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 – I

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	**Comprehensive Knowledge and Understanding:** Postgraduates will possess a profound understanding of their field, encompassing foundational theories, methodologies, and key concepts within a multidisciplinary context.
PO2	**Practical, Professional, and Procedural Knowledge:** Postgraduates will acquire practical skills and expertise necessary for professional tasks, including industry standards, regulations, and ethical considerations, with effective application in real-world scenarios**.**
PO3	**Entrepreneurial Mindset, Innovation, and Business Understanding:** Postgraduates will cultivate an entrepreneurial mindset, identify opportunities, foster innovation, and understand business principles, market dynamics, and risk management strategies.
PO4	**Specialized Skills, Critical Thinking, and Problem-Solving:** Postgraduates will demonstrate proficiency in technical skills, analytical abilities, effective communication, and leadership, adapting and innovating in response to changing circumstances.
PO5	**Research, Analytical Reasoning, and Ethical Conduct:** Postgraduates will exhibit observational and inquiry skills, formulate research questions, utilize appropriate methodologies for data analysis, and adhere to research ethics while effectively reporting findings.
PO6	**Communication, Collaboration, and Leadership:** Postgraduates will effectively communicate complex information, collaborate in diverse teams, demonstrate leadership qualities, and facilitate cooperative efforts toward common goals.
PO7	**Digital Proficiency and Technological Skills:** Postgraduates will demonstrate proficiency in using ICT, accessing information sources, analyzing data using appropriate software, and adapting to technological advancements.
PO8	**Multicultural Competence, Inclusive Spirit, and Empathy:** Postgraduates will engage effectively in multicultural settings, respect diverse perspectives, lead diverse teams, and demonstrate empathy and understanding of others' perspectives and emotions.
PO9	**Value Inculcation, Environmental Awareness, and Ethical Practices:** Postgraduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and promote sustainability and environmental conservation.
PO10	**Autonomy, Responsibility, and Accountability:** Postgraduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts, contributing to societal well-being.

Programme Specific Outcomes (PSOs)

PSO1: To develop an ability to become a specialist in various areas of Physics and apply the same in day to day life.

PSO2: To acquire knowledge about the nature, concepts, methods, techniques and objectives in the core physics subjects.

PSO3: To make the students in mastering in the field of materials science and prepare them for research.

PSO4: Identify, formulate, and analyse complex problems using basic principles of mathematics, physics, and statistics.

PSO5: Design, construct and analyse basic electronic and digital circuits. Understand the basics of programming language and apply it to various numerical problems.

PSO6: To cultivate scientific approach and culture of research aptitude.

PSO7: To enhance the problem-solving skills of the students so that they will be able to tackle the national level competitive exams like NET, GATE and SET etc.

PSO8: To understand the links of Physics to other disciplines and also to the societal issues.

PSO9: To train the students to develop their skill development, employability and entrepreneurship skills.

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-502-MJM: Classical Electrodynamics (Credit 04) PHY-503-MJM: Physics Laboratory-I (Credit 02) PHY-504-MJM: Physics Laboratory-II (Credit 02)	PHY511-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)
	Sem- II	PHY-551-MJM: Atoms, Molecules and Laser (Credit 04) PHY-552-MJM: Quantum Mechanics (Credit 04) PHY-553-MJM: Physics Laboratory-III (Credit 02) PHY-554-MJM: Physics Laboratory-IV (Credit 02)	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	

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	: **I**
Course Type	: Major Mandatory
Course Name	: **MATHEMATICAL METHODS IN PHYSICS**
Course Code	: **PHY-501-MJM**
No. of Lectures	: **60**
No. of Credits	: **4**

PHY-501-MJM: MATHEMATICAL METHODS IN PHYSICS

Course Objectives:

1. The educational methodology of this subject proposes to integrate the domain of concepts and knowledge from mathematics into practical application of physics phenomena, and the development of abilities and skills to solve example problems.
2. Student discussion in interactive forums, which aim to improve the instrumental aspects learned through the lectures and experiences outside the walls.
3. The educational methodology of this subject proposes to integrate the domain of concepts and knowledge from mathematics into practical application of physics phenomena, and the development of abilities and skills to solve example problems.
4. The educational methodology of this subject proposes to integrate the domain of concepts and knowledge from mathematics into practical application of physics phenomena, and the development of abilities and skills to solve example problems.
5. The educational methodology of this subject proposes to integrate the domain of concepts and knowledge from mathematics into practical application of physics phenomena, and the development of abilities and skills to solve example problems.
6. Student discussion in interactive forums, which aim to improve the instrumental aspects learned through the lectures and experiences outside the walls.

7. The educational methodology of this subject proposes to integrate the domain of concepts and knowledge from mathematics into practical application of physics phenomena, and the development of abilities and skills to solve example problems.

Course Outcomes:

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

CO1: From this course, the students are expected to learn some mathematical techniques required to understand the physical phenomena at the postgraduate level.
CO2: The students are expected to be able to solve simple problems in probability, understand the concept of independent events and work with standard continuous distributions.
CO3: The students will have idea of the functions of complex variables; solve nonhomogeneous differential equations and partial differential equations using simple methods.
CO4:The students are expected to be able to solve simple problems on Fourier series and Fourier transform, Laplace transform etc.
CO5: Students are able to solve ordinary second order differential equations important in the physical sciences; solve physically relevant partial differential equations using standard methods like separation of variables, series expansion, and integral transforms.
CO6: Students have a good grasp of the basic elements of complex analysis, including the important integral theorems.
CO7: Students are able to apply variational calculus to find optimal curves and surfaces
CO8: Problem solving ability.
CO9: Critical Analysis

Topics and Learning Points

Unit 1: Complex Analysis **(1 Credit)**

Complex number, Complex function (polynomial, Exponential, Trigonometric complex function, Logarithm), differentiation, Analytical function, Cauchy-Riemann condition, Line integrals, Cauchy integral formula, Derivative of analytical functions, Power Series, Taylor's theorem, Laurent's theorem, Calculus of residues, Evaluation of real definite integrals
References: 1-5

Unit 2: Vector Space and Matrix Algebra (1 Credit)

Revision on Vector space: Vectors (dependent and independent), Vector space, Hilbert space, Dimension of vector space, Matrix representation, Similarity transformation, Eigen values and Eigen vectors, Inner product, Orthogonality, Introduction only to Gramm-Schmidt orthogonalization procedure.
Matrix: Types of matrix, Rank of matrix, Eigen values and Eigen vectors, Unitary transformation, Diagonalization
References: 6, 7

Unit 3: Special Functions (1 Credit)

Bessel function, Legendre, Hermite, and Laguerre functions – Generating function, Recurrence relations and their differential equations, Orthogonality properties, Bessel's function of first and second kind.
References: 4, 5, 7

Unit 4: Fourier Series and Integral Transforms (1 Credit)

Fourier series: Definition, Dirichlet's Condition, Fourier Integral and Fourier transform, convolution theorem, Parseval's identity, Laplace transform and its properties, Fourier transform and Laplace transform, Dirac Delta function.

References: 3, 4, 7

Reference Books:

1. Complex Variables and Application- J. W. Brown, R. V. Churchill - McGraw Hill
2. Complex Variables – Seymour Lipschutz
3. Mathematics for Physical Sciences – Mary Boas, John Wiley and Sons
4. Mathematical methods in Physics- B. D. Gupta
5. Mathematical methods in Physics- Satyaprakash
6. Linear algebra – Seymour Lipschutz, Schaum Outline Series McGraw Hill Edition
7. Mathematical Method for Physicists, Arfken and Weber, 6th Edition, Academic Press
8. Fourier Series - Seymour Lipschutz, Schaum Outlines Series

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**
CO 1	3						2
CO 2							
CO 3	2			2	2		
CO 4							
CO 5				3			
CO 6						2	
CO7			2				
CO8		3					
CO9		3					

Justification

PO1: Disciplinary Knowledge

CO1: From this course, the students are expected to learn some mathematical techniques required to understand the physical phenomena at the postgraduate level.

Mathematical techniques acquired through this course prepares students for the rigors of advanced study.

CO3: The students will have idea of the functions of complex variables; solve nonhomogeneous differential equations and partial differential equations using simple methods.

Understanding complex variables and mastering the solution methods for differential equations lays a strong foundation for more advanced courses and research at the postgraduate level.

PO2: Critical Thinking and Problem Solving

CO8: Problem solving ability

CO9: Critical Analysis Weightage: 3

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

PO3: Social Competence

CO2: The students are expected to be able to solve simple problems in probability, understand the concept of independent events and work with standard continuous distributions.

Weightage: 2

The broader goal of Social Competence by providing students with the quantitative skills necessary for effective decision-making, risk assessment, and collaborative problem-solving in social and professional settings.

PO4: Research-related Skills and Scientific Temper

CO7: Students are able to apply variational calculus to find optimal curves and surfaces Weightage: 3

Research-related skills and scientific temper are directly linked to applying principles like apply variational calculus to find optimal curves and surfaces

PO5: Trans-disciplinary Knowledge

CO3: The students will have idea of the functions of complex variables; solve nonhomogeneous differential equations and partial differential equations using simple methods. Weightage: 2

While this involves applying physics knowledge in different contexts, the direct trans-disciplinary link may not be as strong.

PO6: Personal and Professional Competence

CO6: Students have a good grasp of the basic elements of complex analysis, including the important integral theorems: 2

Personal and professional competence can benefit from problem-solving skills, though the link may not be as direct.

PO7: Effective Citizenship and Ethics

CO1: From this course, the students are expected to learn some mathematical techniques required to understand the physical phenomena at the postgraduate level. Weightage: 2

The ethical application of physics knowledge in understanding some mathematical techniques 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	: **I**
Course Type	: Major Mandatory
Course Name	: **Classical Electrodynamics**
Course Code	: **PHY-502-MJM**
No. of Lectures	: **60**
No. of Credits	: **4**

PHY-502-MJM: CLASSICAL ELECTRODYNAMICS

Course Objectives:

1. To apprise the students regarding the concepts of electrodynamics and Maxwell equations and use them various situations.
2. To introduce the basic mathematical concepts related to electromagnetic vector fields.
3. To impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications.
4. To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications.
5. To impart knowledge on the concepts of Faraday‘s law, induced emf and Maxwell ‘s equations.
6. To impart knowledge on the concepts of Concepts of electromagnetic waves.
7. To familiarize the students about the electric field in material space and learn to solve boundary value problems.
8. To expose the students to various concepts and properties of magneto-static field
9. To identify, formulate and solve fields and electromagnetic waves propagation problems.

Course Outcomes:

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

CO1: Understand the concept of multipole expansions and deeper meaning of Maxwell's equations.

CO2: Understand the technique of deriving formulae for the electromagnetic waves in stationary and conducting medium.

CO3: Calculate the electromagnetic radiations from moving charges, considering retardation effects and make a detailed account for Gauge transformations.

CO4: Embracing the concepts of special relativity as emerged through the laws of electrodynamics.

CO5: To formulate and solve the electromagnetic problems skills In all the topics covered. CO6**:** Explain classical electrodynamics based on Maxwell's equations including its formulation in covariant form.

CO7**:** Solve problems involving the calculation of fields, the motion of charged particles and the production of electromagnetic waves; and

CO8**:** Analyse the solution of these problems in the context of a range of applications.

CO9**:** Problem Solving Ability

Topics and Learning Points

Unit 1: Multiple Expansions and Time Varying Fields (1 Credit)

Multipole expansions for a localized charge distribution in free space, linear quadrupole potential and field, static electric and magnetic fields in material media, boundary conditions, Faraday's law for stationary and moving media, Maxwell's displacement current, differential, and integral forms of Maxwell's equations, Maxwell's equations for moving medium.

Unit 2: Energy, Force, Momentum Relations & Electromagnetic Wave Equations (1 Credit)

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: Inhomogeneous Wave Equations (1 Credit)

Inhomogeneous wave equations, Lorentz's and Coulomb's gauges, Gauge transformations, Wave equations in terms of electromagnetic potentials, D'Alembertian operator, Hertz potential.

Unit 4: Relativistic Mechanics and Covariance (1 Credit)

Galilean Transformation, Lorentz transformations, Relativistic velocity addition, Minkowski's space-time diagram, Four vector potential, Lorentz force on a charged particle.

References:

1) Introduction to Electrodynamics, (3rd Edition) by David J. Griffith Publication: Prentice-Hall of India, New Delhi.
2) Introduction to Electrodynamics, by A.Z. Capri and P.V. Panat Narosa Publishing House.
3) Foundations of Electromagnetic theory by Reitz & Milford, World student series Edition.
4) Classical Electrodynamics, by J.D. Jackson, 3rd Edition John Wiley.
5) Electromagnetic theory and Electrodynamics by Satya Prakash, Kedar Nath & Co-Meerut.
6) Electromagnetics by B.B. Laud, Willey Eastern.
7) Matrices and Tensors in Physics by A. W. Joshi, 3rd Edition, New Age International.
8) Electrodynamics by Kumar Gupta and Singh.
9) Electromagnetic Theory by Umesh Sinha, Satya Prakash and tech. India Publication.

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**
CO 1	3						
CO 2	3						
CO 3							
CO 4				3			
CO 5					2		
CO 6		3					
CO7			2			2	2
CO8							
CO9							

Justification

PO1: Disciplinary Knowledge

CO1: Understand the concept of multipole expansions and deeper meaning of Maxwell's equations. Weightage: 3

This directly aligns with the core disciplinary knowledge in the the concept of multipole expansions and deeper meaning of Maxwell's equations..

CO3: Calculate the electromagnetic radiations from moving charges, considering retardation effects and make a detailed account for Gauge transformation. Weightage: 3

Calculation of electric field and potential using fundamental laws is a direct application of disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO7: Solve problems involving the calculation of fields, the motion of charged particles and the production of electromagnetic waves; and

CO8: Analyse the solution of these problems in the context of a range of applications. Weightage: 2

Critical thinking and problem-solving skills are crucial in solving quantitative problems, indicating a strong relationship.

PO3: Social Competence

CO8: Analyse the solution of these problems in the context of a range of applications. Weightage: 2

While the understanding of electromagnetism has social applications, the direct link may not be as strong as in other cases.

PO4: Research-related Skills and Scientific Temper

CO4: Embracing the concepts of special relativity as emerged through the laws of electrodynamics Weightage: 3

Research-related skills are involved in understanding and applying the concepts of special relativity as emerged through the laws of electrodynamics, indicating a strong relationship.

PO5: Trans-disciplinary Knowledge

CO1: Understand the concept of multipole expansions and deeper meaning of Maxwell's equations. Weightage: 2

While the concept of concept of multipole expansions and deeper meaning of Maxwell's equations, the direct trans-disciplinary link may not be as strong.

PO6: Personal and Professional Competence

CO7: Solve problems involving the calculation of fields, the motion of charged particles and the production of electromagnetic waves; Weightage: 2

Problem-solving skills contribute to personal and professional competence, though the link may not be as direct.

PO7: Effective Citizenship and Ethics

CO8: Analyse the solution of these problems in the context of a range of applications Weightage: 2

The ethical solution of these problems in the context of a range of applications 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	: **I**
Course Type	: Major Mandatory
Course Name	: **PHYSICS PRACTICAL-I**
Course Code	: **PHY-503-MJM**
No. of Lectures	: **60**
No. of Credits	: **2**

Course Objectives

1. To give knowledge of some basic electronic components and circuits.
2. To introduce basics of diode and transistor circuits
3. To understand working of some IC based circuits
4. To study logic gates and their usage in digital circuits
5. To expose the students to working of some power electronic dev ices, transducers and application of transducers.
6. To introduce basic aspect of electronic communication systems.
7. The associated Laboratory Practical course is designed to understand working of various Electronic circuits. The students will u understand how to u se the basic test and measuring instruments to test the circuits.

Course Outcomes:

CO1: Understand mathematical description and representation of continuous and discrete time signals and systems.
CO2: Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
CO3: Understand the limitations of Fourier transform and need for Laplace transform and develop the ability to analyze the system in s-domain.
CO4: Understand the basic concept of probability, random variables & random signals and develop the ability to find correlation, CDF, PDF and probability of a given event

CO5: Comply and verify parameters after exciting devices by any stated method.
CO6: Implement circuit and test the performance
CO7: Design and analyze transformers
CO8: Problem solving ability
CO9: Critical Analysis

Topics and Learning Points

1. Voltage to Frequency Convertor using OP-AMP.
2. DAC (4-bit R-2R Ladder Type).
3. Active filter- Low pass, High pass, Band pass and Notch Filter using OP-AMP.
4. Function generator using OP-AMP.
5. Constant current source using OP-AMP.
6. Study of multiplexer and Demultiplexer.
7. Frequency modulation and demodulation.
8. Pulse code modulation and demodulation.
9. FSK modulation and demodulation.
10. Amplitude modulation and demodulation
11. Optical fibre communication.
12. Op-amp based clipper and clampers
13. Study of optocoupler using IC MCT-2E
14. Study of IC 7490 (Decade counter)
15. Design, built and test oscillator – Wien Bridge oscillator

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									
CO 3			3						
CO 4							2		
CO 5		2			2			2	
CO 6		2				2			2
CO7	3			2		2			2
CO8		2							
CO9									

Justification

PO1: Disciplinary Knowledge

CO1: Understand mathematical description and representation of continuous and discrete time signals and systems. Weightage: 3

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

CO7: Design and analyze transformers Weightage: 3

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

PO2: Critical Thinking and Problem Solving

CO5: Comply and verify parameters after exciting devices by any stated method. Weightage: 2

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

CO6: Implement circuit and test the performance.

Acquire technical and manipulative skills in using laboratory equipment, tools, and materials.

CO8: Problem solving ability

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

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: 3

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

PO4: Research-related Skills and Scientific Temper

CO7: Design and analyze transformers Weightage: 2

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

PO5: Trans-disciplinary Knowledge

CO5: Comply and verify parameters after exciting devices by any stated method. Weightage: 2

While to Comply and verify parameters after exciting devices by any stated method, the direct trans-disciplinary link may not be as strong.

PO6: Personal and Professional Competence

CO6: Implement circuit and test the performance CO7: Design and analyze transformers. 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: Understand the basic concept of probability, random variables & random signals and develop the ability to find correlation, CDF, PDF and probability of a given even.Weightage: 2

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

PO8: Environment and Sustainability

CO5: Comply and verify parameters after exciting devices by any stated method. Weightage: 2

Adhering to laboratory safety procedures can indirectly contribute to environmental and sustainability considerations.

PO9: Self-directed and Life-long Learning

CO6: Implement circuit and test the performance CO7: Design and analyze transformers Weightage: 2

Applying knowledge in project work is relevant to self-directed and life-long learning, though the link may not be as direct.

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	: **I**
Course Type	: Major Mandatory
Course Name	: **PHYSICS PRACTICAL-II**
Course Code	: **PHY-504-MJM**
No. of Lectures	: **60**
No. of Credits	: **2**

PHY-504-MJM: PHYSICS PRACTICAL-II

Course Objectives

1. Understand the depth knowledge of various subjects of Physics.
2. Demonstrate skills and competencies to conduct wide range of scientific experiments.
3. Identify their area of interest in academic and R&D. Perform job in various fields' viz.
4. To provide students a strong foundation education in Physics
5. To provide structured curricula, this supports academic development of students.
6. To provide and prepare the students for employment and higher studies in Physics
7. To provide a good learning environment for Physics

Course Outcomes

CO1: The students would be able to have strong foundation knowledge and comprehend the basic concepts and principles in Physics.
CO2: The students would be able to experience a well-resourced environment for learning Physics
CO3: To motivate and inspire the students to create deep interest in Physics, to develop broad and balanced knowledge and understanding of physical concepts, principles and theories of Physics.
CO4: Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
CO5: Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.
CO6: Emphasize the discipline of Physics to be the most important branch of science for

pursuing the interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas.
CO7: The students would be able to experience a well resourced environment for learning
CO8: Problem solving ability
CO9: Critical Analysis

Topics and Learning Points

(Students must perform Any 8 Experiments)

1. Young's Modulus of steel by Flexural Vibrations of a bar
2. Fabry-Parot Etalon.
3. Hall Effect.
4. Resistivity of Ge at various temperature by Four Probe method and determination of band gap.
5. Determination of wavelength of He-Ne LASER by Reflection grating
6. Michelson Interferometer.
7. Magnetic Susceptibility by Gauoy's method.
8. 'e' by Millikan oil drop method.
9. G.M. Counter – I Counting statistics
10. G.M. Counter –II End point energy and Absorption coefficient using G. M. tube.
11. Measurement of the focal length of a given convex lens using a laser.
12. Electron Diffraction.
13. Determination of wavelength of He-Ne LASER by transmission grating
14. Coherence and width of spectral lines using Michelson Interferometer.
15. Determination of Seebeck coefficient and understanding of Thermocouple working.

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	PO 8	PO 9
CO 1	3								
CO 2							1	1	
CO 3	2								
CO 4				3					
CO 5						2			
CO 6					3				
CO7									
CO8		3							
CO9		3							2

Justification

PO1: Disciplinary Knowledge

CO1: The students would be able to have a strong foundation knowledge and comprehend the basic concepts and principles in Physics.

Weightage: 3 (strong or direct relation)

Justification: CO1 specifically mentions the development of foundational knowledge and comprehension of basic physics concepts, aligning directly with the disciplinary knowledge outlined in PO1.

CO3: To motivate and inspire the students to create deep interest in Physics, to develop broad and balanced knowledge and understanding of physical concepts, principles, and theories of Physics.

Weightage: 2 (moderate or partial relation)

Justification: While CO3 emphasizes motivation and inspiration, it indirectly contributes to disciplinary knowledge by fostering a deep interest and understanding of physical concepts within the discipline of physics.

PO2: Critical Thinking and Problem Solving

CO8: Problem-solving ability

Weightage: 3 (strong or direct relation)

Justification: CO8 explicitly mentions problem-solving ability, aligning directly with the critical thinking and problem-solving skills outlined in PO2.

CO9: Critical Analysis

Weightage: 3 (strong or direct relation)

Justification: CO9 directly correlates with critical thinking by highlighting the importance of critical analysis, reinforcing the connection with the critical thinking aspect of PO2.

PO4: Research-related Skills and Scientific Temper

CO4: Learn, design, and perform experiments in the labs to demonstrate the concepts, principles, and theories learned in the classrooms. Weightage: 3 (strong or direct relation)
Justification: CO4 is closely related to research-related skills and scientific temper, as it involves practical application and experimentation, aligning with the research-oriented skills outlined in PO4.

PO5: Trans-disciplinary Knowledge

CO6: Emphasize the discipline of Physics to be the most important branch of science for pursuing interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas. Weightage: 3 (strong or direct relation)
Justification: CO6 directly addresses the importance of physics in interdisciplinary and multidisciplinary contexts, aligning with the trans-disciplinary knowledge outlined in PO5.

PO6: Personal and Professional Competence

CO5: Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics. Weightage: 2 (moderate or partial relation)
Justification: CO5 contributes to personal and professional competence by emphasizing the application of acquired knowledge in practical scenarios, although it's not as direct as some other connections.

PO7: Effective Citizenship and Ethics

CO2: The students would be able to experience a well-resourced environment for learning Physics. Weightage: 1 (weak or low relation)
Justification: CO2 focuses more on the learning environment and resources, which has a limited connection to effective citizenship and ethics as compared to other outcomes.

PO8: Environment and Sustainability

CO2: The students would be able to experience a well-resourced environment for learning Physics. Weightage: 1 (weak or low relation)
Justification: Similar to PO7, CO2 has a weak connection to environmental and sustainability aspects, as it primarily addresses the learning environment without direct implications for environmental considerations.

PO9: Self-directed and Life-long Learning

CO9: Critical Analysis
Weightage: 2 (moderate or partial relation)
Justification: CO9, by promoting critical analysis, indirectly contributes to self-directed and lifelong learning, although it's not as direct as some other connections.

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	: **I**
Course Type	: Major Elective
Course Name	: **CLASSICAL MECHANICS**
Course Code	: **PHY-511-MJE (A)**
No. of Lectures	: **60**
No. of Credits	: **4**

PHY-511-MJE (A): CLASSICAL MECHANICS

Course Objectives

1. To find the linear approximation to any dynamical system near equilibrium and also know how to derive and solve the wave equation for small oscillations.
2. Understand Poisson brackets, understand canonical transformations
3. To distinguish between ‘inertia frame of reference’ and ‘non-inertial frame of reference’
4. To know how to impose constraints on a system in order to simplify the methods to be used in solving physics problems
5. To know what central, conservative and central-conservative forces mathematically understand the conservative theorems of energy, linear momentum and angular Momentum.
6. To know the importance of concepts such as generalized coordinates and constrained motion
7. To establish that Kepler’s laws are just consequences Newton’s laws of gravitation and that of motion

Learning outcomes:

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

CO1: The students will introduce about the newton’s laws of motion and knowledge about the applications of newton’s laws of motion.

CO2: This paper enables the students to understand the Langrangian approach in classical mechanics.

CO3: The students should be able to understand Hamiltonian formulation with applications

CO4: The paper also enables the students to know about variational principle with applications.

CO5: The students should be able to understand central forces and types of central forces in detail, ideas regarding equations of orbit and deduction of Kepler's laws.

CO6: Students learn about motion of a particle under central force field.

CO7: Students learn about Langrangian and Hamiltonian formulation of Classical Mechanics.

CO8: Problem solving ability

CO9: Critical analysis

Topics and Learning Points

Unit 1: Constrained Motion and Langrangian formulation (1 Credit)

Constrained Motion, Constraints and their Classification**,** Degrees of freedom, generalized coordinates, Virtual Displacement, Principle of Virtual Work, D'Alembert Principle, Configuration space, Lagrange's equation of motion, Theorem on total energy, Cyclic coordinates, Generalized momenta. **Problems solving**

Unit 2: Hamilton's formulation and Variational Principle (1 Credit)

Hamilton's function and Hamiltonian equation of motion, Phase space, Jacobi integrals and energy conservation, Langrangian and Hamiltonian of relativistic particles and light rays, Variational principle, Euler's equation, Applications of Variational principle, Concept of symmetry. **Problems solving**

Unit 3: Canonical Transformations and Poisson's Bracket (1 Credit)

Introduction- Background and definition, Legendre transformations, Generating function, Conditions for canonical transformation, Poisson's bracket-definition, identities, Poisson's theorem, Jacobi identity, Invariance of Poisson Bracket under canonical transformation.
Problems solving

Unit 4: Central Forces and Non-Inertial Frames of Reference (1 Credit)

Introduction, definition, and properties of Central Force, two body central force problem, Stability of orbit, Orbits of artificial satellite, Kepler's problem, Inertial forces in rotating frame, Coriolis force and its effect, Foucault's pendulum. **Problems solving**

Reference Books:

1. Classical mechanics by J.C. Upadhyaya, Himalaya Publishing House.
2. Classical mechanics by N.C. Rana and P.S. Jog, Tata Mc-Graw Hill Publishing Company limited, New Delhi.
3. Classical Mechanics by P.V. Panat, Narosa publishing Home, New Delhi.
4. Classical Mechanics by Kumar, Gupta, Sharma.
5. Classical Mechanics by H. Goldstein, Narosa Publishing Home, New Delhi.
6. Classical Mechanics by D. S. Mathur.
7. Introduction to Classical Mechanics by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

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	PO 8	PO 9
CO 1	3				2			2	
CO 2	3								
CO 3			2			2			
CO 4			2			2			2
CO 5				2					
CO 6	3								
CO7							2		
CO8		2							
CO9		2							

Justification

PO1: Disciplinary Knowledge

CO1: The students will introduce about the newton's laws of motion and knowledge about the applications of newton's laws of motion. Weightage: 3

Understanding about the newton's laws of motion and knowledge about the applications of newton's laws of motion is a direct application of disciplinary knowledge in wave physics.

CO2: This paper enables the students to understand the Langrangian approach in classical mechanics. Weightage: 3 Understanding the Langrangian approach in classical mechanics is fundamental to disciplinary knowledge in classical mechanics.

CO6: Students learn about motion of a particle under central force field. Weightage: 3

Understanding about motion of a particle under central force field is integral to disciplinary knowledge in classical mechanics.

PO2: Critical Thinking and Problem Solving

CO8: Problem solving ability Weightage: 2

Calculating the correct answer requires problem-solving skills in the context of classical mechanics.

CO9: Critical analysis Weightage: 2 Understanding concepts requires critical thinking and problem-solving skills in the context of classical mechanics.

PO3: Social Competence

CO3: The students should be able to understand Hamiltonian formulation with applications Weightage: 2

Understanding the Hamiltonian formulation with applications has social applications, but the direct link may not be as strong.

CO4: The paper also enables the students to know about variational principle with applications.

Knowing about variational principle with applications has social applications, but the direct link may not be as strong.

PO4: Research-related Skills and Scientific Temper

CO5: The students should be able to understand central forces and types of central forces in detail, ideas regarding equations of orbit and deduction of Kepler's laws. Weightage: 2

Understanding the central forces and types of central forces in detail, ideas regarding equations of orbit and deduction of Kepler's laws can be part of research-related skills, but the link may not be as direct.

PO5: Trans-disciplinary Knowledge

CO1: The students will introduce about the newton's laws of motion and knowledge about the applications of newton's laws of motion. Weightage: 2

Understanding the newton's laws of motion and knowledge about the applications of newton's laws of motion has applications in various disciplines, but the direct trans-disciplinary link may not be as strong.

PO6: Personal and Professional Competence

CO3: The students should be able to understand Hamiltonian formulation with applications Weightage: 2

Understanding Hamiltonian formulation with applications contributes to personal and professional competence, though the link may not be as direct.

CO4: The paper also enables the students to know about variational principle with applications.

Understanding about variational principle with applications contributes to personal and professional competence, though the link may not be as direct.

PO7: Effective Citizenship and Ethics

CO7: Students learn about Langrangian and Hamiltonian formulation of Classical Mechanics. Weightage: 2

Understanding the Langrangian and Hamiltonian formulation of Classical Mechanics has ethical implications, contributing to effective citizenship, though the link may not be as strong.

PO8: Environment and Sustainability

CO1: The students will introduce about the newton's laws of motion and knowledge about the applications of newton's laws of motion. Weightage: 2

Understanding newton's laws of motion and knowledge about the applications of newton's laws of motion can indirectly contribute to considerations of environment and sustainability.

PO9: Self-directed and Life-long Learning

CO4: The paper also enables the students to know about variational principle with applications.. Weightage: 2

Understanding the variational principle with applications can be part of self-directed and life-long learning, but the link may not be as direct.

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	: **I**
Course Type	: Major Elective
Course Name	: **ELECTRONICS**
Course Code	: **PHY-511-MJE (B)**
No. of Lectures	: **60**
No. of Credits	: **4**

PHY-511-MJE (B): ELECTRONICS

Course Objectives:

1. To learn Number System, Binary Codes and Boolean Algebra
2. Student will learn Boolean function representation and minimization techniques
3. To learn about Combinational Logic Circuits and Sequential Logic Circuits.
4. Student learn about Counters and their applications.
5. To learn Shift registers and their applications.
6. The objective of the course is to appraise the students about the process which help In communication.
7. Knowledge about digital electronics and digital technique.

Course Outcomes:

After completion of the course, the student should be able to:
CO1: Manipulate voltage, current and resistances in electronic circuits
CO2: Demonstrate familiarity with basic electronic components and use them to design simple electronic circuits
CO3: Design and analyse of electronic circuits,
CO4: Evaluate frequency response to understand behaviour of Electronics circuits
CO5: Problem solving ability
CO6: Critical analysis
CO7: Understand the fundamentals of converting from one number system to another.
CO8: Explain the basic logic operations of NOT, AND, OR, NAND, NOR, and XOR.
CO9: Apply the laws of Boolean algebra and K-map to simplify circuits and Boolean algebra expressions.

Topics and Learning Points

Unit 1: Study and applications of Operational Amplifiers (1 Credit)

Characteristic of op-amp, Parameters of ideal op-amp, Applications of Operational Amplifiers: Inverting and Non-inverting amplifier, Adder and Subtractor, Integrator and Differentiator, Active filters: LPF, HPF, BPF, and Notch filter 1^{st} and 2^{nd} order with designing, Instrumentation Amplifier, Function Generator – Square wave, triangular, saw tooth, sine wave. Half wave and full wave precision rectifiers, Sample and hold circuits.

Unit 2: Communication Electronics (1 Credit)

Basic principle of amplitude, frequency and phase modulation, Simple circuits for amplitude modulation and demodulation, Digital modulation (PCM) and demodulation, Fundamentals of optical communication, Microwave Oscillators (reflex, klystron, magnetron and Gunn diode), Radio detector

Unit 3: Digital Logic circuits (1 Credit)

Combinational Logic: Review of Boolean identities and its use to minimize Boolean Expressions, Minimization of Boolean Expressions using Karnaugh map: SOP and POS, Multiplexer and Demultiplexer

Sequential Logic; Flip-flops (RS, JK, MS-JK, D and T),

Shift registers using IC 7495: Applications as SISO, SIPO, PISO, PIPO etc

Counters: Synchronous, asynchronous and combinational counters, Decade counter IC 7490 with applications, Up-down counter

Unit 4: Data Converters (1 Credit)

Digital to analog Converters: Binary weighted type, R-2R ladder, Study of IC 0808,

Analog to digital converters: Single slope, Dual slope, Flash/Simultaneous type, Counter type, Successive approximation type

Reference Books:

1. Operational Amplifiers – G.B.Clayton (5th edition) Newnes
2. Operational Amplifiers Applications – G.B.Clayton
3. Electronic Principles – A. P. Malvino (TMH Publication)
4. Op-amps and Linear Integrated circuits – Gayakwad (Prentice Hall)
5. Linear Integrated circuits – D.Roy Choudhury, Shail Jain
6. Integrated circuits – Botkar
7. Digital Principles and Applications: Leach and Malvino
8. Data Converters – B.S. Sonde.

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**	**PO 8**	**PO 9**
CO 1				2					
CO 2	3				2		3		
CO 3						2		2	
CO 4		3							
CO 5		2							
CO 6		3							
CO7	3								
CO8				2					
CO9			2						2

Justification

PO1: Disciplinary Knowledge

CO7: Understand the fundamentals of converting from one number system to another. Weightage: 3

Acquiring technical skills in a laboratory setting is fundamental to building disciplinary knowledge.

CO2: Demonstrate familiarity with basic electronic components and use them to design simple electronic circuits. Weightage: 3

Creating experimental models for better understanding involves disciplinary knowledge and direct application, indicating a strong relationship. Weightage: 3

PO2: Critical Thinking and Problem Solving

CO4: Evaluate frequency response to understand behaviour of Electronics circuits. Weightage: 3

Critical thinking is essential in collecting and interpreting data in a laboratory setting.

CO6: Critical analysis. Weightage: 3

Visualizing and experiencing abstract concepts require critical thinking skills.

CO5: Problem solving ability. Weightage: 2

Applying knowledge in project work involves problem-solving skills, but the link may not be as direct as in other cases.

PO3: Social Competence

CO9: Apply the laws of Boolean algebra and K-map to simplify circuits and Boolean algebra expressions. Weightage: 3

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

PO4: Research-related Skills and Scientific Temper

CO1: Manipulate voltage, current and resistances in electronic circuits. Weightage: 2

Acquiring technical skills can be part of research-related skills, but the link may not be as direct.

CO8: Explain the basic logic operations of NOT, AND, OR, NAND, NOR, and XOR. Weightage: 2

Visualizing abstract concepts can be part of developing a scientific temper, but the link may not be as strong.

PO5: Trans-disciplinary Knowledge

CO2: Demonstrate familiarity with basic electronic components and use them to design simple electronic circuits Weightage: 2

Collaborative learning and teamwork contribute to trans-disciplinary knowledge, but the link may not be as strong.

PO6: Personal and Professional Competence

CO3: Design and analyse of electronic circuits 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

CO2: Demonstrate familiarity with basic electronic components and use them to design simple electronic circuits. Weightage: 3

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

PO8: Environment and Sustainability

CO3: Design and analyse of electronic circuits. Weightage: 2

Adhering to laboratory safety procedures can indirectly contribute to considerations of environment and sustainability.

PO9: Self-directed and Life-long Learning

CO9: Apply the laws of Boolean algebra and K-map to simplify circuits and Boolean algebra expressions. Weightage: 2

Applying knowledge in project work is relevant to self-directed and life-long learning, though the link may not be as direct.

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	: **I**
Course Type	: Major Elective
Course Name	: **PHYSICS OF THIN FILMS-I**
Course Code	: **PHY-511-MJE (C)**
No. of Lectures	: **60**
No. of Credits	: **4**

PHY-511-MJE (C): PHYSICS OF THIN FILMS

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: Introduction to thin films **(1 Credit)**

Overview of vacuum techniques, Comparison of thin and thick films, Theory of growth of thin films: Nucleation, condensation, Frank-Van der Merwe model, Volmer-Weber model, Stranski-Krastanov model, Capillarity model, Atomistic model, comparison of models, various stages of film growth.

Unit 2: Deposition Techniques and Measurement of thickness **(1 Credit)**

Physical methods: Vacuum Techniques (i) Thermal evaporation methods: Resistive heating, Electron Beam Evaporation, (ii) Sputtering system: Glow discharge, DC sputtering, Radio frequency sputtering, Magnetron sputtering, Ion beam sputtering. Chemical Methods: Chemical vapor deposition system (CVD), Chemical bath deposition: Ionic and solubility products, Preparation of binary semiconductors, Electrochemical deposition: Deposition mechanism and Preparation of compound thin films, Spray pyrolysis: Deposition mechanism and preparation of compound thin films. Doctor blade technique, Dip coating and Spin coating, Photolithography, Electron–beam deposition, Pulsed Laser Ablation, Tolansky technique, Talystep (styles) method, Quartz crystal microbalance, Stress measurement by optical method, Gravimetric method.

Unit 3: Properties of thin films **(1 Credit)**

Electrical Properties: Source of Resistivity in Metallic conductors, Influence of thickness on the resistivity of thin films, Hall Effect & Magnetoresistance in thin films, Fuch-Sondhemir theory, TCR and its effects. Mechanical properties: Adhesion & its measurement with mechanical and nucleation methods, stress measurement by using optical method. Optical properties: Absorption and transmission.

Unit 4: Applications of Thin Films **(1 Credit)**

Resistors, capacitors, Junction devices (Metal semiconductor junction) Solar cells, ICs, Optical coating, Thin film sensors (gas and humidity), Thin films for information storage, electro acoustics and telecommunication.

Reference books:

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

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**	**PO 8**	**PO 9**
CO 1	3			2					
CO 2	3					2			
CO 3	3					2	3	2	
CO 4									
CO 5		2							
CO 6									
CO7			2		2				
CO8		3		2					2
CO9		3							

Justification

PO1: Disciplinary Knowledge

CO1: To understand the principle, differences and similarities, advantages, and disadvantages of different thin film deposition Techniques. Weightage: 3

Acquiring technical skills in a laboratory setting is fundamental to building disciplinary knowledge.

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. Weightage: 3

Creating experimental models for better understanding involves disciplinary knowledge and direct application, indicating a strong relationship. Weightage: 3

Visualizing and experiencing abstract concepts directly contribute to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO8: Evaluate and use models for nucleating and growth of thin films: 3

CO9: Asses the relation between deposition technique, film structure, and film properties. Weightage3

Critical thinking is essential in use models for nucleating and growth of thin films and interpreting Assess the relation between deposition technique, film structure, and film properties
CO4: To improve problems solving skills related to evaluation of different properties of thin films.
CO5: Problem solving ability Weightage: 2
Applying knowledge in project work involves problem-solving skills, but the link may not be as direct as in other cases.

PO3: Social Competence

CO7: Discuss the differences and similarities between different vacuum based deposition techniques. Weightage: 3
Collaborative learning and teamwork in a laboratory setting directly contribute to social competence.

PO4: Research-related Skills and Scientific Temper

CO1: To understand the principle, differences and similarities, advantages, and disadvantages of different thin film deposition Techniques. Weightage: 2
Acquiring technical skills can be part of research-related skills, but the link may not be as direct.
CO8: Evaluate and use models for nucleating and growth of thin films. Weightage: 2
Evaluate and use models can be part of developing a scientific temper, but the link may not be as strong.

PO5: Trans-disciplinary Knowledge

CO7: Discuss the differences and similarities between different vacuum based deposition techniques. Weightage: 2
Collaborative learning and teamwork contribute to trans-disciplinary knowledge, but the link may not be as strong.

PO6: Personal and Professional Competence

CO2: To understand and evaluate and use models for understanding nucleation and growth of thin film Weightage: 2
Collaborative learning and teamwork contribute to personal and professional competence, though the link may not be as direct.
CO3: To understand about different instrumentation techniques and to analyze thin film properties to apply for various applications.
Collaborative learning and teamwork contribute to personal and professional competence, though the link may not be as direct.

PO7: Effective Citizenship and Ethics

CO2: To understand and evaluate and use models for understanding nucleation and growth of thin films. Weightage: 3
Understanding laboratory procedures, especially safety and scientific methods, directly contributes to effective citizenship and ethics.

PO8: Environment and Sustainability

CO3: To understand about different instrumentation techniques and to analyze thin film properties to apply for various applications. Weightage: 2

Adhering to laboratory safety procedures can indirectly contribute to considerations of environment and sustainability.

PO9: Self-directed and Life-long Learning

CO8: Evaluate and use models for nucleating and growth of thin film. Weightage: 2

Applying knowledge in project work is relevant to self-directed and life-long learning, though the link may not be as direct.

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	: **I**
Course Type	: Research Methodology
Course Name	: Research Methodology
Course Code	: **PHY-521-RM**
No. of Lectures	: **60**
No. of Credits	: **4**

PHY-521-RM: RESEARCH METHODOLOGY

Learning Objectives

1. Students should understand a general definition of research design.
2. Students should know why educational research is undertaken, and the audiences that profit from research studies.
3. Students should be able to identify the overall process of designing a research study from its inception to its report.
4. Students should be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research.
5. Students should know the primary characteristics of quantitative research and qualitative research.
6. Students should be able to identify a research problem stated in a study.
7. Students should be familiar with how to write a good introduction to an educational research study and the components that comprise such an introduction

Learning outcomes

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

CO1: Actively consider and take up research and associated higher studies in large numbers.

CO2: Aware of the details associated with formal research.

CO3: Overcome common misconceptions that may be present in their minds.

CO4:Take up research activities in a more systematic and formal manner right from the beginning.

CO5: Demonstrate the ability to choose methods appropriate to research aims and objectives.

CO6: Understand the limitations of particular research methods.

CO7: Demonstrate the ability to choose methods appropriate to research aims and objectives

CO8: Problem solving ability

CO9: Critical analysis

Topics and Learning Points

Unit 1: Overview of Research **(1 Credit)**

Different aspects of research, difference between ug degree courses and research, Learning and Creativity, Nature of research, Selection of research area and research guide/advisor, Role of advisor and students, Art of enquiry- postulating, Honesty in research, just in time learning, Strategic learning, In-depth learning, Teamwork in research, characteristics of human curiosity, characteristics of researchers

Unit 2: Overview of Literature Survey **(1 Credit)**

Need of literature survey, sources of literature- open access, primary sources, secondary sources, and Tertiary sources, INDEST arrangement, library subscriptions, research gate, academia.edu, sci-hub, some terminologies in literature, Awareness about- Journal impact factor, citation index, h-index, strategies to search-Keyword search, backward chronological search, forward chronological search, systematic manual search, citation information, publishers, major publishers, online access, research papers, thesis, reference manager, literature survey using-web of science, Scopus, Referencing using BibTex in LaTeX.

Unit 3: Data Analysis and Modelling Skills **(1 Credit)**

Experimental skills, need of data analysis, types of analyses-exploratory, quantitative, descriptive, predictive, different types of data in analysis-deterministic, stochastic, terminology in data analysis/statistical inferencing, data analysis procedure, systematic procedure with examples, use of softwares for data analysis, Preliminary questions in analysis, preparing data, Assessing and reporting results, Bibliography, aspects of modelling, first principles and empirical models, systematic procedure for building data driven models, few critical aspects of data driven modelling, modelling skills.

Unit 4: Creativity and Ethics in Research (1 Credit)

Sternberg's theory of creativity, 10,000-hour rule by Herbert Simon, Medawar's ideas on research problems, traits of a creative researcher, attributes of a good researcher, Important instances of creativity, types of intelligence, knowledge, thinking styles, motivation, environment, role of stress in research, principle way for occurrence of creativity, Flow and creativity in research, components of flow, management of creativity, Nobel prize winners and famous scientists in Physics, Lessons from history, key road blocks and aids to creativity, The research process, Ethics and research, ethical dimensions of research, consequences, ethical and associated issues, Research ethics, unethical behaviour, Evolution of modern research ethics, researchers obligations, other important issues in research.11

Reference books:

1. Research in Education, 10th Edition- Best & Kahn
2. Research Methodology- C.R. KOTHAR.
3. Methodology of Educational Research- Lokesh Koul
4. Case Study Research- John McLeod
5. Foundations of Behavioural Research- Fred N Kerlinger
6. Research Methods- Rashmi Agrawal

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**	**PO 8**	**PO 9**
CO 1						2			
CO 2			2		2				
CO 3			2				3		
CO 4	3			2		2		2	
CO 5	3	3		2				2	
CO 6				2					2
CO7		3		2					
CO8		2							
CO9		2							

Justification

PO1: Disciplinary Knowledge

CO5: Demonstrate the ability to choose methods appropriate to research aims and objectives. Weightage: 3

Acquiring technical skills in a laboratory setting is fundamental to building disciplinary knowledge.

CO4: Take up research activities in a more systematic and formal manner right from the beginning Weightage: 3

Creating experimental models for better understanding involves disciplinary knowledge and direct application, indicating a strong relationship. Weightage: 3

Visualizing and experiencing abstract concepts directly contribute to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO5: Demonstrate the ability to choose methods appropriate to research aims and objectives. Weightage: 3

Critical thinking is essential in collecting and interpreting data in a laboratory setting.

CO7: Demonstrate the ability to choose methods appropriate to research aims and objectives. Weightage: 3

Visualizing and experiencing abstract concepts require critical thinking skills.

CO8: Problem solving ability

CO9: Critical analysis. Weightage: 2

Applying knowledge in project work involves problem-solving skills, but the link may not be as direct as in other cases.

PO3: Social Competence
CO2: Aware of the details associated with formal research.
CO3: Overcome common misconceptions that may be present in their minds. Weightage: 3
Collaborative learning and teamwork: Overcome common misconceptions directly contribute to social competence.

PO4: Research-related Skills and Scientific Temper
CO4: Take up research activities in a more systematic and formal manner right from the beginning.
Acquiring technical skills can be part of research-related skills, but the link may not be as direct
CO5: Demonstrate the ability to choose methods appropriate to research aims and objectives.
Acquiring technical skills can be part of research-related skills, but the link may not be as direct
CO6: Understand the limitations of particular research methods. Weightage: 2
CO7: Demonstrate the ability to choose methods appropriate to research aims and objectives. Weightage: 2
Visualizing abstract concepts can be part of developing a scientific temper, but the link may not be as strong.

PO5: Trans-disciplinary Knowledge
CO2: Aware of the details associated with formal research. Weightage: 2
Collaborative learning and teamwork contribute to trans-disciplinary knowledge, but the link may not be as strong.

PO6: Personal and Professional Competence
CO1: Actively consider and take up research and associated higher studies in large numbers.
CO4: Take up research activities in a more systematic and formal manner right from the beginning. 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
CO3: Overcome common misconceptions that may be present in their minds. Weightage: 3
Overcome common misconceptions that may be present in their minds contributes to effective citizenship and ethics.

PO8: Environment and Sustainability

CO4:Take up research activities in a more systematic and formal manner right from the beginning.

CO5: Demonstrate the ability to choose methods appropriate to research aims and objectives.

Weightage: 2

Adhering to laboratory safety procedures can indirectly contribute to considerations of environment and sustainability.

PO9: Self-directed and Life-long Learning

CO1: Actively consider and take up research and associated higher studies in large numbers.

CO2: Aware of the details associated with formal research. Weightage: 2

Applying knowledge in project work is relevant to self-directed and life-long learning, though the link may not be as direct.