Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science and Commerce, Baramati

(Autonomous)

M.Sc. Degree Program in Physics

(Faculty of Science & Technology)

CBCS Syllabus

M.Sc. Part – I (Physics) Semester – II

For Department of Physics

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Choice Based Credit System Syllabus (2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2023-2024

PREAMBLE

Physics, a core discipline, is the fundamental and foremost to all natural sciences. It has been significant and influential through advances in its understanding that have translated into new technologies. Physics interact with the society and other discipline such as Medicine, Chemistry, Agriculture, Engineering etc. in many important ways. Physics department in Tuljaram Chaturchand College has highly qualified faculty members and support staffs and is committed towards the development of innovative and handy ways of teaching at graduate, post graduate and developing a core research group for carrying out cutting edge research in various research fields like Condensed Matter Physics, Solid State Physics, Electronics, Theoretical Physics, Atomic & Molecular Physics and Nuclear Physics. The department also offers Doctoral Programme in order to nurture young minds towards embracing various scientific challenges. Extra care is taken to pay individual attention to the students in their laboratory work and tutorial sessions. Project work and problem sessions are encouraged to develop innovative and analytical approach to physics learning.

Programme Outcomes (POs)

PO1	**Disciplinary Knowledge:** Demonstrate comprehensive knowledge of the discipline that forms a part of a postgraduate Programme. Execute strong theoretical and practical understanding generated from the specific Programme in the area of work.
PO2	**Critical Thinking and Problem solving:** Exhibit the skill of critical thinking and understand scientific texts and place scientific statements and themes in contexts and also evaluate them in terms of generic conventions. Identify the problem by observing the situation closely, take actions and apply lateral thinking and analytical skills to design the solutions.
PO3	**Social competence:** Exhibit thoughts and ideas effectively in writing and orally; communicate with others using appropriate media, build effective interactive and presenting skills to meet global competencies. Elicit views of others, present complex information in a clear and concise way and help reach conclusions in group settings.
PO4	**Research-related skills and Scientific temper :** Infer scientific literature, build a sense of enquiry and able to formulate, test, Analyse, interpret and establish hypothesis and research questions; and to identify and consult relevant sources to find answers. Plan and write a research paper/project while emphasizing on academics and research ethics, scientific conduct and creating awareness about intellectual property rights and issues of plagiarism.
PO5	**Trans-disciplinary knowledge:** Create new conceptual, theoretical and methodological understanding that integrates and transcends beyond discipline-specific approaches to address a common problem.
PO6	**Personal and professional competence:** Perform independently and also collaboratively as a part of a team to meet defined objectives and carry out work across interdisciplinary fields. Execute interpersonal relationships, self-motivation and adaptability skills and commit to professional ethics.
PO7	**Effective Citizenship and Ethics:** Demonstrate empathetic social concern and equity centered national development, and ability to act with an informed awareness of moral and ethical issues and commit to professional ethics and responsibility.
PO8	**Environment and Sustainability:** Understand the impact of the scientific solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
PO9	**Self-directed and Life-long learning:** Acquire the ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Credit Distribution Structure for M.Sc. Part-I (Physics)

Level	Sem. (2 Yr.)	Major		Research Methodology (RM)	OJT/ FP	RP	Cum. Cr.	Degree
		Mandatory	**Electives**					
6.0	Sem-I	PHY-501-MJM: Mathematical Methods in Physics (Credit 04)	PHY-511-MJE: A. Classical Mechanics B. Electronics C. Physics of Thin Films-I (Credit 04)	PHY-521-RM Research Methodology (Credit 04)	--	--	20	PG Diploma (after 3 Year Degree)
		PHY-502-MJM: Classical Electrodynamics (Credit 04)						
		PHY-503-MJM: Physics Laboratory-I (Credit 02)						
		PHY-504-MJM: Physics Laboratory-II (Credit 02)						
	Sem- II	PHY-551-MJM: Atoms, Molecules and Laser (Credit 04)	PHY-561-MJE: A. Physics of Semiconductor Devices B. Biophysics C. Physics of Thin Films-II (Credit 04)	--	PHY-581-OJT/FP Credit 04	--	20	
		PHY-552-MJM: Quantum Mechanics (Credit 04)						
		PHY-553-MJM: Physics Laboratory-III (Credit 02)						
		PHY-554-MJM: Physics Laboratory-IV (Credit 02)						

Course Structure for M.Sc. Part-I (Physics) (2023 Pattern)

Sem	Course Type	Course Code	Course Name	Theory/ Practical	No. of Credits
I	Major (Mandatory)	PHY-501-MJM	Mathematical Methods in Physics	Theory	4
	Major (Mandatory)	PHY-502-MJM	Classical Electrodynamics	Theory	4
	Major (Mandatory)	PHY-503-MJM	Physics Laboratory-I	Practical	2
	Major (Mandatory)	PHY-504-MJM	Physics Laboratory-II	Practical	2
	Major (Elective)	PHY-511-MJE (A)	Classical Mechanics	Theory	4
		PHY-511-MJE (B)	Electronics	Theory	
		PHY-511-MJE (C)	Physics of Thin Films-I	Theory	
	Research Methodology (RM)	PHY-521-RM	Research Methodology	Theory	4
			Total Credit Semester-I		**20**
II	Major (Mandatory)	PHY-551-MJM	Atoms, Molecules and Laser	Theory	4
	Major (Mandatory)	PHY-552-MJM	Quantum Mechanics	Theory	4
	Major (Mandatory)	PHY-553-MJM	Physics Laboratory-III	Practical	2
	Major (Mandatory)	PHY-554-MJM	Physics Laboratory-IV	Practical	2
	Major (Elective)	PHY-561-MJE (A)	Physics of Semiconductor Devices	Theory	4
		PHY-561-MJE (B)	Biophysics	Theory	
		PHY-561-MJE (C)	Physics of Thin Films-II	Theory	
	On Job Training (OJT)/Field Project	PHY-581-OJT/FP	On Job Training Field Project	Training/ Project	4
				Total Credit Semester-II	**20**
				Cumulative Credits Semester I and II	**40**

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I Physics

(w. e. from June, 2023)

Name of the Programme	: M.Sc. Physics
Program Code	: **PSPH**
Class	: **M.Sc. I**
Semester	: **II**
Course Type	: Major Mandatory Theory
Course Name	: **Atoms, Molecules and Laser**
Course Code	: **PHY-551-MJM**
No. of Lectures	: **60**
No. of Credits	: **4**

PHY-551-MJM: ATOMS, MOLECULES AND LASER

Course Objectives:

1. At the end of this course, the student should be able to know about detail structure of atoms and molecules and their energy levels.
2. At the end of this session, the student should be able to know the rotational and vibrational spectra of the molecules.
3. At the end of this session, the student should be able to know different types of quantum numbers associated with vector atom model.
4. At the end of this session, the student should be able to know Zeeman, Paschen and Stark effect.
5. At the end of this session, the student should be able to know characteristics of Laser, Einstein coefficients, possibility of amplification and different types of lasers.

Course Outcomes: After completion of the course, the student should be able to:

CO1: Understand the concept of atomic spectra and their origin, spectral line, fine and hyperfine structure, Zeeman, Paschen and Stark effect.
CO2: To understand different types of coupling schemes, metastable state, types of pumping and different applications of laser.
CO3: Understand the principle of ESR, NMR and concept of Frank Condon principle.
CO4: Understand the working principle and applications of different types of lasers.
CO5: Study the basic principles of lasers, including population inversion, stimulated emission, and the concept of gain.
CO6: Understand different types of lasers and their applications in various fields.
CO7: Demonstrate qualitative problem – solving skills in all the topics covered.

Topics and Learning Points

Unit 1: Atoms **(15 L)**

Introduction to atom, Atomic structure and spectra, quantum states of an electron in an atom [Pauli's Exclusion principle and electronic configuration, electron spin, Hund's rule of maximum multiplicity], Coupling scheme, origin of spectral lines, spectrum of He and alkali atoms, fine and hyperfine structure, Zeeman and Paschen effect selection rule, Stark effect.

Unit 2: Molecules **(15 L)**

Bonding mechanism in molecules, Molecular orbital methods, valence band method, Molecular Spectra – Rotational and vibrational spectra for diatomic molecules, Electronic spectra of diatomic molecules, vibrational analysis of band system, Frank-Condon principle, Dissociation energy, rotational fine structure of electronic vibration transitions, problem solving.

Unit 3: Resonance Spectroscopy **(15 L)**

(a) ESR - Principles of ESR, ESR spectrometer, hyperfine structure.

(b) NMR-Magnetic properties of nucleus, resonance condition, NMR instrumentation, relaxation process, chemical shift, applications of NMR.

Unit 4: Lasers and Its Applications **(15 L)**

Introduction, Basics of LASERs (Absorption, Spontaneous and Stimulated emission, population inversion), metastable state, types of pumping, Gain, Einstein's coefficient, threshold condition, Different types of lasers, He-Ne laser, CO_2 laser, Nd-YAG, Ruby, Excimer laser, Dye laser, semiconductor laser, Applications of lasers: 1.Industrial applications- Cutting, moulding, melting, welding, drilling, 2. Medical applications- Skin therapy, laser eye surgery, 3. Holography- Principle and construction

Problem solving

Reference Books:

1. Molecular structure and spectroscopy, G. Aruldhas
2. Fundamentals of molecular spectroscopy, Collin N, Banwell &Elaine M.
3. Atomic and molecular Physics, J.B. Rajam
4. Principles of Laser and their applications, Rhods
5. An introduction to laser theory and application, M.N. Avdhanulu
6. Lasers, A.G. Sigman, Oxford University Press 1986.

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**
CO 1	3								
CO 2	2								
CO 3			2	2		2			
CO 4			2				2		
CO 5				3		2			
CO 6		3			2				
CO7					1		2		

Justification

PO1: Disciplinary Knowledge

CO1: Understand the concept of atomic spectra and their origin, spectral line, fine and hyperfine structure, Zeeman, Paschen and Stark effect.

Disciplinary knowledge is directly aligned with understanding and applying fundamental concepts like atomic spectra and their origin, spectral line, fine and hyperfine structure, Zeeman, Paschen and Stark effect.

CO2: To understand different types of coupling schemes, metastable state, types of pumping and different applications of laser. Weightage: 2

Program Outcome 1 emphasizes the importance of acquiring in-depth knowledge about coupling schemes, metastable states, types of pumping, and applications of lasers. This knowledge provides a solid foundation for students to understand and contribute to the field of laser physics and technology.

PO2: Critical Thinking and Problem Solving

CO6: Demonstrate quantitative problem-solving skills in all the topics covered. Weightage: 3

Critical thinking and problem-solving skills are essential in physics, making this a strong relationship.

PO3: Social Competence

CO3: Understand the principle of ESR, NMR and concept of Frank Condon principle.

Weightage: 2

CO4: Understand the working principle and applications of different types of lasers.

social competence is justified in the context of CO3 and CO4 by highlighting the collaborative nature of research, the interdisciplinary aspects of understanding complex principles, and the practical applications of the acquired knowledge. The weightage of 2 further emphasizes the critical role of social competence in the overall learning outcomes of the program.

PO4: Research-related Skills and Scientific Temper

CO3: Understand the principle of ESR, NMR and concept of Frank Condon principle.
Weightage: 2

By emphasizing the importance of experimental design, data analysis, critical thinking, problem-solving, and the application of acquired knowledge in research settings. This integration enhances the overall research capabilities and scientific mindset of the students.

CO5: Demonstrate qualitative problem – solving skills in all the topics covered .Weightage: 3

The students not only solve problems qualitatively but also approach problem-solving in a systematic and evidence-based manner, aligning with the principles of scientific inquiry and research.

PO5: Trans-disciplinary Knowledge

CO6: Know different types of quantum numbers associated with vector atom model.

Enhances students ability to solve problems that require insights from multiple disciplines. Understanding quantum numbers in the vector atom model becomes a tool that can be applied not only in physics but also in related fields.

CO7: know the rotational and vibrational spectra of the molecules.

The study of rotational and vibrational spectra involves principles from both physics and chemistry. Understanding these spectra is crucial for elucidating molecular structures, behaviours, and interactions. PO5 encourages students to recognize the interplay of physics and chemistry in molecular spectroscopy.

PO6: Personal and Professional Competence

CO3: Understand the principle of ESR, NMR and concept of Frank Condon principle.

The field of ESR, NMR, and molecular transitions is dynamic and continually evolving. Personal and professional competence requires an ability to adapt to new information and technologies.

CO5: Demonstrate qualitative problem – solving skills in all the topics covered.

Solving qualitative problems often involves ethical considerations. Personal and professional competence.

PO7: Effective Citizenship and Ethics

CO4: Understand the working principle and applications of different types of lasers.
Weightage: 2

The ethical application of physics knowledge in understanding working principle and applications of different types of lasers. to effective citizenship, indicating a moderate relationship.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I Physics

(w. e. from June, 2023)

Name of the Programme : M.Sc. Physics

Program Code : **PSPH**

Class : **M.Sc. I**

Semester : **II**

Course Type : Major Mandatory Theory

Course Name : **Quantum Mechanics**

Course Code : **PHY-552-MJM**

No. of Lectures : **60**

No. of Credits : **4**

PHY-552-MJM: QUANTUM MECHANICS

Course Objectives: The student will be able to learn:

1. Drawback of Classical mechanics and necessity of Quantum Mechanics.
2. The behaviour of particles under Classical and Quantum conditions.
3. Operators in Quantum Mechanics.
4. Approximation Methods to solve problems.
5. Scattering of particles and symmetric and antisymmetric functions.
6. To explain basic principles of quantum mechanics which is later used to understand solid state devices.
7. Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.

Course Outcomes: After completion of the course, the student should be able to:

CO1.Understand the drawbacks of Classical Mechanics and necessity of Quantum Mechanics
CO2. Understand the behaviour of particles under Classical and Quantum conditions.
CO3. Understand the Operators in Quantum Mechanics.
CO4. Learn about Approximation Methods to solve problems.
CO5. Understand scattering of particle and symmetric and antisymmetric functions.
CO6. Perform calculations using angular-momentum techniques
CO7. Manipulate expressions using Dirac’s notation.

Topics and Learning Points

Unit 1: General formalism of Quantum Mechanics (12 L)

Postulates of quantum mechanics: Operators in Quantum mechanics, position and momentum operator, eigen value and eigen function of momentum operator. self-adjoint operators, linear operators, projection operators, unit operator, unitary operator, matrix representation of an operator, unitary transformation, eigen functions and eigen values, Dirac delta function, Completeness and closure property, expansion co-efficient, Hilbert space, Dirac's bra and ket notation. Eigen values and eigen functions of simple harmonic oscillator by operator method.

Unit 2: Angular Momentum (12 L)

Energy relations in quasi-stationary current systems, Magnetic interaction between two current loops, Energy stored in electric and magnetic fields, Poynting's theorem, General expression for electromagnetic energy, Electromagnetic wave equations, Electromagnetic plane waves in stationary medium, Reflection and refraction of electromagnetic waves at plane boundaries (Oblique incidence), Electromagnetic waves in conducting medium, Skin effect and skin depth, wave guides , Dispersion relations(solid, liquid, gas)

Unit 3: Approximation Methods (15 L)

Time-independent Perturbation theory: Non-degenerate and degenerate cases (up to first order). Applications: Stark effect, harmonic oscillator.

Time-dependent Perturbation theory: Transition amplitude 1st and 2nd order, Fermi's golden rule, Harmonic perturbation.

Variational method: Basic principle and applications to SHO, hydrogen atom.

WKB approximation: condition for validity of WKB approximation.

Unit 4: Theory of Scattering (15 L)

Kinematics: Differential and total scattering cross sections, Centre of Mass frame, Laboratory frame. Kinetic energy relation between L-frame and CM frame.

Dynamics – a) Born approximation, Validity of Born Approx., Application to square well potential and Yukawa potential. b) Introduction to Partial wave analysis, scattering amplitudes, optical theorem, scattering by square well potential and perfectly rigid sphere.

Unit 5: Symmetry in Quantum Mechanics (06 L)

Identical particles, symmetric and antisymmetric wave functions, Slater determinant, collision of identical particles, spin functions for system with more than one electron.

References:

1. Quantum Mechanics: Theory and Applications– S. Lokanathan and A. Ghatak, Macmillan India Limited.
2. Quantum Mechanics – Leonard I. Schiff, Tata Mcgraw Hill.
3. Heat and Thermodynamics by M. W. Zymansky, R. H. Dittman, McGraw-Hill.
4. Statistical Physics by K. Huang, Wiley.
5. A Text book of Quantum Mechanics: P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi) 2nd edition, 2004.
6. Modern Quantum Mechanics: J.J. Sakurai (Addison Wesley, Reading), 2004.
7. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi), 1995.
8. Quantum Physics: S. Gasiorowicz (Wiley, New York), 3rd ed. 2003.
9. Quantum Physics: Concepts and Applcations: Nouredine Zettili (Wiley, New York), 2009

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**
CO 1	3								
CO 2	2			3			2		
CO 3	2								
CO 4		2							
CO 5					2				
CO 6		2				2			
CO7			2				2		

Justification

PO1: Disciplinary Knowledge

CO1.Understand the drawbacks of Classical Mechanics and necessity of Quantum Mechanics

This highlights the limitations of Classical Mechanics and the need for Quantum Mechanics. students acquire a deep understanding of Quantum Mechanics, the theories, principles, and mathematical frameworks that form the foundation of modern physics beyond Classical Mechanics.

CO2. Understand the behaviour of particles under Classical and Quantum conditions.

Students, develop the theoretical foundations of Classical Mechanics and Quantum Mechanics, gaining insights into how these frameworks describe and predict the behaviour of particles in different situations.

CO3. Understand the Operators in Quantum Mechanics.

students use the practical applications of their knowledge, bridging the gap between theoretical concepts and real-world advancements.

PO2: Critical Thinking and Problem Solving

CO4. Learn about Approximation Methods to solve problems.

In real-world scenarios, decisions about using approximation methods involve considerations of efficiency, accuracy, and computational feasibility.

CO6. Perform calculations using angular-momentum techniques Weightage: 2

students apply angular-momentum techniques to solve problems. students develop problem-solving skills by effectively applying these techniques in scenarios where angular momentum is a critical factor.

PO3: Social Competence

CO7. Manipulate expressions using Dirac's notation. Weightage: 2

Students, manipulating expressions using Dirac's notation, practice effective communication, teamwork, and cultural sensitivity within the quantum physics community.

PO4: Research-related Skills and Scientific Temper

CO2. Understand the behaviour of particles under Classical and Quantum conditions
Weightage: 3
students not only grasp the theoretical aspects of particle physics but also actively contribute to the ongoing scientific discourse through their research-related competencies.

PO5: Trans-disciplinary Knowledge

CO5. Understand scattering of particle and symmetric and antisymmetric functions.
Weightage: 2
students appreciate the quantum perspective on scattering phenomena, bridging classical and quantum viewpoints. Trans-disciplinary knowledge is evident as students explore the connections between classical scattering and quantum behaviour.

PO6: Personal and Professional Competence

CO6: Demonstrate quantitative problem-solving skills in all the topics covered. Weightage: 2
Problem-solving skills contribute to personal and professional competence, though the link may not be as direct.

PO7: Effective Citizenship and Ethics

CO2. Understand the behaviour of particles under Classical and Quantum conditions. Weightage: 2
This emphasizes transparent and ethical communication of scientific results, ensuring that students present their work with clarity and honesty.
The ethical application of Classical and Quantum conditions in daily life can contribute to effective citizenship, indicating a moderate relationship.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I Physics

(w. e. from June, 2023)

Name of the Programme : M.Sc. Physics

Program Code : **PSPH**

Class : **M.Sc. I**

Semester : **II**

Course Type : Major Mandatory Practical

Course Name : **PHYSICS PRACTICAL-III**

Course Code : **PHY-553-MJM**

No. of Lectures : **60**

No. of Credits : **2**

Course Objectives

1. To give knowledge of electronic components and circuits.
2. To introduce basics of op-amp circuits
3. To understand working of some IC based circuits
4. To study logic gates and their usage in digital circuits
5. To be able to use of common electronic test and measurement instruments, such as oscilloscopes, mustimeters, function generators, and soldering equipment.
6. To explore principles of analog electronics, including amplifiers, filters, and signal processing.
7. To introduce basic aspect of electronic communication systems.

Course Outcomes: After completion of this course the student will be able to-

CO1: Learn how to select appropriate electronic components for specific applications and understand their datasheets.
CO2: Identify and resolve issues in electronic circuits and systems.
CO3: Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in s-domain.
CO4: Implement circuit and test the performance.
CO5: Design and analyze op-amp based circuits.
CO6: Developed the problem-solving ability.
CO7: Learned time management skills, ensuring experiments are completed efficiently within the allocated time.

List of Experiments

1. Precision rectifier using OP-AMP.
2. Frequency to voltage converter using OP-AMP.
3. Sample and hold circuits.
4. Shift Register using 7495.
5. Class-B push pull amplifier using dual power supply and OP-AMP.
6. Fold back power supply.
7. Design, built and test oscillator-phase shift oscillator.
8. Study of voltage-controlled oscillator using IC-566.
9. Frequency multiplier using PLL-565.
10. CVCC using OP-AMP.
11. 8-bit Analog to Digital converter (ADC).
12. Design built and test oscillator – LC oscillator.
13. Diode pump staircase generator using UJT.
14. Crystal Oscillator (Miller type).
15. Instrumentation Amplifier using three op-amps.
16. Study of optoelectronic properties of Solar cell.

Additional Activity (Any one Activity equivalent to two experiments)

Students must perform at least one additional activity out of two activities in addition to eight experiments mentioned above. Total Laboratory work with additional activities should be equivalent to ten experiments.

1. **Mini Projects**
2. **Industrial Visit / Study Tour / Field visit**

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9
CO 1					2				
CO 2		3		3					
CO 3			2						
CO 4							2		
CO 5	3					2			
CO 6		2				2			
CO7	3								

Justification

PO1: Disciplinary Knowledge

CO5: Design and analyze op-amp based circuits. Weightage: 3

Creating experimental models for better understanding involves disciplinary knowledge and direct application, indicating a strong relationship.

CO7: Introduce basic aspect of electronic communication systems. Weightage: 3

Acquiring deeper understanding through hands-on experience in the laboratory aligns directly with disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO2: Identify and resolve issues in electronic circuits and systems. Weightage: 3

Critical thinking is involved in collecting and interpreting data, making this relationship strong.

CO6: Developed the problem-solving ability.

Critical thinking is involved in problem solving, making this relationship strong.

PO3: Social Competence

CO3: Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in s-domain Weightage: 2

Collaborative learning and teamwork in a laboratory setting contribute to social competence.

PO4: Research-related Skills and Scientific Temper

CO2: Identify and resolve issues in electronic circuits and systems. Weightage: 3

Acquiring technical and manipulative skills in a laboratory setting is a fundamental aspect of research-related skills.

CO7: Introduce basic aspect of electronic communication systems. Weightage: 2

Applying knowledge in a project setting is relevant to research-related skills, though the link may not be as direct as acquiring technical skills.

PO5: Trans-disciplinary Knowledge

CO1: Learn how to select appropriate electronic components for specific applications and understand their datasheets. Weightage: 2

Understanding laboratory procedures has applications in various disciplines, but the link may not be as strong as in other cases.

PO6: Personal and Professional Competence

CO5: Design and analyze op-amp based circuits.

CO6: Developed the problem-solving ability. Weightage: 2

Collaborative learning and teamwork contribute to personal and professional competence, though the link may not be as direct.

PO7: Effective Citizenship and Ethics

CO4: Implement circuit and test the performance. Weightage: 2

Understanding laboratory procedures, especially safety and scientific methods, contributes to effective citizenship and ethics in scientific practice.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I Physics

(w. e. from June, 2023)

Name of the Programme : M.Sc. Physics

Program Code : **PSPH**

Class : **M.Sc. I**

Semester : **II**

Course Type : Major Mandatory Practical

Course Name : **PHYSICS PRACTICAL-IV**

Course Code : **PHY-554-MJM**

No. of Lectures : **60**

No. of Credits : **2**

Course Objectives

1. To develop ability in using a variety of laboratory equipment and instruments
2. Understand the knowledge of various subjects of Physics.
3. Demonstrate skills and competencies to conduct wide range of scientific experiments.
4. To understand the fundamentals of precise measurement and the consequent uncertainties in experimental results.
5. To apply theoretical physics concepts learned in lecture courses into lab experiments.
6. To develop the ability to prepare formal lab reports that presents the objectives, procedures, data, and conclusions of experiments.
7. To motivate and inspire the students to create deep interest in Physics, to develop broad. and balanced knowledge and understanding of concepts, principles, and theories of physics.

Course Outcomes: After completion of this course the student will be able to

CO1: Have strong foundation knowledge and comprehend the basic concepts and principles in Physics.

CO2: To experience a well-resourced environment for learning Physics.

CO3: Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.

CO4: Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.

CO5: The students would be able to experience a well-resourced environment for learning.

CO6: Problem solving ability.

CO7: Learned time management skills, ensuring experiments are completed efficiently within the allocated time.

Topics and Learning Points

(Students must perform Any 8 Experiments)

1. Skin depth in Al using electromagnetic radiation.
2. Franck – Hertz Experiment.
3. Thermionic Emission.
4. Electron Spin Resonance (ESR).
5. Study of Hysteresis (B-H curve)
6. Ionic Conductivity of NaCl.
7. To plot the V-I Characteristics of the solar cell and hence determine the fill factor.
8. Study of electromagnetic damping.
9. Study of the characteristics of a laser beam (Beam Divergence).
10. Determination of wavelength of He-Ne LASER by Reflection grating.
11. Energy gap of semiconductor.
12. e/m by Thomson's method
13. Measurement of the focal length of a given convex lens using a laser.
14. Determination of Polarisation
15. G.M. counter: Determination of dead time of GM tube by Double source method.
16. To verify Stefan's law of radiation.

Additional Activity (Any one Activity equivalent to two experiments)

Students must perform at least one additional activity out of two activities in addition to eight experiments mentioned above. Total Laboratory work with additional activities should be equivalent to ten experiments.

1. **Mini Projects**
2. **Industrial Visit / Study Tour / Field visit**

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO8**	**PO9**
CO 1	3								
CO 2			2						
CO 3		2		2					
CO 4		2		2					
CO 5						2	2		
CO 6						2			
CO7				2	2		2		

Justification

PO1: Disciplinary Knowledge

CO1: Have strong foundation knowledge and comprehend the basic concepts and principles in Physics. Weightage: 3

Acquiring deeper understanding through hands-on experience in the laboratory aligns directly with disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO5: The students would be able to experience a well-resourced environment for learning.

CO7: Learned time management skills, ensuring experiments are completed efficiently within the allocated time.

Critical thinking is involved in problem solving, making this relationship strong.

PO3: Social Competence

CO5: The students would be able to experience a well-resourced environment for learning.

Collaborative learning and teamwork in a laboratory setting contribute to social competence.

CO7: Learned time management skills, ensuring experiments are completed efficiently within the allocated time.

Time management and teamwork in a laboratory setting contribute to social competence.

PO4: Research-related Skills and Scientific Temper

CO3: Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.

Acquiring technical and manipulative skills in a laboratory setting is a fundamental aspect of research-related skills.

CO4: Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics. Weightage: 2

Understanding problems in theoretical and experimental Physics a scientific temper, contributing to research-related skills, but the link may not be as strong.

PO5: Trans-disciplinary Knowledge

CO7: Learned time management skills, ensuring experiments are completed efficiently within the allocated time. Weightage: 2

Understanding, time management skills but the direct trans-disciplinary link may not be as strong.

PO6: Personal and Professional Competence

CO5: The students would be able to experience a well-resourced environment for learning.

students are well-prepared to face these challenges, developing the competence needed to navigate complex and dynamic professional landscapes.

CO6: Problem solving ability. Weightage: 2

students develop and enhance their problem-solving skills as an integral part of their personal and professional competence.

PO7: Effective Citizenship and Ethics

CO5: The students would be able to experience a well-resourced environment for learning.

students cultivate a sense of responsibility in the shared use of resources, promoting fair and equitable access among peers and fostering a collaborative and ethical learning community.

CO7: Learned time management skills, ensuring experiments are completed efficiently within the allocated time.

Ethical use of time in experiments ensures that resources such as laboratory equipment, materials, and the time of fellow researchers are used efficiently and fairly.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I Physics

(w. e. from June, 2023)

Name of the Programme : M.Sc. Physics

Program Code : **PSPH**

Class : **M.Sc. I**

Semester : **II**

Course Type : Major Elective Theory

Course Name : **Physics of Semiconductor Devices**

Course Code : **PHY-561-MJE (A)**

No. of Lectures : **60**

No. of Credits : **4**

PHY-561-MJE (A): PHYSICS OF SEMICONDUCTOR DEVICES

Course Objectives

1. To understand difference between direct and indirect band gap materials
2. To understand how the energy bands behaves in forward and reverse bias PN junctions.
3. What's happens when semiconductor material is kept in contacts with metal.
4. What's happens when semiconductor material is kept in contacts with metal oxides.
5. Describe the properties of materials and application of semiconductor electronics
6. Acquire the fundamental knowledge and expose to the field of semiconductor theory and devices and their Applications.

Course outcomes: On successful completion of this course students will be able to do the following:

CO1: Utilize semiconductor models to analyze carrier densities and carrier transport.

CO2: The students should be able to understand and utilize the basic governing equations to analyze semiconductor devices.

CO3: The students should be able to understand and analyze the inner working of semiconductor p-n diodes, Schottky barrier diodes and new semiconductor devices.

CO4: The students should be able to explain how the metal-semiconductor contacts will occur.

CO5: The students should be able to discuss conduction in semiconductors – charge carriers, intrinsic/extrinsic, p-type, n-type.

CO6: The students should be able to know the physics of semiconductor junctions, metal-Semiconductor junctions and metal-insulator-semiconductor junctions.

CO7: Stay informed about recent advancements in semiconductor device technology.

Topics and Learning Points

Unit-1: Properties of Semiconductors [15L]

An introduction to semiconductors, their crystal structure and their band structure, Intrinsic and extrinsic semiconductors, Charge carriers and their effective masses. Carrier concentration at thermal equilibrium for intrinsic and doped semiconductors, Carrier energy distribution, applications of Fermi factor to semiconductors, Density of available states, Excess carriers, carrier transport phenomena, Recombination Process, Basic equation for semiconductor device operation.

Unit-2: PN Junction [15L]

Basic device technology, Depletion region and depletion capacitance, Current Voltage Characteristics: Ideal case, Shockley Equation, Generation recombination process. High injection condition, Diffusion capacitance, Narrow base diode, Junction breakdown.

Unit-3: Metal–Semiconductor and Semiconductor Heterojunctions Devices [15L]

The Schottky Barrier Diode, Qualitative Characteristics, Ideal Junction Properties, Non-ideal Effects on the Barrier Height, Current–Voltage Relationship, Comparison of the Schottky Barrier Diode and the P-N Junction Diode, Metal–Semiconductor Ohmic Contacts, Ideal Non-rectifying Barrier, Tunnelling Barrier, Specific Contact Resistance, Heterojunctions Heterojunction Materials, Energy-Band Diagrams, Current–Voltage Characteristics

Unit 4: Metal Insulator Semiconductor Devices [15L]

Schottky effect, Energy Band relation at metal semiconductor contact, Ideal condition and surface states depletion Layer, General expression for barrier height Current, Transport Theory in Schottky barrier, Thermionic Emission Theory, Diffusion theory, Measurement of Schottky barrier height current voltage measurement

References:

1. Physics of Semiconductor Devices – S.M. Sze
2. Physics Solid State Devices – Streetman B.B.
3. Semiconductor Physics and Devices- Donald A Neamen
4. Semiconductor Physics – Smith
5. Fundamentals of Semiconductor Devices – J. Lindmayer and C.Y. Wrigley
6. Physics of Semiconductor Devices – Michael shur
7. Introduction to Semiconductor devices – K.J.M. Rao

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9
CO 1	3								
CO 2			2						
CO 3		2		2					
CO 4		2		2					
CO 5						2	2		
CO 6						2			
CO7				2	2		2		

Justification

PO1: Disciplinary Knowledge

CO2: The students should be able to understand and utilize the basic governing equations to analyze semiconductor devices.

students develop a foundational understanding of these equations, allowing them to interpret and analyze the behaviour of semiconductor materials and devices accurately.

PO2: Critical Thinking and Problem Solving

CO4: The students should be able to explain how the metal-semiconductor contacts will occur.

Critical thinking skills are engaged as students identify and evaluate the significance of these factors in the context of contact formation. Problem-solving skills come into play when determining optimal conditions for specific applications.

CO6: The students should be able to know the physics of semiconductor junctions, metal-Semiconductor junctions and metal-insulator-semiconductor junctions.

This application-oriented problem-solving enhances their critical thinking by bridging theoretical concepts with practical applications.

PO3: Social Competence

CO2: The students should be able to understand and utilize the basic governing equations to analyze semiconductor devices.

Social competence is developed as students navigate cultural diversity within the academic community, preparing them for collaborative work in culturally diverse professional settings.

PO4: Research-related Skills and Scientific Temper

CO6: The students should be able to know the physics of semiconductor junctions, metal-Semiconductor junctions and metal-insulator-semiconductor junctions.

Research-related skills involve formulating and testing hypotheses. This process fosters a scientific temper by encouraging students to explore, question, and validate their hypotheses.

CO7: Describe the properties of materials and application of semiconductor electronics

This skill contributes to research skills by encouraging students to contribute to advancements in practical applications of semiconductor materials.

PO5: Trans-disciplinary Knowledge

CO4: The students should be able to explain how the metal-semiconductor contacts will occur. students to link engineering principles with semiconductor physics to explain how these contacts occur.

PO6: Personal and Professional Competence

CO2: The students should be able to understand and utilize the basic governing equations to analyze semiconductor devices emphasizing the development of time management skills, a crucial aspect of personal and professional competence.

PO7: Effective Citizenship and Ethics

CO6: The students should be able to know the physics of semiconductor junctions, metal-Semiconductor junctions and metal-insulator-semiconductor junctions

Understanding the physics of semiconductor junctions involves engaging in research and experimentation. can be aligned with Effective Citizenship and Ethics by emphasizing the importance of ethical conduct in research.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I Physics

(w. e. from June, 2023)

Name of the Programme	: M.Sc. Physics
Program Code	: **PSPH**
Class	: **M.Sc. I**
Semester	: **II**
Course Type	: Major Elective Theory
Course Name	: **Fundamental Biophysics**
Course Code	: **PHY-561-MJE (B)**
No. of Lectures	: **60**
No. of Credits	: **4**

PHY-561-MJE (B): FUNDAMENTAL BIOPHYSICS

Course Objectives:

This course aims to introduce Biophysics:

1. To study the basic concepts regarding Cellular and Molecular Biology
2. To impart knowledge about Biophysical Techniques

Course Outcomes:

Upon completion of the course, the student will be able to,

CO1: Understand Basic Structure of Cell

CO2: Identify Biophysical Techniques

CO3: Properties and their significance

CO4: Working of Nervous System

CO5: Apply the knowledge of Physics in Living things.

CO6: Understand the principles of electrical signaling in biological systems, including nerve impulses and action potentials.

CO7: Understand the role of biophysics in the study of sensory receptors and signal transduction.

Topics and Learning Points

Unit 1: Basics of Biophysics (15 L)

Introduction to Biophysics, General organization of prokaryotic and eukaryotic organisms' basic concepts and their detailed structure and functions, Cell, Animal and Plant Cell, Types of Cell and its composition, Prokaryotic cell wall, Eukaryotic cell wall, their functions, ribosomes, Physical and biological properties of protoplasm. Cytoskeleton – basic components, properties, and functions in prokaryotic and eukaryotic cells.

Unit 2: Properties of Lipid Membrane (15L)

Cell surface charge, Resting membrane potential, Action potential, properties of action potential, Nernst-Plank equation, Hodgkin- Huxely equation, Hodking-Kartz experiment, Voltage clamp, Na+, K+ conductance, Membrane impedance and capacitance, Transmembrane potential, Zeta, stern and total electrochemical potential, Chemical synapse, post synaptic potential, Historical perspective of lipid model systems lipid monolayer. Liposomes: small and large unilamellar and multilamellar vesicles, planner lipid bilayer, Application of liposomes in biology and medicine.

Unit 3: Molecular Biophysics (15L)

Types of Protein structure (Primary, secondary and Tertiary), polypeptide chains, potential energy, hydrogen bonding, hydrophobic interactions, disulfide bonds & ways of pairing, Protein stability, chemical & surface denaturation, primary structure sequencing of polypeptide, α and β-helix, Ramchandran plot, protein folding & misfolding, Types of DNA, properties of DNA & RNA, Nucleotide structure, Base pairing, Genetic code symmetry, Structure& function of water and carbohydrates

Unit 4: Neuro-biophysics (15 L)

Neuron –structure and function, excitable membrane, Ion channels, Resting membrane potential, Depolarization, Hyper-polarization, Nernst equation, Goldman equation, Passive electrical prop. of neuron, Nerve conduction, Cell equivalent circuits, Synaptic Integration & transmission, Voltage clamp technique, coding of sensory information, MRI Technique, PET (Positron Emission Tomography) Technique, CT (Computed Tomography).

Reference Books:

1. Biophysics by G. R. Chatwal, Himalaya Publishing House, Mumbai, (2011)
2. Principles of neural science by E. R. Kandel& J. H. Schwatz, Elsevier, North Holland, (1982)
3. Neuron to Brain by S. W. Kuffler and J. G. Nichols, SinacuerAsso. Inc., (1995)
4. Biophysics by Mohan P. Arora, Himalaya Publishing House, (2012)
5. Biophysics An Introduction by Rodney Cotterill, Wiley, (2014)
6. Essentials of Biophysics by P. Narayanan, New Age International Publication, (2005)

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9
CO 1				2			2		
CO 2		2		2					
CO 3						2			
CO 4									
CO 5	3		2		2				
CO 6									
CO7									

Justification

PO1: Disciplinary Knowledge

CO5: Apply the knowledge of Physics in Living things.

Understanding the physics of living systems is crucial for advancements in medical physics and healthcare technologies.

PO2: Critical Thinking and Problem Solving

CO2: Identify Biophysical Techniques

developing the capacity for informed decision-making, enabling students to select techniques that best suit the experimental objectives and conditions.

PO3: Social Competence

CO5: Apply the knowledge of Physics in Living things.

aligns by recognizing the social impact of physics knowledge in improving healthcare outcomes, promoting community health, and addressing public health concerns.

PO4: Research-related Skills and Scientific Temper

CO1: Understand Basic Structure of Cell

ensures that students not only comprehend the basic structure of a cell but also acquire the necessary research-related skills and scientific temper for meaningful contributions to cellular research.

CO2: Identify Biophysical Techniques

students not only identify biophysical techniques but also develop the necessary skills and scientific temperament for effective and ethical engagement in research activities.

PO5: Trans-disciplinary Knowledge

CO5: Apply the knowledge of Physics in Living things.

emphasizes the diverse ways in which physics knowledge is applied across disciplines to enhance our understanding of living organisms and improve health-related outcomes.

PO6: Personal and Professional Competence

CO3: Properties and their significance

students not only understand material properties but also develop the personal and professional competencies necessary for successful and ethical engagement in professional contexts related to materials science and engineering.

PO7: Effective Citizenship and Ethics

CO5: Apply the knowledge of Physics in Living things.

ensures that students not only apply physics knowledge in a responsible and ethical manner but also engage in meaningful discourse about the societal implications of their work.

SYLLABUS (CBCS as per NEP 2020) FOR M.Sc. I Physics

(w. e. from June, 2023)

Name of the Programme : M.Sc. Physics

Program Code : **PSPH**

Class : **M.Sc. I**

Semester : **II**

Course Type : Major Elective Theory

Course Name : **PHYSICS OF THIN FILMS-II**

Course Code : **PHY-561-MJE (C)**

No. of Lectures : **60**

No. of Credits : **4**

PHY-561-MJE (C): PHYSICS OF THIN FILMS-II

Course Objectives

1. To make the students to understand about the difference between bulk and thin film, the optical, electrical, dielectric, and magnetic properties of thin film, the theories explaining the formation of thin film and the fabrication and advantages of thin film devices.
2. Learn the fundamental atomistic mechanisms.
3. Know thin film deposition techniques.
4. Acquire knowledge on thin film device.
5. Acquaint with thin film.
6. Appreciate applications of thin films.
7. Narrate various thin film deposition techniques.

Course Outcomes

CO1: To understand the principle, differences and similarities, advantages, and disadvantages of different thin film deposition Techniques.

CO2: To understand and evaluate and use models for understanding nucleation and growth of thin films.

CO3: To understand about different instrumentation techniques and to analyze thin film properties to apply for various applications.

CO4: To improve problems solving skills related to evaluation of different properties of thin films.

CO5: Problem solving ability.

CO6: Critical analysis

CO7: Discuss the differences and similarities between different vacuum-based deposition Techniques.

CO8: Evaluate and use models for nucleating and growth of thin films.

CO9: Asses the relation between deposition technique, film structure, and film properties.

Topics and Learning Points

Unit 1: Thin Film Characterization Methods (15 L)

Monitoring and Analytical Technique, Deposition Rate and Thickness Measurement , X-ray diffraction, Microstructural Analysis- SEM, TEM, AFM & Composition Analysis

Unit 2: Thin Films In Optics (15 L)

Optics of Thin Films, Antireflection Coatings, Single-Layer AR Coatings, Double-Layer AR Coatings, Multilayer and Inhomogeneous AR Coatings, Reflection Coatings- Metal Reflectors, All-Dielectric Reflectors, Interference Filters- Edge Filters, Band-Pass Filters,

Thin Film Polarizers, Beam Splitters- Polarizing Beam Splitter, Dichroic Beam Splitter, Integrated Optics- Waveguides, Thin Film Optical Components, Passive Devices: Couplers Active Devices

Unit 3: Optoelectronic Applications (15 L)

Introduction Photon Detectors- Photoconductive Detectors, Photoemissive Detectors

Photovoltaic Devices-Thin Film Solar Cells, Applications in Imaging, Electrophotography (Xerography and Electro fax), Thin Film Displays- Electroluminescent (EL) Displays, Electrochromic Displays

Unit 4: Microelectronic Applications (15 L)

Introduction, Thin Film Passive Components, Electrical Behaviour of Metal Films, Dielectric Behaviour of Insulator Films- Resistors, Capacitors, Inductors, Conductors (Interconnections and Contacts), Thin Film Active Components- Thin Film Transistor (TFT), Thin Film Diodes

Thin Film Integrated Circuits, Microwave Integrated Circuits (MICs), Charge-Coupled Devices (CCDs): Introduction, Principle, Applications- Thin Film Strain Gauges, Gas Sensors

Reference books:

1. Handbook of Thin Film Technology: Maissel and Glang, (Mc Graw Hill)
2. Thin Film Device Applications: K. L. Chopra, (Springer)
3. Thin Film Phenomena: K. L. Chopra, (Mc Graw Hill)
4. Material Science of Thin Films: M. Ohring, (Academic Press)
5. Thin Film Process: J. L. Vossen and Kern, (Academic Press)
6. Vacuum Technology (2nd revised edition), A. Roth, (North Hollad)

List of practical:

1. Thickness measurement of thin film.
2. Study of optical absorption of thin film (UV-visible spectroscopy) and determination of band gap of semiconductor thin film
3. Determination of particle size of thin film from X-ray diffraction.
4. Determination of grain size and microstructure description of thin film from SEM
5. Resistivity measurement of thin film by two probe method
6. Crystal structure of thin film

Mapping of Program Outcomes with Course Outcomes

Course Outcomes	Programme Outcomes								
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO9
CO 1	3			2					
CO 2				2					
CO 3									
CO 4				2		2			
CO 5		2				2	2		
CO 6		2							
CO7			2						
CO8					2				
CO9					2				

Justification

PO1: Disciplinary Knowledge

CO1: To understand the principle, differences and similarities, advantages, and disadvantages of different thin film deposition Techniques.

alignment ensures that students not only understand the theoretical aspects of thin film deposition but also possess the knowledge and skills necessary to make informed decisions in practical engineering applications.

PO2: Critical Thinking and Problem Solving

CO5: Problem solving ability.

ensures that students not only develop problem-solving abilities but also cultivate a broader set of critical thinking skills that can be applied across various disciplines and context.

CO6: Critical analysis

ensures that students not only develop problem-solving abilities but also cultivate the specific skill of critically analysing problems, components, and potential solutions in a systematic and informed manner.

PO3: Social Competence

CO7: Discuss the differences and similarities between different vacuum-based deposition Techniques.

enhancing communication skills, promoting collaboration and knowledge sharing, facilitating peer learning and support, understanding diverse perspectives, developing professional interaction skills, enhancing presentation skills, encouraging constructive dialogue, and building conflict resolution skills.

PO4: Research-related Skills and Scientific Temper

CO1: To understand the principle, differences and similarities, advantages, and disadvantages of different thin film deposition Techniques emphasis on promoting research inquiry, experimental understanding, literature review and synthesis, analytical skills, critical evaluation, scientific methodology, problem-solving, and research ethics. This alignment ensures that students not only grasp the theoretical aspects of thin film deposition but also develop the practical research skills and scientific temper necessary for conducting meaningful and ethical research in the field.

CO2: To understand and evaluate and use models for understanding nucleation and growth of thin films. Students not only grasp theoretical models but also develop the practical skills and scientific temper necessary for effective and ethical engagement in research related to thin film processes.

CO4: To improve problems solving skills related to evaluation of different properties of thin films. Not only gain theoretical knowledge but also develop practical problem-solving abilities essential for conducting meaningful and effective research in the evaluation of thin film properties.

PO5: Trans-disciplinary Knowledge

CO8: Evaluate and use models for nucleating and growth of thin films.

the nucleating and growth of thin films is justified by its emphasis on promoting trans-disciplinary understanding, facilitating the synthesis of theoretical frameworks, cultivating interdisciplinary problem-solving skills, promoting cross-domain application of concepts, fostering systems thinking, encouraging a holistic approach to research, enhancing communication skills across disciplines, and emphasizing ethical conduct in trans-disciplinary research.

CO9: Asses the relation between deposition technique, film structure, and film properties. students gain a comprehensive understanding of the intricate relationships in material science and are equipped with the skills necessary for trans-disciplinary analysis in this field.

PO6: Personal and Professional Competence

CO4: To improve problems solving skills related to evaluation of different properties of thin films. Emphasis on fostering critical thinking, analytical skills, the application of theoretical knowledge, practical competencies, decision-making skills, interpersonal competence, adaptability, resilience, communication skills, and overall professional competence.

CO5: Problem solving ability.

Students not only acquire problem-solving skills but also develop a comprehensive set of personal and professional competencies necessary for success in various contexts.

PO7: Effective Citizenship and Ethics

CO1: To understand the principle, differences and similarities, advantages, and disadvantages of different thin film deposition Techniques.

Students learn to appreciate cultural differences, recognizing that ethical considerations may vary in different regions, contributing to their cultural sensitivity as responsible citizens.