and harmonic perturbations, Golden rule for transition probability, Interaction of single electron atom with electromagnetic field (semi classical treatment only), induced absorption and emission. Identical	15

	particles and spin: indistinguishability of identical particles, symmetry of wave functions, spin and statistics, Pauli exclusion principle.	
	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. Quantum Mechanics (3rd edition) by S. Gasiorowicz
4. Quantum Mechanics (3rd 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 (4rd edition) by Richard L. Liboff
8. Quantum Mechanics: Concepts and Applications (2nd 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. Applied Physics		
Semester	1^{st}		
Name of the Course	Electromagnetic Theory		
Course Code	M24-APHY-104		
Course Type	CC-4		
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 104.1:** Learn electromagnetic waves, wave equation for a conducting media, instantaneous, average and complex Poynting vector. **CLO 104.2:** Study Interaction of fields and matter, and learn the concept of TE and TM waves in rectangular and circular guides, attenuation factor and Q of a wave guide. **CLO 104.3:** Understand the basic concepts of radiation, potential function and the electromagnetic field, network theorems and different types of arrays. **CLO 104.4:** Discuss ionosphere propagation, Effective C and O of ionized gas, Reflection and refraction of waves by the ionosphere; study variations in the ionosphere, attenuation factor for ionosphere propagation.		
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	Electromagnetic waves in a homogeneous medium, Uniform plane waves, Wave equation for a conducting media, Sinusoidal time variations, Conductors and dielectrics, direction cosine of a plane wave, Reflection and refraction of plane waves, surface impedance Poynting Theorem, Instantaneous, average and complex Poynting vector, power loss in a plane conductor.	15
II	Interaction of fields and matter, Equation of motion for charged	15

	particles, Force and motion, Circular motion in a magnetic field, Crossed field motion of charged particle. Frequency response of dielectric materials, TE and TM waves in rectangular and circular guides, attenuation factor and Q of a wave guide.	
III	Radiation, Potential function and the electromagnetic field, The oscillating dipole power radiated by a current element, Short antennas Power radiated by a monopole or half wave dipole, Electromagnetic field close to an antenna. Antenna fundamentals, Network Theorems, Directional properties of dipole antennas, Travelling wave antennas, Two element array. Horizontal patterns in broadcasting arrays. Multiplication of patterns, Effect of earth on vertical patterns, Binomial arrays, Antenna gain and effective area.	15
IV	Ionosopheric propagation, Introduction to ionosphere, Effective C and O of ionized gas, Reflection and refraction of waves by the ionosphere, Variations in the ionosphere, Attenuation factor for ionospheric propagation, Sky wave transmission, Effect of earth's magnetic field, Wave propagation in the ionosphere, Faraday rotation, Other ionospheric phenomenon.	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. Electromagnetic Waves and Radiating Systems (2nd Ed.) - Jordanand Balmain, PHI.
2. Electromagnetics - Kraus, Mc Graw Hill
3. Classical Electromagnetic Theory - Reitz and Millford.
4. Classical Electromagnetic Theory - Phillps and Phnofaky.

Session: 2024-25			
Part A-Introduction			
Name of Programme	M.Sc. Applied Physics		
Semester	1st		
Name of the Course	Electronics-I		
Course Code	M24-APHY-105		
Course Type	CC-5		
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:** Be aware of the network theorems, two-port networks, and equivalent circuits; understand clipping and clamping circuits, junction diodes, Bipolar Junction Transistor, load line and operating point. **CLO 105.2:** Study Principle, Characteristics and applications of JFET, MOSFET, negative resistance devices and transducers. **CLO 105.3:** Gain knowledge of operation and determination of efficiency of power amplifiers. Clearly understand the need of regulation, operation and circuit analysis of different voltage and current regulators; Understand effect of negative feedback on amplifiers. **CLO 105.4:** Gain knowledge of operations of oscillators and Operational Amplifier.		
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	Network Theorems: Kirchhoff's Current and Voltage Law, Maximum Power Transfer Theorem, Node Method, Mesh Method, Miller Theorem, Thevenin's Theorem, Norton's Theorem, Superposition Theorem, Clipping and Clamping circuits, Junction Diodes: Rectifying Diode, V-I Characteristics, Varactor Diode, Light Emitting Diode, Zener Diode. Bipolar Junction Transistor: Basic working Principle (Qualitative), Characteristics, basic configurations. Two port network analysis: active circuit models, equivalent circuit for BJT, analysis of CE, CB, and	15

	CC amplifiers, biasing, operating point, load line, biasing for stabilization of operating point.	
II	JFET and MOSFET: Basic working Principle, Characteristics, Pinch-off Voltage. Unijunction Transistor: Basic Working Principle, Characteristics. Power Control Devices: Four Layer Diode (PNPN), Silicon Controlled Rectifier (SCR), Triac, Diac, Principles and Characteristics and Applications, Transducers: Commonly used Transducers like LDR, Thermistors. Thermocouples, Photodiodes, Photo Transistors, IR Detectors, MVDT, Strain Gauge, Application of Transducers in Temperature, Pressure, Light intensity, Humidity Measurements.	15
III	Power amplifiers: class A large signal amplifier, second and higher order harmonic distortions, the transformer coupled power amplifier, impedance matching, efficiency, push-pull amplifiers, class-B amplifiers, complementary stages, cross over distortions, class-AB operation, heat sinks, derating curve. Electronic voltage regulators: basic operation and analysis of Zener diode voltage regulator, single BJT shunt and series regulators, feedback series BJT regulator and current regulator, overload and short circuit protection circuits. Effect of negative feedback on gain and its stability, distortions, input and output impedances of amplifiers.	15
IV	Oscillators: Barkhausen criteria, phase Shift oscillators, Wien bridge oscillator, tuned oscillator, Hartley and Colpits- oscillators, crystal oscillator. Operational Amplifier: inverting and non-inverting OPAMPs, virtual ground, differential Amplifier, CMRR, the emitter coupled differential amplifier, the transfer characteristics of a differential amplifier, measurements of OPAMP parameters. OPAMP as summing and difference amplifier, comparator, differentiator and integrator and instrumentation amplifier.	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. Electrical Engineering - V. Del. Toro
2. Instrumentation - A.K. Shahni
3. Fundamental of Electronics - J.D. Ryder
4. Network Analysis - Van Valkenburg
5. Integrated Electronics by J. Millman and C. C. Halkias
6. Pulse, digital and switching waveforms by J. Millman and H. Taub
7. Electronic devices and circuits by Y. N. Bapat
8. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick
9. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
10. 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	M.Sc. Applied Physics		
Semester	1st		
Name of the Course	Applied Physics Lab-I		
Course Code	M24-APHY-106		
Course Type	PC-1		
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 106.1:** Determine the strength of α-source and verify nuclear statistics using SSNTD; Find the refractive index of transparent material by measuring Brewester's angle the width of a narrow slit using diffraction phenomenon. **CLO 106.2:** Estimate the efficiency of the G.M. Detector; Measure the mass absorption coefficient using gamma source. **CLO 106.3:** Calculate the Planck's constant using a suitable light source. Find Numerical aperture and attenuation loss using Optical Fiber. **CLO 106.4:** Demonstrate Magnetostriction in metallic rod using Michelson's interferometer.		
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. Solid State Nuclear Track Detector (SSNTD) 2. To find the refractive index of transparent material by measuring Brewester's angle. 3. Estimate the mass absorption coefficient using the G.M. counter. 4. Find the Linear and Mass Attenuation coefficient using gamma source (for Al, Pb and Cu). 5. Determination of Planck's constant using photoelectric cell. 6. To find Numerical Aperture and attenuation loss using Optical Fiber. 7. To study the Magnetostriction in metallic rod using Michelson's interferometer. 8. To find the slit width using Diffraction.	120

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.:	10	
• Mid-Term Exam:	15	

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Modern Physics by Arthur Beiser
2. Elements of Nuclear Physics by W. E. Meyerhof.
3. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy.

Session: 2024-25			
Part A - Introduction			
Subject	Applied Physics		
Semester	1st		
Name of the Course	Seminar		
Course Code	M24-APHY-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)	-----		
Course Learning Outcomes(CLO):	**CLO 107.1:** Achieve effective communication skills and understand the concepts involved in the topic of seminar; acquire skills for working in team and develop confidence for facing audience. **CLO 107.2:** Learn to write effectively a report on a particular topic and know the techniques of responding to the questions posed by audience; Enhance the presentation abilities and improve interpersonal skills.		
Credits	Seminar	Practical	Total
	2	0	2
Contact Hours	2	0	2

Session: 2024-25			
Part A - Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	2nd		
Name of the Course	Atomic and Molecular Physics		
Course Code	M24-APHY-201		
Course Type	CC-6		
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:** Understanding of origination of atomic physics, analysis of spectral lines, change in behavior of atoms in external applied electric and magnetic field on atomic spectral lines, their selection rule. **CLO 201.2:** Construct and Analysis the rotational, vibrational and Raman spectra of molecules, learn the basic principle and instrumentation of IR and Raman spectrometer **CLO 201.3:** Understand electronic energy spectroscopy, its rule, spectral range, application in understanding the characteristic feature molecular and electronic transition, the working and principle of UV-Visible and PL spectroscopy. **CLO 201.4:** Understand the theory and description of the nucleus interaction with external field, effect on their spectrum to understand the molecule, principle and instrumentation of NMR and ESR spectroscopy and formulation used in these spectroscopy.		
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			

<u>Instructions for Paper- Setter:</u> 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	Atomic Physics**:** Qualitative description of H-atom Spectrum, Physical interpretation of quantum numbers, Pauli principle and the building-up principle, Space Quantization: Stern-Gerlach experiment, spectrum of He-atom: its quantum mechanical description and Heisenberg resonance, LS and jj Coupling, Terms for equivalent & non-equivalent electron atom, Branching rule, Normal & anomalous Zeeman effect, Stark Effect, Paschen – Back effect; Intensities of spectral lines: General selection rule; Hyperfine structure of Spectra lines: Isotope effect and effect of Nuclear Spin.	15
II	Molecular Physics: Rotation of molecules: Classification of molecules, Interaction of radiation with rotating molecules, Rotational spectra of rigid diatomic molecules, Isotope effect in rotational spectra, Intensity of rotational lines, Non rigid rotator, Information derived from rotational spectra; Infrared spectroscopy: The vibrating diatomic molecule, The diatomic vibrating-rotator spectra of diatomic molecules, Infrared spectrophotometer; Raman Spectroscopy: Introduction, Pure rotational Raman spectra, Vibrational Raman Spectra, Nuclear Spin and intensity alternation in Raman spectra, Isotope effect, Raman Spectrometer.	15
III	Electronic Spectra of diatomic molecules and Fluorescence spectroscopy: Born Oppenheimer approximation, Vibrational coarse structure of electronic bands, Progression and sequences, Intensity of electronic bands-Frank Condon Principle, Dissociation and pre-dissociation, Dissociation energy; Rotational fine structure of electronic bands, The Fortratparabole, Electronic structure of diatomic molecules; UV-Visible Absorption spectroscopy, Lambert-Beer law, Absorption spectrometer, Fluorescence spectroscopy: Fluorescence and Phosphorescence, Kasha's rule, Quantum Yield, Non-radiative transition, Jablonski Diagram, Spectrofluorometer, Time resolved fluorescence and determination of excited state lifetime.	15
IV	Resonance Spectroscopy: NMR: Basic principles, Classical and quantum mechanical description, Bloch equations, Spin-spin and spin-lattice relaxation times, Chemical shift, isotropy and anisotropy in chemical shift and coupling constant, NMR spectrometer, Experimental methods – Single coil and double coil methods, High resolution methods; ESR: Basic principles, ESR spectrometer, nuclear interaction and hyperfine structure, relaxation effects, g-factor, Characteristics, Free radical studies and biological applications.	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. Applied Physics		
Semester	2nd		
Name of the Course	Laser Physics		
Course Code	M24-APHY-202		
Course Type	CC-7		
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 202.1:** Understand laser, homogenous and inhomogenous broadening, Induced transition, Einstein Coefficients, Origin of the line shape function, Shape and width of the spectral lines and Spiking behaviour of lasers. **CLO 202.2:** Obtain Laser rate equation, Fabry Perot Laser, Oscillations frequency, Three and Four levels Lasers, Power in laser Oscillation and understand the theory of Curved Mirror Oscillator. **CLO 202.3:** Understand Laser Systems: Ruby Laser, Nd $^{3+}$: YAG Laser. He-Ne Laser, N_2-Laser, CO_2 Laser, Ar^+ Laser, Excimer Laser, Semiconductor junction Laser and Organic-Dye Lasers, Free electron Laser and X-Ray Lasers. **CLO 202.4:** Study Spatial Frequency Filtering, Holography, Laser induced Fusion, Light wave communications, Fundamental Characteristics of High energy density beams, oscillating Laser Beam. Applications of Laser, Stimulated Raman's Scattering and Self Focussing of Optical beams, Harmonic Generation, Second harmonic generation and Phase matching.		
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	Introduction to laser, Spontaneous transitions between atomic levels - Homogenous and Inhomogenous broadening, Induced transition, Absorption and Amplification. Einstein Coefficient, significance of Einstein coefficients. Active material, population inversion, Laser medium, Pumping. Properties of laser – Coherence, Spatial coherence, Temporal coherence, Directionality, Monochromaticity, Focusability. Origin of the line shape function, Shape and width of the spectral lines, Spiking behaviour of the lasers.	15
II	Laser rate equation, Fabry Perot Laser, Oscillations frequency, Three and Four levels Lasers, Power in laser Oscillation and Mode Locking. Q- switched lasers. Curved Mirror Oscillator Theory: Optical Resonator with Spherical Mirrors, Mode stability criteria, Modes in generalised resonator, Resonance Frequencies of Optical resonators.	15
III	Laser System and Applications: Ruby Laser, Nd^{3+}: YAG Laser. He-Ne Laser, N_2-Laser, CO_2 Laser, Ar^+ Laser, Excimer Laser, Semiconductor junction Laser and Organic-Dye Lasers, Free electron Laser and X-Ray Lasers.	15
IV	Spatial Frequency Filtering, Holography, Laser induced Fusion, Light wave communications, Lasers in Isotope Separation. Fundamental Characteristics of High energy density beams in materials processing. An oscillating Laser Beam. Hardfacing using a CW Laser. Applications of Laser Technology: Drilling, Cutting, Welding, Engraving, Stimulated Raman's Scattering and Self Focussing of Optical beams. Harmonic Generation, Second harmonic generation, Phase matching.	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. Laser and Optical Engineering - P. Das, Narosa Publication.
2. Lasers and Nonlinear Optics - B. B. Land.
3. Optical Electronics – A. Ghatak and K. Thyagarayan.
4. Introduction to Optical Electronics - A. Yariv, Holt, Rinehart andWinston.

<table>
<tr><td colspan="4">Session: 2024-25</td></tr>
<tr><td colspan="4">Part A - Introduction</td></tr>
<tr><td>Name of Programme</td><td colspan="3">M. Sc. Applied Physics</td></tr>
<tr><td>Semester</td><td colspan="3">2nd</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Nuclear and Particle Physics</td></tr>
<tr><td>Course Code</td><td colspan="3">M24-APHY-203</td></tr>
<tr><td>Course Type</td><td colspan="3">CC-8</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 (CLOs)
After completing this course, the learner will be able to:</td><td colspan="3">CLO 203.:1 Understand the energy loss processes of different energetic particles in a medium and mechanisms of interaction of gamma photon with matter and Learn about the basic properties and characteristics of Nuclear forces, and their mediating particle.
CLO 203.:2 Know and learn about various type of detectors used in nuclear physics experiments, unique properties of different detectors and their applications in the field of nuclear physics and Differentiate between different type of nuclear reactions, relevant aspects associated with nuclear reactions and kinematics of such reactions.
CLO 203.:3 Describe certain properties associated with nuclei, models governing different aspects of nuclear behaviour and detailed understanding of deuteron problem and understand the phenomenon of radioactive decays of alpha and beta particles, their detailed formalism.
CLO 203.:4 Know about different elementary particles, their quark content and quark model and Learn about decay of some elementary particles and laws governing such decays.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>4</td><td>0</td><td>4</td></tr>
<tr><td>Teaching Hours per week</td><td>4</td><td>0</td><td>4</td></tr>
<tr><td>Internal Assessment Marks</td><td>30</td><td>0</td><td>30</td></tr>
<tr><td>End Term Exam Marks</td><td>70</td><td>0</td><td>70</td></tr>
<tr><td>Max. Marks</td><td>100</td><td>0</td><td>100</td></tr>
<tr><td>Examination Time</td><td>3 hours</td><td></td><td></td></tr>
</table>

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	Radiation Interaction and Nuclear Forces: Interaction of Charged Particles with Matter: qualitative description of various energy loss mechanisms, their relative contribution in case of heavy ions and electrons, classical stopping power equation for electronic energy-loss (no derivation) with significance of various terms involved, behavior of electronic energy-loss curve as a function of ion velocity, concept of energy straggling and range straggling and their correlation; Interaction of Gamma Radiation with Matter: features of photoelectric, Compton and pair production processes, Nuclear Forces: experimental evidence of charge symmetry and charge independence of nuclear forces, concept of isospin, Meson theory of nuclear forces, relationship between the range of the force and mass of the mediating particle.	15
II	Radiation Detectors and Nuclear Reactions**:** Gamma Ray Spectrometer: basic principle and working of NaI (Tl) scintillation detector, mechanism of pulse formation, basic idea of pulse processing unit, concept of energy resolution and efficiency of detector and its applications; Semiconductor Detectors: basic principle, construction and working and applications of Si surface barrier detector, high purity germanium detector. Nuclear Reactions: types of nuclear reactions, Q-value of a nuclear reaction and its determination, definition of cross section and its significance, elementary idea of compound nuclear reactions and direct reactions. Concept of neutron detection, Coulomb excitation, nuclear kinematics.	15
III	Nuclear Properties and Radioactive Decays: Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model, Deuteron problem; Ground state of deuteron, Magnetic moment and its importance in the determination of exact ground state of deuteron. Radioactive Decays: energetics of alpha decay, tunnel theory of alpha decay, energetics of beta decay, Fermi theory of allowed beta decay, importance of Fermi-Kurie plot, parity non-conserving property of neutrino;	15
IV	Particle Physics: Units in high energy physics; Classification of particles-fermions and bosons, particles and antiparticles; Strange particles, Basic idea of different fundamental types of interactions with suitable examples; Quark flavors and their quantum numbers, Quarks as constituents of Hadrons, Qualitative idea of Quark confinement and asymptotic freedom, necessity of introducing the Color quantum no., Quark model, decay of pion and muon, Gell-Mann Nishijima formula, conservation laws.	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. Applied Physics		
Semester	2^{nd}		
Name of the Course	Solid State Physics		
Course Code	M24-APHY-204		
Course Type	CC-9		
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 204.1:** Analyze the structure of a crystalline solid in terms of lattice, basis and unit cell, and of a non-crystalline solid on the basis of pair-distribution function and deduce the structure of a crystalline solid from the XRD pattern. **CLO 204.2:** Calculate the dispersion of lattice waves for crystals with mono- and diatomic basis, and acquire an understanding of phonon and use it to determine the lattice heat capacity in the Einstein and Debye models. **CLO 204.3:** Learn the Bloch's theorem, solve the KP model & one-electron Schrödinger equation for a periodic potential, classify materials into conductors, semiconductors and insulators, and apply the tight binding & Wigner-Seitz methods for calculation of energy bands. **CLO 204.4:** Grasp main characteristics of superconductors, along with qualitative aspects of the BCS theory, explain flux quantization in a superconducting ring, and the DC & AC Josephson effects.		
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	Crystal Structure: Recapitulation of basic concepts: Bravais lattice and Primitive vectors; Primitive, Conventional and Wigner-Seitz unit cells; Crystal structures and lattices with bases; Symmetry operations and fundamental types of lattices; Index system for crystal planes. Determination of crystal structure by X-ray diffraction: Reciprocal lattice and Brillouin zones (examples of *sc*, *bcc* and *fcc* lattices); Bragg and Laue formulations of X-ray diffraction by a crystal and their equivalence; Laue equations; Ewald construction; Brillouin interpretation; Crystal and atomic structure factors; Structure factor of the *bcc* and *fcc* lattices, Examples of NaCl and diamond; Experimental methods of structure analysis: Types of probe beam, The Laue, rotating crystal and powder methods. Non-crystalline solids: Diffraction pattern; Monatomic amorphous materials; Pair-distribution function.	15
II	Lattice dynamics and thermal properties: Binding in solids: Crystals of inert gases, Van der Waals-London interaction, Repulsive interaction, Lennard-Jones potential, Equilibrium lattice constants, Cohesive energy; Qualitative idea of Ionic, Covalent and Metallic binding. Classical theory of lattice vibration (in harmonic approximation): Vibrations of crystals with monatomic basis- Dispersion relation, First Brillouin zone, Group velocity; Two atoms per primitive basis- dispersion of acoustical and optical modes. Quantization of lattice waves: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons. Thermal properties: Lattice (phonon) heat capacity; Normal modes; Density of states in one and three dimensions; Models of Debye and Einstein, Debye T^3 law; Effects due to anharmonic crystal interactions; Thermal expansion; Thermal conductivity.	15
III	Electronic properties of solids: Sommerfeld’s free electron gas model, Density of states, Fermi sphere, Fermi and ground-state energy; Difficulties with the free electron gas model; Band theory of solids: Nearly free electron model, Origin and magnitude of the energy gap; Periodic potential and Bloch's theorem; Kronig-Penney model; Wave equation of electron in a periodic potential, Central equation, Crystal momentum of electron, Solution of the central equation, Approximate solution at and near a zone boundary; Periodic, extended and reduced zone schemes of energy band representation; Number of orbitals in a band; Classification into metals, semiconductors and insulators. Calculation of energy bands: Tight binding method and its application to *sc*, *bcc* and *bcc* structures; Wigner-Seitz method, Cohesive energy; Pseudo-potential methods (qualitative idea).	15
IV	Superconductivity: Experimental survey: Superconductivity and its occurrence, Destruction of superconductivity by magnetic fields, Meissner effect, Type I and type II superconductors, Entropy, Free energy, Heat capacity, Energy gap, Microwave and infrared properties, Isotope effect; Theoretical survey: Thermodynamics of the superconducting	15

	transition, London equation, London penetration depth, Coherence length; Microscopic theory: Qualitative features of the BCS theory, BCS ground state wave function; Quantitative predictions of the BCS theory, critical temperature, energy gap, critical field, specific heat; Flux quantization in a superconducting ring, duration of persistent currents; Dc and Ac Josephson effects; Macroscopic long-range quantum interference; High T_c superconductors (introduction only).	
	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 (7th 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 (2nd 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. Applied Physics		
Semester	2nd		
Name of the Course	Electronics-II		
Course Code	M24-APHY-205		
Course Type	CC-10		
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 205.1:** Grasp the basics of number system, Boolean algebra and logic gates. **CLO 205.2:** Design and describe the operations of various families of logic gates. Simplify involved Boolean expressions with the help of Boolean algebra and K-map. **CLO 205.3:** Understanding of Combinational and Sequential Circuits. **CLO 205.4:** Design and describe the IC fabrication along with the knowledge of clean rooms.		
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	Number Systems: Introduction to Decimal, Binary, Octal, Hexadecimal Number Systems, BCD Codes, Inter conversions of Decimal, Binary and BCD Numbers, Parity. Excess-3, Grey and Johnson Codes, 1's Complement, 2's compliments. Logic Gates, Boolean Algebra and their Applications: Positive and Negative Logic. Different Logic Gates such as AND, OR, NOT, NAND, NOR, EX-OR, Boolean Axioms D'Morgan's Theorems: Statement, Verification and Applications.	15
II	Modified DTL gates, fan-in and fan-out, wired logics, high threshold logic (HTL) gates, transistor- transistor logic (TTL) gates, output stages	15

	for TTL gates, resistance-transistor logic (RTL) gates, direct coupled transistor logic (DCTL) gates, emitter coupled logic (ECL) gates, digital MOSFET circuits, complementary MOS (CMOS) logic gates, comparison of logic families, Karnaugh- map (K-map) up to four variable and its applications. Half Adder, Full Adder, Half Subtractor, Full Subtractor.	
III	Combinational and Sequential Circuits: Multiplexer, Demultiplexer, Encoders, Decoders, Flip Flops (RS, JK, MS-JK, D, T), Shift Registers, asynchrous and synchrous Counters, Semiconductor Memories: ROM, RAM, EPROM.	15
IV	Monolithic IC technology, BJT fabrication, PNP transistor, multi-emitter Schottky transistor, super beta transistor fabrication, fabrication of FET/NMOS enhancement as well as depletion transistors, fabrication of CMOS devices, monolithic diodes, IC resistors and capacitors, clean rooms & their classifications.	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 CC Halkias
2. Theory and Application of Micro Electronics by SK Gandhi.
3. Micro Electronics by J Millman & A Grabel.
4. Digital Computer Electronics by AP Malvino.
5. Device Electronics for Integrated Circuits by RS Muller and TI Kamins.

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc. Applied Physics		
Semester	2nd		
Name of the Course	Applied Physics Lab-II		
Course Code	M24-APHY-206		
Course Type	PC-2		
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:** Design and understand the operations of JFET & MOSFET; Determine Young's modulus in Solids by piezo electric effect. **CLO 206.2:** Study the Hall's effect and determine the Hall's Coefficient; describe thermoluminesence. **CLO 206.3:** Explain amplitude and frequency Modulation and demodulation; verify truth tables of the basic logic gates. **CLO 206.4:** Determine the Curie temperature and study the dielectric Constant of piezo electric material; Study the Clipping and Clamping circuits.		
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 characteristics of JFET & MOSFET. 2. To determine Young's modulus in Solids by piezo electric effect. 3. To study the Hall's effect and determine the Hall's Coefficient. 4. Thermoluminesence experiment. 5. To study the amplitude and frequency Modulation and demodulation. 6. To verify the Boolian Identities using Logic Gates. 7. To determine the Curie temperature and study the dielectric Constant of piezo electric material. 8. To study the clipping and clamping circuits.	120

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.:	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. Materials Science and Engineering: An Introduction **by** William D. Callister Jr. and David G. Rethwisch.
3. Introduction to Solid State Physics (7^{th} edition) by Charles Kittel
4. Modern Physics by Arthur Beiser.
5. Pulse, digital and switching waveforms by J. Millman and H. Taub

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	M24-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 1.1:** Learn the different Constitutional Values, Fundamental rights and duties enshrined in the India Constitution. **CLO 1.2:** Understand humanism, human virtues and values, and idea of International peace. **CLO 1.3:** 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 1.4:** 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 PrivateLimited.
14. Palekar, Subhas, *How to practice Natural Farming*, Pracheen (Vaidik) KrishiTantraShodh, 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., SantoshAjmera, *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, Shubhamet. 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*, Cyclewala Productions.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	3^{rd}		
Name of the Course	Microwave Devices		
Course Code	M24-APHY-301		
Course Type	CC-11		
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:** Describe the propagation of *em* waves through different media and learn about the concept of total internal reflection. **CLO 301.2:** Understand the concept of rectangular and coaxial waveguides and learn the concept of transmission lines. **CLO 301.3:** Understand the basic concepts of Klystron operation and microwave switching devices. **CLO 301.4:** Understand the basics of microwave generation using various types of electronic diodes and learn about controlling various microwave parameters.		
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	Wave equation and boundary conditions, Plane monochromatic wave in non-conducting media, Reflection and refraction at the boundary of two non-conducting media, oblique Incidence, reflection from a conducting plane, total internal reflection propagation between parallel conducting plane.	15
II	Wave-guides, Rectangular and Coaxial wave guides, Resonant cavities, Qof a cavity resonator. Transmission lines: Transmission lines equation and solutions, Quarter and Half wavelength lines, Impedance matching	15

	using Smith chart.	
III	Klystron-operation, velocity modulation, bunching, output power, beam loading, Reflex Kylstron-operation velocity modulation, power output. Travelling wave tube, Backward wave amplifier and oscillator. Microwave switching devices - Krytron.	15
IV	Transferred Electron devices, Gunn effect diode-operation, Modes of operation. Microwave generation, amplification, LSA, InP and CdTe diodes Avalanche Transit time Devices, (ATD) READ diode, IMPATT diode, TRAPATT diode, BARITT diode. Detector diodes and mounts, measurements of wavelengths, frequency, impedance, power scattering parameters, Theory and property of scattering parameters, directionalcouplers, Faraday rotation in ferrites.	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. Foundations of Electromagnetic theory - J.R. Reitz and Milford,Addition Wesley.
2. Microwave Devices and Circuits - Samuel Y. Liao. PHI Pvt. Ltd.
3. Electronic Communication - Roody and Coolen.
4. Electronic Communication - George Kennedy

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	3rd		
Name of the Course	Radiation Physics		
Course Code	M24-APHY-302		
Course Type	CC-12		
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 302.1:** Have an in depth understanding about radiation and their sources and will be able to work out the parameters of the radiations and analyze minimum permissible levels for safe handling of radiations. **CLO 302.2:** Elucidate the impact of radiation on biological ecosystems and learn to apply the understanding on management and safe disposal of radiation waste. **CLO 302.3:** Will be able to understand the medicinal applications of radiations in various diagnostic instruments such as X-ray, CAT scan, ultra sound, Positron emission tomography etc. **CLO 302.4:** Understand various methods of radiation dose measurements such as ionization chamber, TL, SSNTD, ESR dosimeter and apply them to elucidate and optimize the radiation dose for practical 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	Radiation and need for its measurement, physical features of radiation, conventional sources of radiation, exposure to natural radiation: external to the body, radiation from cosmic rays and solar radiation,	15

	internal exposure to the body, radioactivity arising from technological development: possible health hazards from nuclear and laser radiations. Maximum permissible level of radiation, concept of energy flux, energy fluence, cross-section, linear energy transfer, specific energy and absorbed dose, relative effectiveness of radiation, dose equivalent.	
II	Biological effects of radiation: dose - response characteristics, direct and indirect action, acute effects, delayed effects, cumulative effect, accidental exposure, radiation induced chemical changes in tissues, radiation protection procedures (diagnostics and therapy). Basic radiation safety criteria, protection from direct radiation, energy deposition, effect of distance and shielding, protection from contamination, preparation of a safe radiation area, Radioactive waste disposal and management: type of radioactive waste, airborne waste, solid and liquid waste, assessment of hazard.	15
III	Basic Principles of patient monitoring and diagnostic using radiation and isotopes, principles of radiation therapy. Physics of diagnostic X-rays, production and absorption of X-rays, X-ray imaging, X-ray fluoroscopy. Computerized Axial Tomography (CAT), ultrasound scanning, ultrasound picture of the body, ultrasound to measure motion, physiological effects of ultrasound in therapy, electrocardiography (ECG), Pacemakers, gamma camera, position emission tomography (PET), magnet resonance imaging (MRI).	15
IV	Basic features of radiation dose measurements, brief introduction and principles of ionization chamber, generation of charge, ionization and exposure, electron equilibrium. Thermo luminescence (TL): principles and methods, basic concepts, TL emission process, characteristic of TL, glow curves and spectra of TL. Solid state nuclear track detector (SSNTD), track processing methods, chemical track etching, track dyeing, track decoration, etch track evolution, plastic detectors. ESR dosimeter: basic principle and applications.	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 Health Physics - Herman Cember, Pergamon Press.
2. Introduction to Radiation Protection - Martiz and Harbinsor, JohnWilley and Sons.
3. Medical Physics - J.R. Cameron, and J.G. Skotronick, John Wiley y& Sons.
4. Introduction to Radiobiology and Radiation Dosimetery - F. H. Aurix, John Wiley.
5. Techniques of Radiation Dosimetery - Editors K. Mahesh and D. R. Vij Wiley Eastern Limited.
6. Nuclear Energy - Raymond L. Murray, Pergamon Press, N.Y.

Session: 2024-25			
Part A–Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	3rd		
Name of the Course	Material Science-I		
Course Code	M24-APHY-303		
Course Type	DEC-1		
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 303.1:** 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 303.2:** Understand strengthening and grasp the importance of various strengthening mechanisms and describe various parameters involved in elastic deformation, plastic deformation, anelastic deformation etc. **CLO 303.3:** Grasp the concept of phase diagrams and be able to predict microstructures and understand transformation mechanisms (nucleation and growth, martensitic) and comprehend Iron-Carbon system and ceramics. .**CLO 303.4:** Elucidate the kinematics of elastic collisions and have in depth understanding energetic ion beam based techniques for analysis of materials and perform computations of depth profiles and concentration analysis using these techniques, choose the most appropriate technique for characterization.		
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	Imperfections in Solids: Point Defects: vacancy, substitutional, interstitial, Frenkel and Schottky defects, equilibrium concentration of Frenkel and Schottky defects; Line Defects: slip planes and slip directions, edge and screw dislocations, Burger's vector, cross-slip, glide and climb, jogs, dislocation energy, super & partial dislocations, dislocation multiplication, Frank Read sources; Planar Defects: grain boundaries and twin interfaces; Dislocation Theory – experimental observation of dislocation, dislocations in FCC, HCP and BCC lattice.	15
II	Mechanical Properties: Stress Strain Curve; Elastic Deformation: atomic mechanism of elastic deformation and anisotropy of Young's modulus, elastic deformation of an isotropic material; Anelastic and Viscous deformation; Plastic Deformation: Schmid's law, critically resolved shear stress; Strengthening Mechanisms: work hardening, recovery, recrystallization, strengthening from grain boundaries, low angle grain boundaries. Yield point. Strain aging, solid solution strengthening, two phase aggregates, strengthening from fine particles; Fracture: ideal fracture stress, brittle fracture-Griffith's theory, ductile fracture.	15
III	Microstructure: Solid Solutions and Intermediate Phases: phase rule, unitary & binary phase diagrams, Lever rule, Hume-Rothery rule; Free Energy and Equilibrium Phase Diagrams: complete solid miscibility, partial solid miscibility-eutectic, peritectic and eutectoid reactions, eutectaid mixture; Nucleation, Growth and Overall Transformation Kinetics; Martenstic Transformation; The Iron-Carbon System: various phases, phase diagram, phase transformations, microstructure and property changes in iron-carbon system; Ceramics: glass transition temperature, glassformers, commercial ceramics, mechanical properties, high temperature properties.	15
IV	Materials Processing and Characterization: Ion Implantation: introduction, ion implantation process, depth profile, radiation damage and annealing effects of trace-impurities, implantation induced alloying and structural phase transformation; Rutherford back scattering Spectrometry (RBS): principle, kinematics of elastic collision, shape of the backscattering spectrum, depth profiles and concentration analysis, applications; Elastic Recoil Detection Analysis (ERDA): basic principle, kinematics, concentration analysis, depth profiling, depth resolution, applications; Secondary Ion Mass Spectroscopy (SIMS): basic principle, working, yield of secondary ions and applications.	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 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. Applied Physics		
Semester	3rd		
Name of the Course	Non Destructive Testing		
Course Code	M24-APHY-304		
Course Type	DEC-1		
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:** Understand the basic concepts of liquid penetrant methodology and relate it to various industrial applications. **CLO 304.2:** Grasp the importance of sound waves and ultrasonic waves and its applications in multiple disciplines. **CLO 304.3:** Understand and explore various advanced non destructive techniques such as thermometry, holography and their applications in industry. **CLO 304.4:** Understand the concept of eddy currents and its applications in various sensing devices.		
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	Liquid Penetrant Testing**:** Principles, types and properties of liquid penetrants – developers, advantages and limitations of various methods, Preparation of test materials – Application of penetrants to parts, removal of surface penetrants, post cleaning selection of penetrant method, solvent removal, water washable, Post emulsifiable, Units and lighting for penetrant testing - dye penetrant process.	15
II	Ultrasonic Testing: Nature of sound waves, wave propagation - modes of sound wave generation, Various methods of ultrasonic wave generation, Piezo electric effect, Piezoelectric materials and their properties, Principle of pulse echo method, through transmission method, resonance	15

	method - Advantages, limitations - contact testing, immersion testing, couplants - Data presentation A, B and C scan displays - Time of Flight Diffraction (TOFD).	
III	Advanced NDT: Thermography: Contact and non contact inspection methods, Heat sensitive paints and other coatings, Heat sensitive papers Advantages and limitation, Instrumentations and methods, applications. Optical holography: recording and reconstruction, holographic interferometry, real-time, double-exposure & time-averaged techniques, holographic NDT – methods of stressing and fringe analysis. Acoustical Holography: Liquid Surface Acoustical Holography: Optical System, Reconstruction.	15
IV	Eddy Current**:** Generation of eddy currents, effect of created fields, effect of change of impedance on instrumentation, properties of eddy currents, eddy current sensing elements, probes, type of arrangement - a) absolute b) differential lift off, operation, applications, advantages, limitations, Through encircling or around coils, type of arrangements a)absolute b) differential fill factor, operation, application, advantages, limitations.	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. American Metals Society, Non-Destructive Examination and Quality Control, Metals Hand Book, Vol.17, 9th edition, Metals Park, OH (1989).
2. Ultrasonic Testing of Materials, 3rd edition by Krautkramer, Josef and Hebert Krautkramer, New York, Springer-Verlag (1983).
3. Industrial Radiography by R. Halmshaw, Applied Science Publishers Inc., Englewood, NJ (1982).

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	3rd		
Name of the Course	Thin Films and Vacuum Techniques		
Course Code	M24-APHY-305		
Course Type	DEC-2		
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:** Understand various methods of thin film deposition using various evaporation techniques such as thermal evaporation, flash evaporation etc. **CLO 305.2:** Understand the concept of sputtering and various methodologies to have a deep insight of sputtering and will be able to learn methods of measurement of thickness of thin films. **CLO 305.3:** Understand the basic concepts of vacuum technologies and apply it to vacuum gauges. **CLO 305.4:** Identify the characteristics of material for vacuum application and apply the vacuum technology in various devices and industries.		
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	Thin film deposition processes : Introduction to thin film deposition technology, Thermal evaporation methods : Resistive heating – thermal evaporation sources, multiple component evaporation, Sublimation, Flash evaporation, Arc evaporation, Exploding wire technique, Laser evaporation, RF heating Electron bombardment heating.	15
II	Cathodic sputtering yields. Glow - Discharge sputtering, pressure, deposite distribution Current and Voltage dependence, Cathode	15

	contamination problem, Deposition control, Ion Beam Sputtering Reactive Sputtering, Electro deposition, chemical vapor deposition (CVD) - Thermal decomposition, Hydrogen reduction, Halide dispropartionation, Transfer reaction, polymerization. Techniques for the measurement of thin film thickness.	
III	Theories of gas flow, basic principles and process for production of vacuum, Construction and working of rotary, Absorption, Diffusion, Cryogenic, Turbo molecular, Getter and Ion pumps, Measurement of vacuum - Principle of vacuum gauges for different vacuum ranges up to UHV, Leak detection.	15
IV	Materials for vacuum system and their characteristics, Vacuum system and their applications in Microelectronics, Optical, Instrumentation, Packaging, Drying, Impregnation, Metallurgy, Space, Pharmaceutical and cryogenic industries.	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. Thin Film Phenomena - Kasturi L. Chopra, McGraw Hill Book Company.
2. Hand Book of Thin Film Technology - Leon
3. Handbook of Analytical Instrumentation - R.S. Khandpur
4. Vacuum Science and Technology - A. Roth.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	3rd		
Name of the Course	Microprocessors		
Course Code	M24-APHY-306		
Course Type	DEC-2		
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 basic structure of a digital computer and apply it to understand the bus architecture of a microprocessor. **CLO 306.2:** Understand the concept of I/O mapping in 8085 microprocessor and relate to its application in synchronous and asynchronous applications. **CLO 306.3:** Understand various other types of microprocessors such as 8255, 8253, 8259A etc. **CLO 306.4:** Understand the internal architecture of 8086 microprocessor and its 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	Basic components of a digital computer – CPU-ALU – Timing and control unit Memory – Bus architecture – I/O devices – 8085 Microprocessor architecture, Various registers, stacks.	15
II	8085 addressing modes – instruction set – Instruction cycle – Timing diagram –subroutines, programming examples Memory and I/O interfacing, memory mapped I/O, I/O mapped I/O schemes, Data transfer schemes, Interrupt structure in 8085 – Hardware and software interrupt, I/O Ports – DMA principles, Serial I/O: Basic concepts, Asynchronous and synchronous communication.	15
III	Programmable Peripheral interfacing(PPI) – 8255, pins and signals,	15

	operation, interfacing, Programmable 8253 Timer/Counter, Programmable Interrupt controller (PIC), 8259A, Programmable 8237 DMA controller – Special purpose Interfacing devices.	
IV	8086 Internal Architecture – Addressing modes, bus cycles – bus controller, 8086 Instruction set, programming examples – 8086 interrupts – Protected mode operation, Virtual memory, multitasking – Special features and overviews of 80286, 80386, 80486, Pentium, and Pentium-IV processors.	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. Vacuum Science and Technology - A. Roth. . R.S. Gaonkar, Microprocessor Architecture: Programming and Applications, 3rd edition, Penram International Publishing India (1997).
2. B. Ram, Fundamentals of Microprocessors and Microcomputers, 5th edition, Dhanpat Rai publication, India (2001).
3. Yu Cheng Liu and G.A. Gibson, Microprocessor Systems: The 8086 /8088 Family: Architecture, Programming and Design, Prentice Hall of India (1994).
4. B.B. Brey, The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80486 Pentium and Pentium Pro Processor – Architecture, Programming and Interfacing, 4th edition, Prentice Hall of India.
5. N. Mathivanan, Microprocessors: PC Hardware and Interfacing, Prentice Hall of India (2005).

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	3rd		
Name of the Course	Surface Modification and Characterization Techniques		
Course Code	M24-APHY-307		
Course Type	DEC-3		
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 307.1:** Have an in depth understanding energetic ion beam based techniques for analysis of materials and perform computations of depth profiles and concentration analysis using these techniques and understand how these can affect engineering properties and limit their use in service. **CLO 307.2:** Elucidate the kinematics of elastic collisions and strengthening the importance of various scattering mechanisms and describe various parameters involved in these mechanisms in spectroscopy. **CLO 307.3:** Understand the basic concepts of electron spectroscopy and , choose the most appropriate technique for characterization **CLO 307.4:** Understand various other spectroscopic techniques and learn to apply them in material identification and characterization.		
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	Ion Implantation: Introduction, Ion implantation process, Basic Features of an ion implanter, Radiation Damage and Ion Ranges, Channeled ion ranges, Ion beam mixing, microstructure of irradiated	15

	surfaces, change in mechanical, electrical and optical properties of metals and semiconductor materials due to ion irradiation.	
II	Rutherford back scattering spectrometery (RBS): Principle, Kinematics of elastic collision, Scattering crosssection and impact parameter, The energy width in backscattering, Shape of the backscattering spectrum, Depth Profiles with Rutherford Scattering, Electron energy loss spectroscopy (EELS): Principle, Spectrum yield, Influence of thin film morphology on electron attenuation, Layer by layerattenuation, single layer plus islanding. Atomic Force Microscope (AFM): Basic principle, Tip and cantilever, Tapping mode operation, Some typical applications of AFM.	15
III	Low energy electron diffraction (LEED): Principle, Schematic of lowenergy electron diffraction, Leed pattern applications, Glancing angle X-ray diffraction (GXRD), Basic concept, Seeman - Bohlin X-ray diffractometer, instrumentation and applications Scanning electron Microscope (SEM): Principle, Instrumentation, Electron optics, Magnification, Application, Transmission Electron Microscopy (TEM): Principle, Instrumentation and Applications Scanning Tunneling Microscope (STM): Principle, Sample scanner, computer interface.	15
IV	Aüger Electron spectroscopy (AES): Principle, Nomenclature, Schematic of the energy level, Instrumentation, Aüger spectrometer, Scanning Auger Microprobe (SAM). Composition analysis, Detection limits, Application of AES in study of ion irradiated samples, depth profile. X-ray photoelectron spectroscopy (XPS) or ESCA: Principle, Photoemission process, Schematic of the energy level, Instrumentation, Experimental consideration, Electron multiplier, Photoelectron energy spectrum, Chemical shift, Oxidation state, Quantitative analysis and Applications. Secondary Ion mass Spectroscopy (SIMS): Basic principle, instrumentation, working and applications.	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. Ion Implantation by G. Dearnally 2. Ion implantation technology by J. W. Mayers 3. Fundamentals of surface and thin film analysis - Leonard C,Feldman and James W. Mayer, North Holland. 4. Instrumental Methods of Analysis - Willard et al CBS Publishers. 5. Methods of Surface Analysis - Technique and application. 6. Principles of Instrumental Analysis, Douglas A Skoog et al. Saunders Golden Sunbrust series. 7. Electron spectroscopy: Theory, techniques and application - C. R. Brundee and A.D. Baker eds. Academic Press.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	3rd		
Name of the Course	Material Characterization Techniques		
Course Code	M24-APHY-308		
Course Type	DEC-3		
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 308.1:** Grasp the concept of epitaxy and its types and applications in thin film deposition. **CLO 308.2:** Understand the basics of thermometry and understand its applications to fabricate various types of thermometers. **CLO 308.3:** Grasp the concept and working of XRF and its practical applications in modern day nuclear/material research. **CLO 308.4:** Understand and elucidate mass spectroscopy and its applications in material characterization.		
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	Thin film deposition techniques: Radio frequency and magnetron Sputtering, CVD reaction types, PECVD, LECVD, MOCVD, HTCVD, Introduction to Epitaxy, lattice misfit, epitaxy of compound semiconductors, Applications of epitaxy: Optical communications, Light emitting semiconductor devices (e.g. GaN), Molecular beam epitaxy (MBE), Liquid Phase epitaxy (LPE), Vapour phase epitaxy (VPE), Langmuir Blodgett films, Spray method: Spray Hydrolysis, Spray pyrolysis, Ion Implantation techniques.	15
II	Principles of Cryo-cooling and Thermometry: Cooling techniques, Liquifaction of gases, Closed cycle refrigerators, sample helium bath	15

	cryostats, Dilution refrigerators, Pomeranchuk cooling, adiabatic demagnetization, nuclear spin demagnetization. Primary thermometers, 3He melting curve Thermometer, Superconducting fixed-point Thermometers, Nuclear- Orientation Thermometers. Secondary Thermometers: Resistance Thermometers, Thermoelectric Elements, Magnetic Thermometers, Nuclear Spin Resonance Thermometers.	
III	Low and high resolution mass spectrometry, Chromatography-mass spectrometry, Tandem mass spectrometry, Gas chromatography, Liquid chromatography, Ion chromatography, gel permeation chromatography. Atomic absorption spectroscopy, emission spectrographic analysis, flame emission spectrometry, inductively coupled argon plasma emission spectroscopy, neutron activation analysis.	15
IV	SAXS and SANS (small angle X-ray and neutron scattering, spectroscopy, synchrotron X-ray sources, SEM/EPMA (scanning electron microscopy, electron probe microanalysis) Scanning Auger microscopy(AES), SIMS (Secondary ion mass spectrometry), Ultraviolet and Bremsstrahlung isochromat spectroscopy, Angular dependent X-ray photoelectron spectroscopy. Low energy electron diffraction (LEED), Reflection high energy electron diffraction (RHEED), Electron energy loss spectroscopy (EELS), Surface Scanning tunneling microscopy (STM), Atomic-force microscopy (AFM).	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. Handbook of thin film technology by L.I. Maissel and R. Glang (McGraw-Hill).
2. The Materials Science of thin films by Milton Ohring (Academic press).
3. Thin Film Phenomena by K. L. Chopra (McGraw-Hill).
4. Surface Science: An Introduction By K. Oura, V.G. Lifshitz, A. A. Saranin, A. V. Zotov and M. Katayama, Springer-Verlag, 2003.
5. Materials characterization and chemical analysis by John P. Sibilia.
6. Preparation of thin films by Joy George.
7. Low Temperature Physics: Christian Enns and Siegfried Hunklinger, Springer-Berlag Berlin Heidelberg (2005).
8. Matter and Methods at low Temperature (3rd edition): Frank Pobell, Springer-Verlag Berlin Heidelberg (2007).

Session: 2024-25

Part A - Introduction

Name of the Programme	M.Sc. Applied Physics		
Semester	3rd		
Name of the Course	Physics Lab-III		
Course Code	M24-PHY-309		
Course Type	PC-3		
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 309.1:** Draw and understand the frequency response of different Filter circuits in high pass, low pass and band pass configurations. **CLO 309.2:** Draw and understand electron spin resonance and hysteresis curve. **CLO 309.3:** Design and understand the operations of DIAC & TRIAC, differentiating and integrating circuits. **CLO 309.4:** Understand and use gamma ray spectrometer and GM counter for simple nuclear experiments.		
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 DIAC and TRIAC. 2. To study low pass, high pass and band pass filters. 3. To study Hysteresis curve & determination of retentivity and coercivity of ferromagnetic materials. 4. To record gamma ray spectrum of Cs^{137} and Co^{60} and to find energy calibration and resolution of scintillation Spectrometer. 5. To study clipping and clamping circuit. 6. To study Differentiating and Integrating circuits using OPAMP. 7. To study the stabilized A.C. power supply. **8.** To determine Beta & gamma efficiency of G.M counter.	120

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.:	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.
9. Solid state Physics by C. Kittle.

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc. Applied Physics		
Semester	3rd		
Name of the Course	Elements of Nano Science and Nano Technology		
Course Code	M24-OEC-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 1**: Understand the basics of nanoscience. **CLO 2**: Describe the various techniques to fabricate nanostructure. **CLO 3**: Comprehend the principles and working of characterization tools for analyses of nanostructure. **CLO 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	Introduction to Nanomaterials: Bottom up and Top Down approach, Classification of nanostructures: Zero dimension, one dimension and two dimensional nanostructures, Smart materials.	7
II	Nanostructure fabrication by Physical Methods: Physical Vapor deposition: evaporation, Molecular beam epitaxy, sputtering, comparison of evaporation and sputtering, Lithography: Photolithography, Electron Beam Lithography, X-ray lithography.	8
III	Structural characterization: X-ray diffraction, small angle X-ray scattering, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy, Spectroscopic Techniques: UV-Visible Spectroscopy, Photo-luminescence spectroscopy, Infra-red spectroscopy, Raman Spectroscopy	8
IV	Physical properties of nanomaterials: Melting points and lattice constants, Mechanical properties, Optical properties, Electrical conductivity, Superparamagnetism.	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. Applied Physics		
Semester	4^{th}		
Name of the Course	Computational Physics		
Course Code	M24-APHY-401		
Course Type	CC-13		
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 401.1:** Understand the working of Python programming language and will be able to implement the learning into code writing. **CLO 401.2:** Understand different type of errors, their propagation, and to minimize errors while writing a program. **CLO 401.3:** Solve numerical problems involving addition, subtraction of matrices and finding out eigenvalues and eigenvectors of matrices. **CLO 401.4:** Understand and solve problems involving numerical differentiation and integration using programming in Python.		
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	Programming in Python : Introduction to Python, Python interpretor, importing mudules, data types, vectors, matrices, and multidimensional arrays, symbolic computing, plotting and visualization, equation solving, data input and output, looping conditions, defining functions, data fitting, arithmetic operations, Boolean arrays and conditional expressions, debugging.	15
II	Errors: Round off error, Truncation error, Machine error and propagation of error. Solution of algebraic equations: Bisection method, Iteration method,	15

	Newton-Raphson method. Interpolation and extrapolation: Finite differences, Forward differences and Backward differences.	
III	Matrix addition, subtraction and multiplication, trace and normalization of matrix, inverse of matrix. Solutions of simultaneous linear algebraic equation: Gauss elimination method, Gauss-Jordon elimination method. Matrix eigen values and eigenvectors.	15
IV	Differentiation: Taylor series method, Numerical differentiation using Newton's forward difference formula, backward difference formula Integration: Trapezoidal rule, Simpson's 1/3 rule and 3/8 rule, Gaussian quadrature, Legendre - Gauss quadrature.	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. Numerical Methods – C Balachandra Rao and C K Santha.
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. Numerical Python by Robert Johnson.
6. Numerical Computational Methods by P.B. Patil and U.P. Verma.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	4th		
Name of the Course	Fiber Optics		
Course Code	M24-APHY-402		
Course Type	CC-14		
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 402.1:** Explain the principle of optical fibers, their various types & fabrication techniques and comprehend its applications in communication of light signals. **CLO 402.2:** Understand different types of optical fibers and learn various techniques of fabrication of optical fibers and fiber cables. **CLO 402.3:** Understand and comprehend various parameters related to measurement of optical fibers. **CLO 402.4:** Apply the understanding of optical fibers in communication 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	Introduction to optical fibers: Importance, An Idea about generations of Telephone System and optical fibers. Propagation of light in optical fibers, propagation of light in an optical fiber, basic structure and optical path of an optical fiber, acceptance angle and acceptance cone, numerical aperture, modes of propagation, meridional and skew rays, number of modes and cut off parameters of fibers, single mode propagation, comparison of step and graded index fibers.	15

II	Classification of optical fibers: stepped-index fiber, mono mode fiber, disadvantage of mono mode fiber, graded index multi mode fiber. Fiber fabrication techniques: Outside vapor phase oxidation, vapor phase axial deposition, modified chemical vapor deposition. Fiber cables: fiber cable construction, strength member, cable tensile loading, minimum bend radius, losses incurred during installation of cables or during subscriber service, testing of cables, cable selection criteria.	15
III	Measurement of optical fibers: measurement of numerical aperture and its related terms, measurement of fiber attenuation, loss measurement of each mode, scattering losses measurement, measurement of dispersion losses, measurement of refractive index, cut off wavelength measurement, measurement of dispersion together with cut off wavelength, macro bending loss measurement, measurement of mode field diameter, near field scanning technique, indirect method, transverse offset technique, variable aperture technique.	15
IV	Optical fiber communication systems : transmitter for fiber optic communication - high performance transmitter circuit, LED analog transmitter, comparison between analog and digital transmitter, laser transmitter, digital laser transmitter, analog laser transmitter, analog laser transmitter with A/D conversion and digital multiplexing, Transmitter design, bit stuffing: fiber optic receiver, a high performance receiver, repeaters, fiber based modems, trans receiver.	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. Optical fiber communication (2^{nd} edition) -Gerd Keiser,McGraw Hill, Inc. New York.
2. Optical fibers and fiber optic communication systems - S. Sarkar.
3. Opto Electronics (2nd edition) - J. Wilson, J.F.B. Hawkes, Prentice Hall of India, New Delhi.

Session: 2024-25			
Part A–Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	4^{th}		
Name of the Course	Material Science-II		
Course Code	M24-APHY-403		
Course Type	DEC-4		
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 403.1:** Comprehend various tests (Tension test, hardness tests, Impact test, fatigue test, creep test) used for measuring the mechanical properties of materials and Realize the difference between strength and hardness of materials. Compute various strength and ductility measures from engineering stress-strain curve and true stress-strain curves. **CLO 403.2:** 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 403.3:** Elucidate the physics describing dielectrics and ferroelectric materials, with focus on the functionality and Describe the optical properties of insulators **CLO 403.4:** Understanding of the surface and concepts of salvage depth and Grasp the concept, working and applications of different electron and photon based surface analysis techniques.		
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	**Material Testing:** The Tension Test: engineering stress-strain curve, true stress-strain curve, instability in tension, Considere's construction, ductility measurement, effect of strain rate on flow properties, strain rate sensitivity; notch tensile test; The Hardness Test: Brinell hardness, Meyer hardness, Vicker's hardness number and test, Rockwell hardness test, Knoop hardness number and test; The Impact Test: brittle fracture problem, notched bar impact tests-Carpy and Izod Impact tests; The Fatigue Test: fatigue failures, stress cycles, the S-N curve, fatigue limit; The Creep Test: creep curve, primary, secondary and tertiary creep, effect of temperature and stress on the creep curve.	15
II	**Magnetic Materials:** Magnetic Processes: Larmor frequency; Diamagnetism, magnetic susceptibility, Langevin's diamagnetism equation; Paramagnetism, Curie constant, density of states curves for a metal; Ferromagnetism, Curie temperature, Curie-Weiss law, exchange interactions, domain structure; Antiferromagnetism and magnetic susceptibility of an antiferromagnetic material; Ferrimagnetism and Ferrites; Paramagnetic, ferromagnetic and cyclotron-resonance.	15
III	**Dielectric, Optical and Ferroelectric Materials:** Introduction, Energy bands, dielectric constant, complex permittivity, dielectric loss factor, polarization, mechanism of polarization, classification of dielectrics-frequency dependence of dielectric constant; Optical Phenomena in Insulators Colour of crystals - Excitons - weakly bound and tightly bound excitons. Colour centers – F-centers and other electronic centers in alkali halides. Ferroelectrics: General characteristics - piezoelectric, pyroelectric and ferroelectric materials. Classification of ferroelectrics and representative materials. Ferroelectric domains. Polarization catastrophe, Landau theory of first and second-order phase transitions, antiferroelectric materials .	15
IV	**Solid Surfaces and Analysis:** Surface and its importance, selvedge depths of surface; Methods of Surface Analysis: Auger Electron spectroscopy (AES)- basic principle, methodology, composition analysis and depth profiling; X-ray photoelectron spectroscopy (XPS) or ESCA: principle, methodology and quantitative analysis; Glancing angle X-ray Diffraction (GXRD), basic concept, methodology and structural analysis; Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM): Principle, methodology and Applications in surface analysis; Atomic Force Microscopy (AFM): Basic principle, Methodology, applications in structural analysis.	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

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	4^{th}		
Name of the Course	Sensors and Transducers		
Course Code	M24-APHY-404		
Course Type	DEC-4		
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 404.1:** Grasp main characteristics of mechanical and electrochemical sensors and their types and properties. **CLO 404.2:** Understand the basic principle of thermal sensors and their types, properties and applications. **CLO 404.3:** Understand the basic concepts of magnetic sensors and their applications. **CLO 404.4:** Grasp the basic properties of radiation based sensors and nanosensors.		
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	Mechanical and Electromechanical Sensors: Introduction to sensors, classification: static and dynamic, characteristics, characterization: mechanical and electromechanical sensors, resistive potentiometer, strain gauge-inductive sensors, capacitative sensors, ultrasonic sensors.	15
II	Thermal Sensors: Gas thermometric sensors, thermal expansion type, Acoustic, dielectric constant and refractive index thermosensors, Helium low temperature thermometer-nuclear thermometer, magnetic thermometer, resistance change type, thermo emf-junction, semiconductor type, thermal radiation sensors, quartz crystal thermoelectric sensors.	15
III	Magnetic Sensors: principles behind Yoke coil, coaxial type and force	15

	and displacement sensors, magneto resistive sensors, Hall effect sensors inductance and eddy current sensors, angular/rotary movement transducers, Electromagnetic flow meter-switching magnetic sensors-SQUID sensors.	
IV	Radiation Sensors**:** basic characteristics, types of photo sensistors/ photo detectors and nuclear radiation sensors, fiber optic sensors. smart sensors, applications of sensors: introduction, primary sensors, excitation amplification, filters, converters-data communication, standards for smart sensor interface, film sensors, MEMS sensors, nano sensors, applications of sensors.	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. D. Patranabis, Sensors and Transducers, 2nd edition, Prentice-Hall of India (2005).
2. M.J. Usher, Sensors and Transducers, Macmillan, London (1985).

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	4^{th}		
Name of the Course	Communication Systems		
Course Code	M24-APHY-405		
Course Type	DEC-5		
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:** Explain the principle of pulse communication and comprehend its applications in digital communication systems. **CLO 405.2:** Understand response of filters and their usage in binary and digital modulation systems. **CLO 405.3:** Gain a fair understanding of the error coding and noise control in communication. **CLO 405.4:** Understand the necessary circuitry of digital modulation techniques and Radars and apply the understanding in practical applications such as SSR and TV 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	Pulse Communication - PAM, PWM, PPM, PCM and applications, digital communication (characteristic of data transmission circuit), model of communication system, analysis and design of communication system, classification of signals and systems.	15
II	System response and filters, spectral analysis of modulation and demodulation operations, random signal theory, information and channel capacity, base band data transmission - base band binary PAM system, modulation schemes - Binary ASK, PSK, FSK schemes, comparison of digital modulation schemes.	15

<table>
<tr><td>III</td><td colspan="3">Error control coding, methods of controlling errors. Facsimile - introduction, transmission and reception. Satellite Communication - introduction, orbits, station keeping, satellite altitude, transmission path, path losses, noise consideration.</td><td colspan="2">15</td></tr>
<tr><td>IV</td><td colspan="3">Point to point communication: telephone networks, automatic exchange switching systems, introduction to computer based communication - ISDN (integrated Service Digital Network), LAN (Local Area Network).

Basic RADAR concept: R ADAR system, Primary radar, secondary surveillance radar (SSR), introduction to TV systems and standards.</td><td colspan="2">15</td></tr>
<tr><td colspan="4" align="right">Total Contact Hours</td><td colspan="2">60</td></tr>
<tr><td colspan="6" align="center">Suggested Evaluation Methods</td></tr>
<tr><td colspan="3" align="center">Internal Assessment: 30</td><td colspan="3" align="center">End Term Examination: 70</td></tr>
<tr><td colspan="2">➢ Theory</td><td>30</td><td colspan="2">➢ Theory:</td><td>70</td></tr>
<tr><td colspan="2">• Class Participation:</td><td>5</td><td colspan="3" rowspan="3" align="center">Written Examination</td></tr>
<tr><td colspan="2">• Seminar/presentation/assignment/quiz/class test etc.:</td><td>10</td></tr>
<tr><td colspan="2">• Mid-Term Exam:</td><td>15</td></tr>
<tr><td colspan="6" align="center">Part C-Learning Resources</td></tr>
<tr><td colspan="6">Recommended Books/e-resources/LMS:
1. Foundations of Electromagnetic theory - J.R. Reiz and Milford, Addition Wesley.
2. Microwave Devices and Circuits - Samuel Y. Liao, PHI Pvt. Ltd.
3. Electronic Communications - Roody and Coolon.
4. Electronic Communication - George Kennedy.
5. Digital and Analog Communication System - K. Sam Shanmugan,John Wiley and Sons 1994.
6. Electronic Engineers Reference Book - FF Mazda (Sixth Ed.),Butter Worth International.</td></tr>
</table>

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	4^{th}		
Name of the Course	Digital Signal and Image Processing		
Course Code	M24-APHY-406		
Course Type	DEC-5		
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 406.1:** Explain the principle of basic digital filters and comprehend their applications in digital signal processing. **CLO 406.2:** Gain a fair understanding of the filter design techniques and apply it various FFT filters design. **CLO 406.3:** Understand the underlying principle and working of eye and its significance as a signal processing device. **CLO 406.4:** Understand the basic concepts of image processing and enhancement.		
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

<u>Instructions for Paper- Setter:</u> 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	Discrete Time Signal and Systems: discrete-time signals, sequences, linear shift invariant systems, stability and causality, linear constant co-efficient difference equations, frequency-domain, representation of discrete-time systems and signals – representation of discrete-time signals by Fourier transform. Basic Digital filter structures - FIR and IIR filters.	15
II	Filter design techniques and fast Fourier transform**:** design of FIR filters by window method, rectangle – Hanning, Hamming – Kaiser – IIR filters design, bilinear transformation – discrete Fourier transform, computation of DFT- decimation in time, FFT and frequency. Introduction to optimal filters.	15

III	Continuous and digital image characterization: image representation 2D-systems, 2DFourier transform, Light perception, eye physiology, visual phenomena – monochrome, vision model – 2D Image sampling & reconstruction – image sampling systems – Aliasing effects, image reconstruction systems – vector-space image representation – image Quantization – monochrome.	15
IV	Linear image processing and image enhancement**:** generalized 2D linear operator, superposition, convolution, unitary transformations, Fourier Transform, Cosine Transformation, image enhancement, contrast manipulation – histogram modification, noise cleaning, edge crispening.	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. William K. Pratt, Digital Image Processing, 3rd edition, John Wiley & Sons, Inc., USA (2001).
2. Alan V. Oppenheim and Ronald W. Schafer, Digital Signal Processing, New Delhi (2000).
3. L. R. Rabiner and B. Gold, Theory and Applications of Digital Signal Processing, Prentice Hall of India.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	4^{th}		
Name of the Course	Nuclear Techniques		
Course Code	M24-APHY-407		
Course Type	DEC-6		
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 407.1:** Grasp the concept and working of different ion accelerators used in modern day nuclear/material research. **CLO 407.2:** Understand the basics of charged particle induced spectroscopy and apply them in various fields such as archeology, biology, etc. **CLO 407.3:** Grasp the concept and working of XRF and its practical applications in modern day nuclear/material research. **CLO 407.4:** Understand the basics of NAA and its applications in various fields.		
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	Basic principle, working and applications of Van-de-Graff, Tandom and Pelletron accelerators. Cyclotron, focusing in cyclotrons, relativistic limitation, variable energy cyclotron, Microtron. Betatron: induction of acceleration machine, electron synchroton, proton synchrotron. Medical application of accelerators, mega volt therapy.	15
II	Charged particle induced X-ray emission (PIXE) spectrometry: basic principle, X-ray production process, radiative and non-radiative	15

	transitions, Coster Krönig transitions, continuous background, Bremsstrahlung, PIXE set-up, instrumentation, beam preparation, collimation, beam current measurement. Qualitative analysis: energy calibration, comparison with standard. quantitative analysis : Absolute method, relative method, relationship between X-ray intensities and concentrations, limits of detection, accuracy of analysis, application of PIXE in air and water pollution industry, archaeology, biology, and earth science, external beam PIXE, micro beam PIXE, proton microprobe, micro beam applications.	
III	X-rays fluorescence spectrometry: nature and origin of X-rays, characteristic X-ray, notation for spectrum, continuous spectra, Duane - Hunt Law, relationship between X-ray emission and atomic number, sources of X-rays: X-ray tube, function and requirements, radioisotope source. XRF spectrometer, wave length dispersive devices, energy dispersive devices, pulse height selection. Data analysis identification of the peaks, equation for concentration of elements, matrix effects, absorption - enhancement effect, detection limits. Application of XRF in various fields, advantages and disadvantage of XRF.	15
IV	Neutron Activation Analysis (NAA): introduction, theory of activation method, neutron energy distribution, classification of neutron activation methods: prompt gamma-ray neutron activation, delay gamma-ray neutron activation. Radiochemical and instrumental NAA, kinetics of activation. Experimental considerations in activation methods: irradiation conditions, measurements of radioactivity, methods of standardization, classic relative method, analysis of the gamma spectra, applications of NAA for semiconductor materials, soil science, geological science, accuracy and sensitivity of NAA.	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. Instrumental methods of Analysis - Hobart H. Willard, et al. VIITH ed. CBS Publishers.
2. Handbook of Analytical Instrumentation – R S Khandpur.
3. Principles of Instrumental Analysis - Douglas A Skoog et al. Saunders Golden Sunbrust series.

4. Particle Induced X-ray Emission spectroscopy - Sven A. E. Johnson et al., John Willey and Sons, N.Y.
5. Principles and Practice of X-ray spectroscopy - Eugene P. Bertin Plenum Press.
6. An Introduction to X-ray Spectrometer, R. JenKins, Heydon London Publication.
7. Neutron Activation Analysis - D. De Soete et al. Johan Wiley and Sons N.Y.
8. Activation Analysis: Vol. I and II - Z.B. Alfarsi CRC Press.

Session: 2024-25			
Part A– Introduction			
Name of Programme	M. Sc. Applied Physics		
Semester	4th		
Name of the Course	Instrumentation		
Course Code	M24-APHY-408		
Course Type	DEC-6		
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 408.1:** Have an in depth understanding errors involved in the measurements and analyze the goodness of a fit. **CLO 408.2:** Elucidate the principle and working of optical devices such as monochromators, spectrophometers, etc. **CLO 408.3:** Understand the basic principle of devices based on magnetic fields and their applications. **CLO 408.4:** Understand various instruments to produce high and low temperatures as desired for specific 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	Errors in observations and treatment of experimental data – estimation of errors – theory of errors and distribution laws – least squares method: curve fitting, statistical assessment of goodness of fit.	14
II	Optical mono chromators, filters and spectrophotometers for UV, visible and infrared. Measurement of reflectivity, absorption and fluorescence. Radiation detectors: pyroelectric, ferroelectric, thermoelectric, photo conducting, photoelectric and photomultiplier, scintillation types of detectors, circuits, sensitivity and spectral response, photon counters.	16
III	Magnetic resonance techniques: NOR, ESR, NMR, ENDOR – principles and schematic working systems – measurement of high and low	16

	electrical resistivity – d.c. and a.c. four probe technique – Impedance considerations and accuracy – signal processing and signal averaging – Time domain measurements box car integrator – computer data processing, programming languages	
IV	Production and measurement of low temperatures – design of cryostats – high temperature, furnaces: resistance, induction and arc furnaces – measurement of high temperatures.	14
	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.S. Rangan, G.R. Sharma and V.S.V. Mani, Instrumentation Devices and Systems, Tata McGraw-Hill (1983).
2. H.H. Willard, L.L. Merrit and John A. Dean, Instrumental Methods of Analysis, 6thedition, CBS Publishers & Distributors (1986).
3. Barry E. Jones, Instrumentation Measurement and Feedback, Tata McGraw-Hill (1978).
4. J.F. Rabek, Experimental Methods in Photochemistry and Photophysics, Parts 1 and 2, John Wiley (1982).
5. R.A. Dunlap, Experimental Physics: Modern Methods, Oxford University Press (1988).
6. N.C. Barford, Experimental Results: Precision, Error and Truth, John Wiley, 2nd edition (1985).
7. D. Malacara (ed), Methods of Experimental Physics, Series of Volumes, Academic Press Inc. (1988).

Session: 2024-25			
Part A - Introduction			
Name of the Programme	M.Sc. Applied Physics		
Semester	4th		
Name of the Course	Physics Lab-IV		
Course Code	M24-PHY-409		
Course Type	PC-4		
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 409.1:** Develop Python programs to evaluate definite integrals by employing Simpson methods, apply Python programming to solve problems based on Newton Raphson and Trapezoidal methods. **CLO 409.2:** Construct Python program to find Eigenvalues of a square matrix, roots of an equation of using bisection method and curve fitting through least square method. **CLO 409.3:** Acquaintance of hands on training through various workshops. **CLO 409.4:** Explore their understanding of the concepts through a project.		
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

In this course, students will complete total eight experiments in a semester as per allotment by the teacher incharge of the Laboratory. 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) computer programming, (ii) report and analysis of the workshop practice and (iii) student project.

	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. Program for finding Eigen values of square matrices. 2. Program for finding roots of an equation using Bisection method. 3. Numerical Integration using Simpson 1/3 method. 4. Numerical Integration using Simpson 3/8 method. 5. Program for least square fitting for finding slope, intercept of a straight line. 6. Solution of simultaneous linear equations by gauss elimination	120

	method. 7. Numerical Integration by Trapezoidal method. **8.** Program to evaluate the roots of equations by Newton Raphson Method.	

Suggested Evaluation Methods			
Internal Assessment: 30		**End Term Examination: 70**	
• Class Participation:	5	Practical(includes experiment, lab record, viva-voce)	30
• Seminar/Demonstration/Viva-voce/Lab records etc.:	10	Workshop (viva- voce)	20
• Mid-Term Exam:	15	Project (demonstration and viva- voce)	20

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Numerical Methods – C Balachandra Rao and C K Santha.
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. Numerical Python by Robert Johnson.
6. Numerical Computational Methods by P.B. Patil and U.P. Verma.

Employability and Entrepreneurship Skills Course (EEC) with 2 Credits (2 Theory +0 Practical)

<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. Applied Physics</td></tr>
<tr><td>Semester</td><td colspan="3">4th</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Space Science and Sensors</td></tr>
<tr><td>Course Code</td><td colspan="3">M24-APHY-410</td></tr>
<tr><td>Course Type</td><td colspan="3">EEC</td></tr>
<tr><td>Level of the course (As per Annexure-I</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>Course Learning Outcomes (CLO)
After completing this course, the learner will be able to:</td><td colspan="3">CLO 410.1: Understanding of Astronomical model, basic principles involved, remote sensing, GIS.
CLO 410.2: Understand the fundamentals of the astronomical gravity, Sun, Earth Moon atmosphere and basics of tidal forces.
CLO 410.3: Understand the thermodynamics of star, stellar, and able to calculate mass of white dwarf.
CLO 410.4: Understand the basics of different sensors used in space science and principal behind them.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>2</td><td>0</td><td>2</td></tr>
<tr><td>Teaching Hours per week</td><td>2</td><td>0</td><td>2</td></tr>
<tr><td>Internal Assessment Marks</td><td>15</td><td>0</td><td>15</td></tr>
<tr><td>End Term Exam Marks</td><td>35</td><td>0</td><td>35</td></tr>
<tr><td>Max. Marks</td><td>50</td><td>0</td><td>50</td></tr>
<tr><td>Examination Time</td><td>3 hours</td><td></td><td></td></tr>
</table>

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 formation, solar atmosphere –chromosphere and corona; Thermonuclear	7

	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 fro 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 (WorldScientific, 2005)
10. The Physical Universe, Frank Shu (University Science Books, 1982)
11. Cosmology: The Science of the Universe, Edward Harrison (Cambridge UniversityPress, 2000)
12. From Black Clouds to Black Holes, J. V. Narlikar (World Scientific, 1985)
13. Archeoastronomy- 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. Microsensors: Principles and Applications, J. W. Gardner (John Wiley, 1994)
17. Sensor Technology and Devices, L. R. Ristic (Artech House publishers, 1994)