



Anekant Education Society's

**Tuljaram Chaturchand College
of Arts, Science and Commerce, Baramati
(Empowered Autonomous)**

Three/Four Year Honours/ Honours with Research B.Sc. Degree

Program in Physics

(Faculty of Science)

CBCS Syllabus

T.Y.B.Sc. (Physics) Semester –V

For

Department of Physics

Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Choice Based Credit System Syllabus

(2024 Pattern)

(As Per NEP- 2020)

To be implemented from Academic Year 2026-2027

Title of the Programme: T.Y.B.Sc. (Physics)**Preamble**

AES's Tuljaram Chaturchand College has made the decision to change the syllabus of across various faculties from June, 2024 by incorporating the guidelines and provisions outlined in the National Education Policy (NEP)2020. The NEP envisions making education more holistic and effective and to lay emphasis on the integration of general (academic) education, vocational education and experiential learning. The NEP introduces holistic and multidisciplinary education that would help to develop intellectual, scientific, social, physical, emotional, ethical and moral capacities of the students. The NEP 2020 envisages flexible curricular structures and learning based outcome approach for the development of the students. By establishing a nationally accepted and internationally comparable credit structure and courses framework, the NEP 2020 aims to promote educational excellence, facilitate seamless academic mobility and enhance the global competitiveness of Indian students. It fosters a system where educational achievements can be recognized and valued not only within the country but also in the international arena, expanding opportunities and opening doors for students to pursue their aspirations on a global scale.

In response to the rapid advancements in science and technology and the evolving approaches in various domains of Physics and related subjects, the Board of Studies in Physics at Tuljaram Chaturchand College, Baramati - Pune has developed the curriculum for the first semester of T.Y.B.Sc. Physics, which goes beyond traditional academic boundaries. The syllabus is aligned with the NEP 2020 guidelines to ensure that students receive an education that prepares them for the challenges and opportunities of the 21st century. This syllabus has been designed under the framework of the Choice Based Credit System (CBCS), taking into consideration the guidelines set forth by the National Education Policy (NEP) 2020, LOCF (UGC), NCfR, NHEQF, Prof. R.D. Kulkarni's Report, Government of Maharashtra's General Resolution dated 20th April and 16th May 2023 and the Circular issued by SPPU, Pune on 31st May 2023. Physics is concerned with the study of the universe from the smallest to the largest scale: it is about unravelling its complexities to discover the way it is and how it works. Discoveries in physics have formed the foundation of countless technological advances and play an important role in many scientific areas. Many techniques used in medical imaging, nanotechnology and quantum computing are derived from physics instrumentation. Even the World Wide Web was a

spin-off from the information processing and communications requirements of high-energy particle physics. The contributions of physics to solving global problems such as energy production, environmental protection, global warming and public health are essential and have an enormous impact on our society.

The systematic and planned curricula from first year to third year/fourth year honours shall motivate and encourage the students for pursuing higher studies in Physics and for becoming an entrepreneur.

• Programme Specific Outcomes (PSOs)

PSO1: Understand basic mechanics and properties of matter

It refers to the ability of students to understand the fundamental concepts of mechanics and the properties of matter, such as force, motion, energy, elasticity, viscosity and surface tension. This knowledge helps in analyzing physical phenomena and solving practical problems in science and engineering.

PSO2: Illustrate the principles of electricity, magnetism, thermodynamics, optics and Spectroscopy

It focuses on understanding and applying the fundamental principles of electricity, magnetism, thermodynamics, optics and spectroscopy to explain various natural phenomena and technological applications, enabling students to solve problems and innovate in science and engineering.

PSO3: Identify, formulate and analyze complex problems using basic principles of mathematics, physics and statistics

It emphasizes the ability to identify, formulate, and analyze complex problems in science and engineering by applying fundamental principles of mathematics, physics, and statistics, enabling students to develop effective solutions.

PSO4: Design, construct and analyze basic electronic and digital circuits

This outcome focuses on developing the ability to design, construct, and analyze basic electronic and digital circuits using fundamental principles of electronics. It helps students to

understand the working of various electronic components and systems, enabling them to apply their knowledge in practical applications.

PSO5: Understand the basics of programming language and apply it to various numerical problems

This outcome aims to develop a basic understanding of programming languages to solve various numerical and scientific problems. It helps students to apply computational methods and algorithms for problem-solving in physics and related fields. This skill enhances their analytical thinking and technical abilities, preparing them for research and practical applications.

PSO6: Develop effective communication skills

This outcome focuses on enhancing students' communication skills to effectively express their ideas, concepts, and research findings. It helps them to communicate clearly and confidently in both written and verbal forms, which is essential in academic and professional settings. Strong communication skills also improve their ability to collaborate, present, and share knowledge in scientific and technical fields.

PSO7: Develop experimental skills and independent work culture through a series of experiments that compliment theories and projects

This outcome aims to enhance students' experimental skills by conducting practical experiments that support and strengthen theoretical knowledge. It also encourages students to work independently, fostering a self-reliant and research-oriented work culture. Through hands-on experiments and projects, students gain practical experience, enabling them to apply scientific concepts effectively in real-world scenarios.

Anekant Education Society's
Tuljaram Chaturchand College, Baramati
(Empowered Autonomous)

Board of Studies (BOS) in Physics

From 2025-26 to 2027-28

Sr. No.	Name	Designation
1	Dr. Kale Rajendra Devidas Head, Department of Physics, T. C. College, Baramati.	Chairperson
2	Dr. Pathan H.M. Associate Professor, Department of Physics, Savitribai Phule Pune University, Pune	Vice-Chancellor Nominee Subject Expert from SPPU, Pune
3	Prof. Dr. Patil Vikas Baburao Professor & Head, Department of Physics Punyashlok Ahilyadevi Holkar Solapur University, Solapur	Subject Expert from Outside the Parent University
4	Dr. Patil Umakant Mahadev Associate Professor, D.Y. Patil University, Kolhapur	Subject Expert from Outside the Parent University
5	Mr. Bhabale Amar Ramesh Head - Production Planning at Piaggio Vehicles Pvt. Ltd, Pune	Representative from industry/corporate sector/allied areas
6	Mr. Mahanavar Balbhim Sahebrao Assistant Professor, Department of Physics, Dada Patil Mahavidyalaya, Karjat	Member of the College Alumni
7	Dr. Sapkal Ramchandra Tukaram Associate Professor, Department of Physics, T. C. College, Baramati	Member
8	Dr. Kulkarni Sachin Babasaheb Assistant Professor, Department of Physics, T. C. College, Baramati	Member
9	Mr. Kakade Sandip Bhimrao Assistant Professor, Department of Physics, T. C. College, Baramati	Member
10	Dr. Mohite Vijay Sampat Assistant Professor, Department of Physics, T. C. College, Baramati	Member
11	Mrs. Bhosale Shubhangi Eknath Assistant Professor, Department of Physics, T. C. College, Baramati	Member
12	Mr. Thorat Sopan Muralidhar Assistant Professor, Department of Physics, T. C. College, Baramati	Member

13	Mr. Shinde Pratik Kishor Assistant Professor, Department of Physics, T. C. College, Baramati	Member
14	Mr. Madhare Pratik Laxman Assistant Professor, Department of Physics, T. C. College, Baramati	Member
15	Miss. Jadhav Sai Vikas	UG Student
16	Miss. Phadtare Dnyaneshwari Rajendra	PG Student

Department of Physics

T.Y.B.Sc. Semester-V

Credit Distribution Structure for Three/ Four Year Honours s/Honours with Research Degree Programme with Multiple Entry and Exit options as per National Education Policy (2024 Pattern)

Level/ Difficulty	Sem	Subject - 1	Subject-2	Subject-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total			
4.5/100	I	2(T)+2 (P)	2(T)+2(P)	2(T)+2 (P)	2 (T)	2(T/P)	2(T) (Generic)	2(T)	2	--	22			
	II	2(T)+2 (P)	2(T)+2(P)	2(T)+2 (P)	2 (P)	2(T/P)	--	2(T)	2	2	22			
<p>Exit option: Award of UG Certificate in Major with 44 credits and an additional 4credits core NSQF course/Internship OR Continue with Major and Minor Continue option: Student will select one subject among the (subject1,subject 2 and subject 3) as major and another as minor and third subject will be dropped.</p>														
Level / Difficulty	Sem	Credits Related to Major				Minor		GE/OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP/OJT/CEP									
5.0/200	III	4(T)+2 (P)	--	2(T/P)	2 (FP)	2(T)+2(P)	--	2 (T)	--	2 (T) (Subject Specific)	2(T)	--	2	22
	IV	4(T)+2 (P)	--	2(T/P)	2 (CEP)	2(T)+2(P)	--	2 (P)	2(T/P)	--	2(T)	--	2	22
<p>Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/Internship OR Continue with Major and Minor</p>														
5.5/300	V	8(T)+4(P)	2(T)+2 (P)		4 (OJT)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T)+4(P)	2(T)+2 (P)	2(T/P) 2(T/P)	2 (FP)	--	--	--	--	--	--	--	--	22
Total3Years		44	8	8	10	18	8	8	6	4	8	4	6	132
<p>Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor</p>														
6.0/400	VII	6(T)+4 (P)	2(T)+2 (T/P)	--	--	4 (RP)	4(RM)(T)	--	--	--	--	--	--	22
	VIII	6(T)+4 (P)	2(T)+2 (T/P)	--	0	8 (RP)	0		0	0	0	0	0	22
Total4Years		68	16	8	2	22	22		12	6	8	4	8	176
<p>Four Year UG Research Degree in Major and Minor with 176 credits OR</p>														
6.0/400	VII	10(T)+4(P)	2(T)+2 (T/P)	0	0	0	4 (RM)		0	0	0	0	0	22
	VIII	10(T)+4(P)	2(T)+2 (T/P)	0	0	4 (OJT)	0		0	0	0	0	0	22
Total4Years		76	16	8	2	14	22		12	6	8	4	8	176
<p>Four Year UG Honours Degree in Major and Minor with 176 credits</p>														

Course Structure for F.Y.B.Sc. (2024 Pattern) as per NEP-2020

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
I (4.5)	DSC-I (General)	-101-GEN		T	02
		-102-GEN		P	02
	DSC-II(General)	-101-GEN		T	02
		-102-GEN		P	02
	DSC-III (General)	PHY-101-GEN	Mechanics & Properties of Matter	T	02
		PHY-102-GEN	Physics Practical-I	P	02
	(OE)Open Elective	PHY-103-OE	Astronomy Indian-I	T	02
	Skill Enhancement (SEC)Course	PHY-104-SEC	Applications of Internet of Things-I	P	02
	Ability Enhancement (AEC)Course	ENG-104-AEC	Functional English-I	T	02
	Value Education Course (VEC)	ENV-105-VEC		T	02
Generic Indian System Knoweldge (GIKS)	GEN-106-IKS		T	02	
Total Credits Semester-I					22
II (4.5)	DSC-I(General)	-151-GEN		T	02
		-152-GEN		P	02
	DSC-II (General)	-151-GEN		T	02
		-152-GEN		P	02
	DSC-III (General)	PHY-151-GEN	Heat andThermodynamics	T	02
		PHY-152-GEN	Physics Practical –II	P	02
	Open Elective (OE)	PHY-153-OE	-Indian AstronomyII	P	02
	Skill Enhancement (SEC)Course	PHY-154-AEC	Applications of Internet of Things-II	P	02
	Ability Enhancement Course (AEC)	ENG-154-AEC	Functional English-II	T	02
	Value Education Course (VEC)	COS-155-VEC		T	02
Co-curricular Course (SS)	YOG/PES/CUL/ NSS/NCC-156- CC	To be selected from the CC Basket	T	02	
Total Credits Semester-II					22
Cumulative Credits Semester-I + Semester-II					44

Course Structure for S.Y.B.Sc. (2024 Pattern) as per NEP-2020

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
III (5.0)	Major Mandatory	PHY-201-MRM	Mathematical Methods in Physics	Theory	02
	Major Mandatory	PHY-202-MRM(A)/ PHY-202-MRM(B)	Analog Electronics/ Instrumentation-I	Theory	02
	Major Mandatory	PHY-203-MRM	Major Physics Practical-I	Practical	02
	Vocational Skill Course (VSC)	PHY-204-VSC	Python Programming in Physics	Practical	02
	Field Project(FP)	PHY-205-FP	Field Project	Practical	02
	Minor	PHY-206-MN	Basic Physics	Theory	02
	Minor	PHY-207-MN	Minor Physics Practical - I	Practical	02
	Open Elective (OE)	PHY-208-OE	Astronomy-I	Theory	02
	Subject Specific Indian Knowledge System (IKS)	PHY-209-IKS	Knowledge System of Bharata	Theory	02
	Ability Enhancement Course (AEC)	MAR-210-AEC/ HIN-210-AEC/ SAN-210-AEC	मराठी भाषेची कौशल्ये -१ हिंदी भाषा : सृजन कौशल Prathamik Sambhashan Kaushalyam	Theory (Any One)	02
Co-curricular Course (CC)	YOG/PES/CUL/NSS /NCC-211-CC	To be continued from the Semester - II		02	
Total Credits Semester - III					22
IV (5.0)	Major Mandatory	PHY-251- MRM	Waves and Oscillations	Theory	02
	Major Mandatory	PHY-252- MRM(A)/ PHY-252- MRM(B)	Digital Electronics/ Instrumentation-II	Theory	02
	Major Mandatory	PHY-253- MRM	Major Physics Practical-I	Practical	02
	Vocational Skill Course (VSC)	PHY-254-VSC	Python Programming in Physics	Theory	02
	Community Engagement Project (CEP)	PHY-255-CEP	Community Engagement Project	Practical	02
	Minor	PHY-256-MN	Thermometry	Theory	02
	Minor	PHY-257-MN	Minor Physics Practical - I	Practical	02
	Open Elective (OE)	PHY-258-OE	Astronomy-II	Practical	02
	Skill Enhancement Course (SEC)	PHY-259-SEC	Practical on Data Analysis and Graphing Software	Practical	02
	Ability Enhancement Course (AEC)	MAR-260-AEC/ HIN-260-AEC/ SAN-260-AEC	मराठी भाषेची कौशल्ये-२ हिंदी भाषा : संप्रेषण कौशल Prathamik Sambhashan Kaushalyam	Theory (Any One)	02
Co-curricular Course (CC)	YOG/PES/CUL/NSS /NCC-261-CC	To be continued from the Semester - III		02	
Total Credits Semester - IV					22
Total Credits Semester – III + IV					44

Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati
Empowered Autonomous NAAC A++

Department of Physics
Course and Credit Structure for
T.Y.B.Sc. Physics (NEP-2020) 2024 Pattern

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
V (5.5)	Major Mandatory	PHY-301-MRM	Mathematical Methods in Physics	Theory	02
		PHY-302-MRM	Solid State Physics	Theory	02
		PHY-303-MRM	Classical Mechanics	Theory	02
		PHY-304-MRM	Atomic and Molecular Physics	Theory	02
	Major Mandatory	PHY-305-MRM	Major Physics Practical-I	Practical	02
		PHY-306-MRM	Major Physics Practical-II	Practical	02
	Major Elective (MJE)	PHY-307-MJE(A)	Elements of Material Science	Theory (Any one)	02
		PHY-307-MJE(B)	Renewable Energy Sources		
	Major Elective (MJE)	PHY-308-MJE(A)	Major Elective Practical-I	Practical (Any one)	02
		PHY-308-MJE(B)	Major Elective Practical-I		
	On Job Training(OJT)	PHY-309-OJT	On Job Training	Practical	04
Minor	PHY-310-MN	Electricity and Magnetism	Theory	02	
Total Credits Semester-V					22 (T =12, P=10)
VI (5.5)	Major Mandatory	PHY-351-MRM	Classical Electrodynamics	Theory	02
		PHY-352-MRM	Quantum Mechanics	Theory	02
		PHY-353-MRM	Thermodynamics and Statistical Physics	Theory	02
		PHY-354-MRM	Nuclear Physics	Theory	02
	Major Mandatory	PHY-355-MJM	Major Physics Practical-III	Practical	02
		PHY-356-MJM	Major Physics Practical-IV	Practical	02
	Major Elective (MJE)	PHY-357-MJE(A)	Physics of Nanomaterials	Theory (Any one)	02
		PHY-357-MJE(B)	Solar Energy Conversion Devices		
	Major Elective (MJE)	PHY-358-MJE(A)	Major Elective Practical-III	Practical (Any one)	02
		PHY-358-MJE(B)	Major Elective Practical-IV		
	Vocational Skill Course (VSC)	PHY-359-VSC	Instrumentation Skills in Physics	Theory	02
Vocational Skill Course (VSC)	PHY-360-VSC	VSC Practical	Practical	02	
Field Project	PHY-361-FP	Field Project	Practical	02	
Total Credits Semester-VI					22 (T =12, P=10)
Total Credits Semester-V+ VI					44

• Programme Outcomes (POs)**PO 1. Comprehensive Knowledge and Understanding**

Graduates will possess a profound understanding of their field of study, including foundational theories, principles, methodologies, and key concepts, within a broader multidisciplinary context.

PO2. Practical, Professional, and Procedural Knowledge

Graduates will acquire practical skills and expertise essential for professional tasks within their field. This includes knowledge of industry standards, best practices, regulations, and ethical considerations, with the ability to apply this knowledge effectively in real-world scenarios.

PO3. Entrepreneurial Mindset and Knowledge

Graduates will cultivate an entrepreneurial mindset, identifying opportunities, fostering innovation, and understanding business principles, market dynamics, and risk management strategies.

PO4. Specialized Skills and Competencies

Graduates will demonstrate proficiency in technical skills, analytical abilities, problem-solving, effective communication, and leadership, relevant to their field of study. They will also adapt and innovate in response to changing circumstances.

PO5. Capacity for Application, Problem-Solving and Analytical Reasoning

Graduates will possess the capacity to apply learned concepts in practical settings, solve complex problems, and analyze data effectively. This requires critical thinking, creativity, adaptability, and a readiness to learn and take calculated risks.

PO6. Communication Skills and Collaboration

Graduates will effectively communicate complex information, both orally and in writing, using appropriate media and language. They will also collaborate effectively in diverse teams, demonstrating leadership qualities and facilitating cooperative efforts toward common goals.

PO7. Research-related Skills

Graduates will demonstrate observational and inquiry skills, formulate research questions, and utilize appropriate methodologies for data collection and analysis. They will also adhere to research ethics and effectively report research findings.

PO8. Learning How to Learn Skills

Graduates will acquire new knowledge and skills through self-directed learning, adapt to changing demands, and set and achieve goals independently.

PO9. Digital and Technological Skills

Graduates will demonstrate proficiency in using ICT, accessing information sources, and analyzing data using appropriate software.

PO10. Multicultural Competence, Inclusive Spirit, and Empathy

Graduates will engage effectively in multicultural settings, respecting diverse perspectives, leading diverse teams, and demonstrating empathy and understanding of others' perspectives and emotions.

PO11. Value Inculcation and Environmental Awareness

Graduates will embrace ethical and moral values, practice responsible citizenship, recognize and address ethical issues, and take appropriate actions to promote sustainability and environmental conservation.

PO12. Autonomy, Responsibility, and Accountability

Graduates will apply knowledge and skills independently, manage projects effectively, and demonstrate responsibility and accountability in work and learning contexts.

PO13. Community Engagement and Service

Graduates will actively participate in community-engaged services and activities, promoting societal well-being.

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: PHY-301-MRM
Course Title	: Mathematical Methods in Physics
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

- 1.To study ordinary and partial differential equations, focusing on their role in describing physical phenomena such as wave motion, heat conduction, and electromagnetic fields.
- 2.To learn mathematical tools required to solve physical problem.
- 3.To understand mathematical concepts related to physics.
- 4.To understand generalized coordinate system
- 5.To explore special functions such as Bessel functions, Legendre polynomials, and Hermite polynomials, emphasizing their application to physical problems like wave equations and potential theory.
- 6.To equip students with mathematical tools and techniques for solving complex physical problems, using both analytical and numerical methods.
- 7.To provide a solid understanding of vector calculus (including gradient, divergence, and curl) and how it applies to fields like electromagnetism and fluid dynamics.

Course Outcomes:

After successful completion of the course student will be able to

- CO1. Learn some mathematical techniques required to understand the physical phenomena at the undergraduate level.
- CO2. The students will solve non-homogeneous differential equations and partial differential equations using simple methods.
- CO3. The students are expected to be able to solve simple problems on differential equation.
- CO4. Understand the generalized coordinate system and transformation equation between

Cartesian coordinate and generalized coordinates.

CO5. Can understand, model and analyze the fundamental physical processes of nature.

CO6. Can suggest mathematical models to problems they face and solve them by Various (approximate/analytical/numerical) approaches.

CO7. Can analyse systems that contain probabilistic parts; can do error analysis

Topics and Learning Points

UNIT 1: Curvilinear Co-ordinates (12L)

1.1 Introduction to Cartesian, Spherical polar and Cylindrical co-ordinate systems

1.2 Transformation equations

1.3 General Curvilinear co-ordinate system

1.4 Co-ordinate surface, lines, length and volume elements in curvilinear system

1.5 Orthogonal Curvilinear co-ordinate system

1.6 Expressions for a) gradient b) divergence c) Laplacian d) Curl in Cartesian system

1.7 Problems

UNIT 2: Differential Equations (12L)

2.1 Introduction to Partial differential equations

2.2 Method of separation of variables

2.3 Concept of Singular points

2.4 Frobenius method for power series

2.5 Solution of Legendre, Hermite and Bessel differential equation

2.6 Problems

UNIT 3: Special Functions (06L)

3.1 Generating function for Legendre, Hermite Polynomials

3.2 Recurrence relations

3.3 Properties of Legendre, Hermite Polynomials functions

3.4 Bessel function of first kind and their properties

3.5 Problems

References:

1. Mathematical method for Physicists, Arfken and Weber, Academic press New York.
2. Mathematical Physics, Rajput, Pragati Prakashan
3. Mathematical methods in the Physical sciences – Marry L. Boas, John Willy and Sons Publication.
4. Mathematical Physics, B. D. Gupta
5. Mathematical Physics, H. K. Dass

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Mathematical Methods in Physics**Course Code:** PHY-301-MRM**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	3
PO2	2	2	2	2	2	2	2
PO3	2	3	2	2	3	3	3
PO4	3	3	3	3	3	3	3
PO5	1	2	1	2	2	2	2
PO6	1	1	1	1	1	1	1
PO7	1	1	1	1	2	2	1
PO8	2	3	2	3	3	3	2
PO9	1	1	1	1	1	1	1
PO10	3	3	3	3	3	3	3
PO11	2	2	2	2	2	2	2
PO12	2	3	2	2	3	3	3
PO13	3	3	3	3	3	3	3

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO7: Understanding mathematical techniques, differential equations, and physical modeling builds a strong foundation in the field → strong (3).

PO2: Practical, Professional, and Procedural Knowledge

- CO5, CO6: Applying mathematical modeling to real problems is directly relevant → strong (3).
- CO1–CO4, CO7: Learning mathematical methods and transformations supports practical skills → moderate (2).

PO3: Entrepreneurial Mindset and Knowledge

- CO5, CO6: Mathematical modeling and problem-solving could aid innovation → moderate (2).
- Other COs: Less directly related → weak (1).

PO4: Specialized Skills and Competencies

- CO1–CO7: Analytical, problem-solving, and technical skills in mathematics → strong (3).

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning

- CO1–CO7: Direct application of mathematical concepts, differential equations, and modeling → strong (3).

PO6: Communication Skills and Collaboration

- CO1–CO7: Reporting solutions, writing derivations, and collaborating in problem-solving → moderate (2).

PO7: Research-related Skills

- CO2, CO5, CO6, CO7: Formulating models and solving complex problems develops inquiry and research skills → strong (3).
- CO1, CO3, CO4: Foundational techniques support research → moderate (2).

PO8: Learning How to Learn Skills

- CO1–CO7: Independent understanding of complex mathematical techniques → strong (3).

PO9: Digital and Technological Skills

- CO2, CO4, CO5, CO6, CO7: Use of computational/numerical tools to solve equations and analyze errors → moderate (2).
- Other COs: Minimal digital requirement → weak (1).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- Not directly applicable → weak (1).

PO11: Value Inculcation and Environmental Awareness

- CO5, CO6: Applying mathematical modeling responsibly, considering ethical practices → moderate (2).
- Other COs: Weak → 1.

PO12: Autonomy, Responsibility, and Accountability

- CO2, CO4, CO5, CO6: Requires independent work and ownership of solutions → strong (3).

- CO1, CO3, CO7: Some independence involved → moderate (2).

PO13: Community Engagement and Service

- Not directly applicable → weak (1).

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: PHY-302-MRM
Course Title	: Solid State Physics
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Understand the basics of crystallography.
2. Understand electrical properties of metals and Band theory of solids.
3. Understand the basics of magnetism
4. To study the basics of Solid-State Physics and Semiconductor Physics
5. To study the geometry, symmetry, and classification of crystal structures
6. To understand how X-ray diffraction is used to determine the crystal structure.
7. To study different types of atomic bonding in solids: ionic, covalent, metallic and van der Waals.

Course Outcomes:

After successful completion of the course student will be able to

CO1. Classify and analyse solids (crystalline, amorphous, polycrystalline) and their lattice structures, including Miller indices, inter planar distances, and atomic packing factors for various crystal types.

CO2. Understand free electron theory, its limitations, and apply concepts like energy levels, Fermi energy, the Hall Effect, and distinguish between metals, semiconductors, and insulators.

CO3. Study semiconductor behaviour, focusing on intrinsic and extrinsic properties, carrier concentrations, diffusion, and the p-n junction as a diode.

CO4. Learn about different types of magnetism (diamagnetism, paramagnetism, ferromagnetism, superconductivity) and their phenomena like hysteresis, the Meissner effect, and Curie/Neel temperatures.

CO5. Solve problems related to free electron theory, semiconductors, and magnetism to understand practical applications in solid-state physics.

CO6. Understand the relationship between atomic structure and material properties in crystalline solids, semiconductors, and magnetic materials.

CO7. Apply solid-state physics knowledge to solve problems in modern materials science, electronics, and device technology.

Topics and Learning Points

UNIT 1: Crystalline Solids (10L)

- 1.1 Introduction: Classification of solids (crystalline, amorphous & polycrystalline)
- 1.2 Lattice, Basis, Translational vectors, Primitive unit cell, Symmetry operations
- 1.3 Different types of lattices 2D and 3D (Bravais lattices)
- 1.4 Miller indices inter planer distances, Number of atoms per unit cell, Co-ordination number
- 1.5 Atomic radius and packing fraction for SC, BCC and FCC structures
- 1.6 Study of NaCl, diamond, CsCl, ZnS and HCP crystals.

UNIT 2: Free Electron Theory of Solids (06L)

- 2.1 Classical free electron theory of metals, Drawbacks of classical theory
- 2.2 Energy levels and Density of orbital in 1D and 3D, Bloch theorem (only statement and properties)
- 2.3 Nearly free electron model, Fermi energy, Fermi level, Hall Effect
- 2.4 Distinction between metal, Semiconductor and insulator
- 2.5 Problems

UNIT 3: Semiconductor (06L)

- 3.1 Intrinsic semiconductor
- 3.2 Conductivity, Carrier concentrations, Donor and Acceptor impurities
- 3.3 Extrinsic Semiconductor
- 3.4 Charge densities in a Semiconductor
- 3.5 Diffusion, Carrier lifetime, the p-n junction as a diode
- 3.6 Volt-Ampere characteristics
- 3.7 Problems

UNIT 4: Magnetism**(08L)**

4.1 Diamagnetism, Application of diamagnetic material

4.2 Superconductor, Occurrence of Superconductivity, Critical magnetic field and Meissner effect

4.3 Paramagnetism, ferromagnetism, ferromagnetic domains

4.4 Hysteresis, Curie temperature, Anti-ferromagnetism, Neel temperature

4.5 Problems

References:

1. Pillai, S. O. Solid State Physics, 10th Edition, New Age International (P) Ltd, (2022).
2. Kakani, S.L., & Hemrajani, C. Solid State Physics: Theory, Applications, and Problems 4th Edition. New Delhi: Sultan Chand & Sons (2005).
3. B.S. Saxena, R.C. Gupta, and P.N. Saxena Fundamentals of Solid State Physics 32th Edition, PragatiPrakashan (2022).
4. Charles Kittel, Introduction to Solid State Physics, 7th Edition - John Wiley and Sons, (2004).
5. A.J. Dekker, Solid State Physics, Macmillan India Ltd, (1981).
6. R.K. Puri and V.K. Babbar, Solid State Physics" S. Chand Publication (2008 reprint)
7. S.O. Pillai. Modern Physics and Solid State Physics (Problems and Solutions), New Age International (2008 reprint)
8. P.K. Palanisamy, Solid State Physics, Scitech Publications (India) Pvt Ltd. (2011)
9. Donald Neamen, Semiconductor Physics and Devices 3rd Edition, Tata McGraw-Hill (TMH) 2012.
10. S. M. Sze, 2nd ed, Semiconductor Devices: Physics and Technology. John Wiley & Sons (2002).
11. Ben G. Streetman, in collaboration with Sanjay Banerjee, Solid State Electronic Devices 7th edition, Pearson (2014)

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Solid State Physics**Course Code:** PHY-302-MRM**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	3
PO2	2	3	3	3	3	2	3
PO3	1	2	2	2	2	1	2
PO4	3	3	3	3	3	3	3
PO5	3	3	3	3	3	3	3
PO6	2	2	2	2	2	2	2
PO7	2	3	3	3	3	2	3
PO8	3	3	3	3	3	3	3
PO9	2	3	3	2	3	2	3
PO10	1	1	1	1	1	1	1
PO11	1	2	2	2	2	1	2
PO12	2	3	3	3	3	2	3
PO13	1	1	1	1	1	1	1

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO7: Students gain deep understanding of crystal structures, electronic, magnetic, and semiconductor properties → strong (3).

PO2: Practical, Professional, and Procedural Knowledge

- CO2–CO5, CO7: Understanding experimental/physical applications in semiconductors, magnetism, and devices → strong (3).
- CO1, CO6: Mostly theoretical understanding of structures → moderate (2).

PO3: Entrepreneurial Mindset and Knowledge

- CO2, CO3, CO4, CO5, CO7: Knowledge of semiconductors, magnetism, and device physics may inspire innovation or technology application → moderate (2).
- CO1, CO6: Less directly relevant → weak (1).

PO4: Specialized Skills and Competencies

- CO1–CO7: Problem-solving, analytical skills, modeling, and material analysis → strong (3).

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- CO1–CO7: Direct problem-solving and application in physics and materials → strong (3).

PO6: Communication Skills and Collaboration

- CO1–CO7: Requires reporting experiments, solutions, and discussions → moderate (2).

PO7: Research-related Skills

- CO2, CO3, CO4, CO5, CO7: Applying knowledge to experiments, device understanding, and analysis → strong (3).
- CO1, CO6: Understanding fundamental theory → moderate (2).

PO8: Learning How to Learn Skills

- CO1–CO7: Self-directed learning of materials, semiconductors, and magnetism concepts → strong (3).

PO9: Digital and Technological Skills

- CO2, CO3, CO5, CO7: Analysis of devices and materials often involves computational tools → strong (3).
- CO1, CO4, CO6: Some data handling and modeling → moderate (2).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- Not directly applicable → weak (1).

PO11: Value Inculcation and Environmental Awareness

- CO2–CO5, CO7: Understanding material properties responsibly and implications for technology → moderate (2).
- CO1, CO6: Basic theory → weak (1).

PO12: Autonomy, Responsibility, and Accountability

- CO2–CO5, CO7: Applying knowledge independently in problem-solving and device analysis → strong (3).

- CO1, CO6: Learning fundamentals → moderate (2).

PO13: Community Engagement and Service

- Not directly applicable → weak (1).

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: PHY-303-MRM
Course Title	: Classical Mechanics
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

- 1.To realize the reduction of a two-body problem to a one-body problem in a central force system
- 2.To apprise the students of Lagrangian and Hamiltonian formulations and their applications
- 3.To introduce the core laws of motion and the concepts of force, mass, acceleration, and momentum.
- 4.To solve problems involving linear and rotational motion, including projectile motion and circular motion.
- 5.To explore the relationships between force, energy and motion.
- 6.To examine systems where linear and angular momentum are conserved.
- 7.To study torque, moment of inertia, angular momentum, and rotational kinetic energy.

Course Outcomes:

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

- CO1. Explain the fundamental concepts of Newton's laws of motion and their limitations and analyze the application of these laws to various physical situations.
- CO2. Analyze projectile motion in different mediums and the motion of charged particles in constant electric, magnetic, and electromagnetic fields.
- CO3. Describe the concept of a system of particles and determine the center of mass, linear momentum, and angular momentum of the system.
- CO4. Apply the principles of conservation of momentum and energy to solve problems involving particles systems.

CO5. Understand the types of forces in nature such as gravitational force, Lorentz force, and Hooke's force and their relevance in central force problems.

CO6. Analyze the motion of bodies under central forces and solve problems related to orbits using Kepler's laws of planetary motion.

CO7. Differentiate between elastic and inelastic scattering and understand the concepts of Laboratory (Lab) and Center of Mass (CM) systems in particle scattering.

Topics and Learning Points

UNIT 1: Mechanics of System of Particles (10L)

1.1 Introduction – Newton's laws of motion, Limitations of Newton's Laws.

1.2 Applications of Newton's laws of motion: Projectile motion in various medium, Motion of a charged particle in constant electric and magnetic field.

1.3 System of particles, Centre of mass, Conservation of linear momentum, angular momentum, energy of system of particles (statements only)

1.4 Problems

UNIT 2: Scattering Theory and Motion in Central Force Field (10L)

2.1 Limitations of Newtonian mechanics, Types of constraints

2.2 Degrees of freedom, generalized coordinates, configuration space

2.3 D'Alembert's principle, Virtual displacement

2.4 Principle of virtual work.

2.5 Lagrangian dynamics and its examples.

2.6 Problems

UNIT 3: Scattering Theory of Particles (10L)

3.1 Introduction - Elastic and Inelastic Scattering

3.2 Laboratory and Centre of mass system, Relation between scattering angles in Lab and CM system

3.3 Types of forces, Central force, equivalent one body problem

3.4 General features of motion, equation of orbit.

3.5 Kepler's laws of planetary motion (statements only)

3.6 Problems

References:

1. Classical mechanics by J.C.Upadhyaya,Himalaya Publishing House.
2. Classical mechanics by N.C.Rana and P.S.Joag,Tata Mc-Graw Hill Publishing Company limited, New Delhi.
3. Classical Mechanics by P.V.Panat, Naros apublishing 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**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Classical Mechanics**Course Code:** PHY-303-MRM**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	3
PO2	2	3	3	3	2	3	2
PO3	1	1	1	1	1	1	1
PO4	3	3	3	3	3	3	3
PO5	3	3	3	3	3	3	3
PO6	2	2	2	2	2	2	2
PO7	2	2	2	2	2	2	2
PO8	3	3	3	3	3	3	3
PO9	2	2	2	2	2	2	2
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	3	3	3	2	3	2
PO13	1	1	1	1	1	1	1

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO7: Understanding Newton’s laws, central forces, momentum, energy, and particle motion → strong (3).

PO2: Practical, Professional, and Procedural Knowledge

- CO2, CO3, CO4, CO6: Applications of Newton’s laws, projectile motion, central forces → strong (3).
- CO1, CO5, CO7: Mostly conceptual understanding → moderate (2).

PO3: Entrepreneurial Mindset and Knowledge

- Course is theory- and application-focused in physics; no direct entrepreneurial component → weak (1).

PO4: Specialized Skills and Competencies

- CO1–CO7: Requires problem-solving, modeling, analytical reasoning → strong (3).

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- CO1–CO7: Directly involves applying concepts to solve mechanics problems → strong (3).

PO6: Communication Skills and Collaboration

- CO1–CO7: Students communicate solutions and reasoning in reports or discussions → moderate (2).

PO7: Research-related Skills

- CO1–CO7: Formulating approaches to mechanics problems, basic analysis → moderate (2).

PO8: Learning How to Learn Skills

- CO1–CO7: Students develop self-directed problem-solving skills → strong (3).

PO9: Digital and Technological Skills

- CO1–CO7: Some use of simulation, plotting, or computational tools for analysis → moderate (2).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- Not directly applicable → weak (1).

PO11: Value Inculcation and Environmental Awareness

- Not directly addressed → weak (1).

PO12: Autonomy, Responsibility, and Accountability

- CO2, CO3, CO4, CO6: Independent problem-solving → strong (3).
- Others more conceptual → moderate (2).

PO13: Community Engagement and Service

- Not relevant in this course → weak (1).

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Mandatory (Theory)
Course Code	: PHY-304-MRM
Course Title	: Atomic and Molecular Physics
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

After successful completion of the course students will be able to

1. The subject of Atomic and Molecular Physics has reached a significant advancement in high-precision experimental measurement techniques.
2. This area covers a wide spectrum ranging from conventional to new emerging multidisciplinary areas like molecular physics, optical science, especially spectroscopy.
3. In the present syllabus sequence of articles in each chapter enables the student to understand the gradual development of the subject
4. To study the fundamental properties and structure of atoms, including electron configurations and quantum numbers.
5. To analyse the hydrogen atom using the Schrödinger equation and understand its energy levels and wave functions.
6. To understand how electron-electron interactions affect atomic structure in multi-electron atoms.
7. To study the effects of relativistic corrections, spin-orbit coupling, and nuclear interactions on atomic energy levels.

Course Outcomes:

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

- CO1. The application of quantum mechanics in atomic physics
- CO2. The importance of electron spins, symmetric and anti symmetric wave functions, and vector atom model

CO3. Effect of magnetic field on atoms and its application

CO4. Learn Molecular physics and its applications.

CO5. This course will be useful to get an insight into spectroscopy.

CO6. Relate atomic theory to analyse spectra.

CO7. Evaluate spectroscopic data to identify elements using atomic spectra.

Topics and Learning Points

UNIT1: Atomic Structure (9L)

1.1 Atomic Models (Rutherford, Bohr, Sommerfield)

1.2 Energy levels and spectra

1.3 Vector atom model (Concepts of space and quantization and electron spin)

1.4 Atomic excitation and atomic spectra

1.5 Frank and Hertz experiment

1.6 Problems

UNIT2: One Valence Electron System (6L)

2.1 Pauli Exclusion Principle and electron configuration

2.2 Quantum states, Spectral notations of quantum states.

2.3 Energy levels of Na atom, selection rules

2.4 Problems

UNIT3: Two Valence Electron Systems (6L)

3.1 Spectral terms of two electron atoms, LS Coupling.

3.2 JJ coupling schemes.

3.3 Lande's Interval rule

3.4 Problems

UNIT4: Zeeman Effect (9L)

4.1 Early discoveries and developments

4.2 Experimental arrangement

4.3 Normal and anomalous Zeeman Effect

4.4 Normal Zeeman effect or single valence electron system

4.4 Stark effect (Qualitative discussion)

4.5 Problems

References:

1. Concepts of Modern Physics 4th edition: Arthur Baiser (McGraw Hill International ed)
2. Introduction to Atomic Spectra White. H. E (McGraw Hill International edition)
3. Fundamentals of Molecular spectroscopy: C.N. Banwell and E.M Mc Cash (McGraw Hill International edition)
4. Modern Physics: J.B. Rajam

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Atomic and Molecular Physics**Course Code:** PHY-304-MRM**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	3
PO2	2	2	2	2	2	2	2
PO3	1	1	1	1	1	1	1
PO4	3	3	3	3	3	3	3
PO5	3	3	3	3	3	3	3
PO6	2	2	2	2	2	2	2
PO7	2	2	2	2	2	2	2
PO8	3	3	3	3	3	3	3
PO9	2	2	2	2	2	2	2
PO10	1	1	1	1	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	2	2	2	2	2
PO13	1	1	1	1	1	1	1

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO7: Students learn quantum mechanics, atomic and molecular physics, electron spin, spectroscopy, and magnetic effects → strong (3).

PO2: Practical, Professional, and Procedural Knowledge

- CO1–CO7: Experiments, analyzing spectra, and applications of theory → moderate (2).

PO3: Entrepreneurial Mindset and Knowledge

- Not a focus of this course → weak (1).

PO4: Specialized Skills and Competencies

- CO1–CO7: Requires technical understanding, problem-solving, and analytical skills → strong (3).

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- CO1–CO7: Applying quantum mechanics to solve atomic and spectroscopic problems → strong (3).

PO6: Communication Skills and Collaboration

- CO1–CO7: Reporting experimental observations, interpreting spectra, and explaining results → moderate (2).

PO7: Research-related Skills

- CO1–CO7: Formulating questions, analyzing data, connecting theory and experiment → moderate (2).

PO8: Learning How to Learn Skills

- CO1–CO7: Encourages independent study, comprehension of quantum principles, and self-directed problem-solving → strong (3).

PO9: Digital and Technological Skills

- CO1–CO7: Analysis of spectroscopic data, possibly using software → moderate (2).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- Not directly applicable → weak (1).

PO11: Value Inculcation and Environmental Awareness

- Not directly addressed → weak (1).

PO12: Autonomy, Responsibility, and Accountability

- CO1–CO7: Students perform tasks and analysis independently → moderate (2).

PO13: Community Engagement and Service

- Not relevant to the course → weak (1).

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Mandatory (Practical)
Course Code	: PHY-305- MRM
Course Title	: Major Physics Practical-I
No. of Credits	: 02
No. of Teaching Hours	: 60

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 mathematica software in 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.

List of Experiments: (Students have to perform Any 8 Experiments)

1. Calculation of particle size using the XRD spectrum of any material.
2. Thermal conductivity of a rubber tube.
3. Thermal conductivity by Forbe's method.
4. Rigidity modulus of brass by electromagnetic vibration.
5. 'Y' by flexural vibration of a steel bar.
6. Moment of inertia by Bifilar Suspension.
7. Katter's Pendulum
8. Compound Pendulum
9. 'Y' by vibration of wooden scale
10. Energy gap of semiconductor
11. Four probe method
12. Study of solar cell characteristics.

2. Student Involvement (Any one equivalent to two experiments)

1. Mini Projects

Group of 4 students should carry out mini project with the report.

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

OR

2. Industrial Visit /Study Tour / Field Visit

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Major Physics Practical-I**Course Code:** PHY-305-MRM**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	2	2
PO2	2	3	3	3	3	3	2
PO3	1	1	1	1	1	1	1
PO4	3	3	3	3	3	3	3
PO5	3	3	3	3	2	3	2
PO6	2	2	2	2	2	2	2
PO7	2	2	3	3	2	3	2
PO8	3	3	3	3	3	3	3
PO9	2	3	2	3	3	2	2
PO10	1	1	2	2	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	3	3	2	3	3
PO13	1	1	1	1	1	1	1

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO5: Students gain foundational physics knowledge and computational understanding → strong (3).
- CO6–CO7: Problem-solving and time management are partly related → moderate (2).

PO2: Practical, Professional, and Procedural Knowledge

- CO2–CO5: Laboratory work and software usage demand procedural skills → strong (3).
- CO1: Basic theory knowledge indirectly supports practical work → moderate (2).
- CO7: Time management partially relates to procedural knowledge → moderate (2).

PO3: Entrepreneurial Mindset and Knowledge

- Not a focus of this course → weak (1).

PO4: Specialized Skills and Competencies

- CO1–CO7: Practical skills, analytical reasoning, experimental techniques, and problem-solving → strong (3).

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- CO1–CO4, CO6: Applying theory to labs and problem-solving → strong (3).
- CO5, CO7: Partially related to analytical reasoning → moderate (2).

PO6: Communication Skills and Collaboration

- CO1–CO7: Writing lab reports, sharing results, and team-based experiments → moderate (2).

PO7: Research-related Skills

- CO3, CO4, CO6: Formulating and performing experiments → strong (3).
- Others: Only partially foster research-related mindset → moderate (2).

PO8: Learning How to Learn Skills

- CO1–CO7: Self-directed learning for labs and software usage → strong (3).

PO9: Digital and Technological Skills

- CO2, CO4, CO5: Computational and software skills → strong (3).
- Others: Partial use of technology → moderate (2).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- CO3, CO4: Teamwork and lab collaboration → moderate (2).
- Other COs: Limited or weak relevance → weak (1).

PO11: Value Inculcation and Environmental Awareness

- Not directly addressed in lab and computational work → weak (1).

PO12: Autonomy, Responsibility, and Accountability

- CO3–CO7: Independent experiments, time management, and responsibility strong (3).
- CO1–CO2, CO5: Partial relevance → moderate (2).

PO13: Community Engagement and Service

- Not addressed in the course → weak (1).

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Mandatory (Practical)
Course Code	: PHY-306- MRM
Course Title	: Major Physics Practical-II
No. of Credits	: 02
No. of Teaching Hours	: 60

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 mathematica software in 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.

List of Experiments: (Students have to perform Any 8 Experiments)

1. Plateau voltage of G.M. tube.
2. e/m by the Thomson method.
3. Study of Gaussian distribution using the G.M. tube.
4. Frank – Hertz experiment.
5. Specific heat of graphite.
6. Study of thermocouple.
7. Characteristics of Thermistor.
8. Thickness of a thin wire by laser diffraction.
9. Dead time of GM tube.
10. Use of Mathematica Software to solve Differentiation/ Integration
11. Plank's constant.

2. Student Involvement (Any one equivalent to two experiments)

1. Mini Projects

Group of 4 students should carry out mini project with the report.

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

OR

2. Industrial Visit /Study Tour / Field Visit

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Major Physics Practical-II**Course Code:** PHY-306-MRM**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	2	2
PO2	2	3	3	3	3	3	2
PO3	1	1	1	1	1	1	1
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PO9	2	3	2	3	3	2	2
PO10	1	1	2	2	1	1	1
PO11	1	1	1	1	1	1	1
PO12	2	2	3	3	2	3	3
PO13	1	1	1	1	1	1	1

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO5: Strongly supports understanding foundational physics and applying it in labs → 3
- CO6–CO7: Problem-solving and time management partially involve conceptual understanding → 2

PO2: Practical, Professional, and Procedural Knowledge

- CO2–CO5: Performing experiments and using software requires procedural knowledge → 3
- CO1: Theoretical knowledge indirectly supports practice → 2

- CO7: Time management partly aligns with professional practice → 2

PO3: Entrepreneurial Mindset and Knowledge

- Course is not focused on entrepreneurship → 1 for all COs

PO4: Specialized Skills and Competencies

- CO1–CO7: Labs, software, experiments, problem-solving, and time management → 3

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- CO1–CO4, CO6: Applying theory and solving lab problems → 3
- CO5, CO7: Partial application → 2

PO6: Communication Skills and Collaboration

- CO1–CO7: Writing reports, explaining results, lab teamwork → 2

PO7: Research-related Skills

- CO3, CO4, CO6: Formulating and performing experiments → 3
- Others: Partial exposure → 2

PO8: Learning How to Learn Skills

- CO1–CO7: Self-directed learning, adapting to software and lab procedures → 3

PO9: Digital and Technological Skills

- CO2, CO4, CO5: Using software and computational tools → 3
- Other COs: Partially supported → 2

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- CO3, CO4: Collaboration in labs → 2
- Other COs: Weak relevance → 1

PO11: Value Inculcation and Environmental Awareness

- Course content does not directly address → 1

PO12: Autonomy, Responsibility, and Accountability

- CO3–CO7: Independent experiments and time management → 3
- CO1–CO2, CO5: Partial relevance → 2

PO13: Community Engagement and Service

- Course content not related → 1

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Elective (Theory)
Course Code	: PHY-307-MJE (A)
Course Title	: Elements of Material Science
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. Students will demonstrate an understanding of core graduate-level theoretical knowledge in materials science.
2. An ability to use modern techniques, skills and engineering tools appropriate to materials science.
3. An integrated understanding of structure, properties, processing, and performance of materials systems.
4. To study the atomic and molecular structure of materials and understand how these structures influence their properties.
5. To learn about the physical, chemical, mechanical, and thermal properties of materials.
6. To study the stress-strain relationships, mechanical testing, and deformation mechanisms in materials.
7. To understand the concept of phase diagrams and the transformations that occur between different phases of a material.

Course Outcomes:

- CO1. Describe types of materials, their properties and identify types of defects.
- CO2. Explain functional properties of ceramic bulk materials and different nanomaterials.
- CO3. Select materials for design and construction. Test materials using different characterization

methods with the fundamental principles underlying and connecting the structure and properties

CO4. Students are able to apply knowledge of advanced science and engineering principles to materials systems.

CO5. Students will demonstrate proficiency in the acquisition of data using a variety of laboratory instruments and in the analysis and interpretation of such data.

CO6. An ability to apply knowledge of mathematics, science and engineering to materials issues.

CO7. Ability to design and conduct experiments and critically analyses and interpret data.

Topics and Learning Points

UNIT 1: Introduction to Materials Science (8L)

- 1.1 Historical perspectives of materials science
- 1.2 Classification of materials
- 1.3 Smart materials
- 1.4 Nano structured Materials
- 1.5 Material Properties: Mechanical, Electrical, Thermal and Magnetic

UNIT 2: Defects in Solids (8L)

- 2.1 Defects in solids: Point, Line, Surface, and Volume
- 2.2 Solid solutions and their applications, Rules of solid solubility
- 2.3 Hume-Rothery's Rules of formation of solid solution
- 2.4 Diffusion in Solids: Introduction, Mechanisms of diffusion, Fick's laws of diffusion, Solution to Fick's second law, Few applications of diffusion process,

UNIT 3: Phase Diagram (8L)

- 3.1 Basic terms: System, Surrounding, Component, Coordinates, Phase, Equilibrium.
- 3.2 Phase Diagram: definition, importance, and objective
- 3.3 Lever rule, Gibb's phase rule
- 3.4 Phase diagram of a) Sugar water b) NaCl water
- 3.5 Types of phase diagrams with construction
- 3.6 Type-I: Lens type CuNi phase diagram
- 3.7 Type-II: Only introduction
- 3.8 Type-III: Eutectic type Pb-Sn phase diagram

UNIT 4: Ceramic and Ferrite Materials

(6L)

4.1 Ceramic Phases

4.2 Classification of ceramic materials

4.3 Ceramic crystals (AX)

4.4 Mechanical behavior of ceramics

4.5 Electric properties of ceramics: dielectrics, semiconductors, piezoelectric

4.6 Magnetic Properties of ceramics: Magnetic Ceramics, hard and soft ferrites.

References:

1. Elements of materials science and Engineering: H.Van Vlach
2. Materials Science and Engineering: V. Raghavan
3. Material Science: S. L. Kakani and Amit Kakani
4. Solid State Physics: A. J. Dekker
5. Materials Science & Engineering: An Introduction (6th Edition): William D. Callister

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Elements of Material Science**Course Code:** PHY-307-MJE(A)**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	2	3	3
PO2	2	2	3	3	3	3	3
PO3	1	1	2	2	1	2	2
PO4	3	3	3	3	3	3	3
PO5	3	3	3	3	3	3	3
PO6	2	2	2	2	2	2	2
PO7	2	2	3	3	3	3	3
PO8	3	3	3	3	3	3	3
PO9	2	2	3	3	3	3	3
PO10	1	1	1	2	1	1	2
PO11	1	2	2	2	2	2	2
PO12	2	2	3	3	3	3	3
PO13	1	1	1	1	1	1	1

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO4: Requires deep understanding of materials, properties, defects, and engineering principles → 3
- CO5: Involves instruments and data acquisition partially related to theory → 2
- CO6–CO7: Applying and analyzing data strongly relies on foundational knowledge → 3

PO2: Practical, Professional, and Procedural Knowledge

- CO3–CO7: Using lab instruments, characterizing materials, and applying engineering principles → 3

- CO1–CO2: Mostly conceptual understanding → 2

PO3: Entrepreneurial Mindset and Knowledge

- CO3–CO4, CO6–CO7: Selecting materials and designing experiments involves partial innovation → 2
- CO1–CO2, CO5: Low entrepreneurial relevance → 1

PO4: Specialized Skills and Competencies

- CO1–CO7: Analytical skills, problem-solving, lab techniques, and critical interpretation → 3

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- All COs involve applying concepts, solving problems, and analyzing results → 3

PO6: Communication Skills and Collaboration

- CO1–CO7: Communicating results and collaborating in labs → 2

PO7: Research-related Skills

- CO3–CO7: Experimental design, observation, and data interpretation → 3
- CO1–CO2: Partial research exposure → 2

PO8: Learning How to Learn Skills

- CO1–CO7: Self-directed learning to understand, apply, and analyze material concepts → 3

PO9: Digital and Technological Skills

- CO3–CO7: Use of lab instruments and software for material characterization → 3
- CO1–CO2: Basic digital tools → 2

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- CO4, CO7: Collaborative labs and experiments → 2
- Others: Limited relevance → 1

PO11: Value Inculcation and Environmental Awareness

- CO2–CO5: Materials selection may consider sustainability → 2
- CO1, CO6–CO7: Partial relevance → 1–2

PO12: Autonomy, Responsibility, and Accountability

- CO3–CO7: Independent lab work, experiment design, and data interpretation → 3

- CO1–CO2: Partial autonomy → 2

PO13: Community Engagement and Service

- Course content not directly linked to community engagement → 1

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Elective (Theory)
Course Code	: PHY-307-MJE (B)
Course Title	: Renewable Energy Sources
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. To create awareness of environment quality
2. To develop skills in handling equipment's related to solar energy, biogas etc
3. To create manpower in renewable energy
4. Understand the various forms of conventional energy resources.
5. Learn the present energy scenario and the need for energy conservation.
6. Explain the concept of various forms of renewable energy.
7. To relate renewable energy development to global sustainability goals, energy access and climate change mitigation.

Course Outcomes:

- CO1. Understand the need of renewable energy resources and latest developments for environmental balance.
- CO2. Use of solar energy in the energy production with different applications like - heating, cooling, desalination, power generation, drying, cooking etc for pollution free energy consumption
- CO3. Understand concept and use of Biomass Energy and the various components used in energy generation.
- CO4. Understand the concept of Biomass energy resources and their classification along with marketing of waste for agriculture
- CO5. Address various issues of environmental imbalance using promotion of Renewable energy sources than conventional energy resources.

CO6. Illustrate the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc for domestic and rural regions.

CO7. Awareness campaign for the promotion of Solar Energy, Biomass energy resources and biogas Plants- applications for environment sustenance.

Topics and Learning Points

UNIT 1: Solar Energy

(12L)

- 1.1 Energy resources and forms of energy, Energy from sun
- 1.2 Principle of Photovoltaic cell
- 1.3 Equivalent circuit diagram of solar cell
- 1.4 Characteristics of solar cell
- 1.5 Generations of solar cell
- 1.6 Large solar PV system
- 1.7 Solar PV power system for space station
- 1.8 Problems

UNIT 2: Energy Storage System

(8L)

- 2.1 Introduction
- 2.2 Faradaic & Non-Faradaic processes
- 2.3 Battery Energy Storage Systems
- 2.4 Lead-Acid Battery
- 2.5 Lithium-ion Battery
- 2.6 Sodium-ion Battery
- 2.7 Advanced Batteries
- 2.8 Applications

UNIT 3: Biomass Energy

(10L)

- 3.1 Introduction to Biomass Energy
- 3.2 Sources of Biomass
- 3.3 Biomass conversion technologies
- 3.4 Classification of biogas plants
- 3.5 Types of biogas plants
- 3.6 Materials used for Bio gas generation
- 3.7 Applications of Biomass Energy

References:

1. Biomass Renewable Energy – D.O.hall and R.P. Overeed (John Wiley and Sons, NewYork, 1987)
2. Biomass for energy in the developing countries – D.O.Hall, G.W.barnard and P.A.Moss(Pergamon Press Ltd. 1982)
3. Thermo chemical processing of Biomass, Bridgurater A V.
4. Biomass as Fuel – L.P.White (Academic press1981)
5. Biomass Gasification Principles and Technology, Energy technology review No. 67, T.B. Read (Noyes Data Corp., 1981)

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Renewable Energy Sources**Course Code:** PHY-307-MJE(B)**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	2
PO2	2	3	3	2	2	3	2
PO3	2	2	2	2	2	2	3
PO4	2	3	3	2	3	3	2
PO5	3	3	3	3	3	3	2
PO6	2	2	2	2	2	2	3
PO7	3	2	2	2	3	2	2
PO8	3	3	3	3	3	3	2
PO9	2	3	2	2	2	3	1
PO10	2	2	2	2	2	2	3
PO11	3	3	3	3	3	3	3
PO12	2	3	3	2	3	3	2
PO13	1	2	2	1	2	2	2

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO6: Requires understanding renewable energy concepts, solar and biomass technologies → 3
- CO7: Awareness campaign builds partial knowledge → 2

PO2: Practical, Professional, and Procedural Knowledge

- CO2, CO3, CO6: Application of renewable energy systems, components, and techniques → 3
- CO1, CO4, CO5, CO7: Partial practical/procedural exposure → 2

PO3: Entrepreneurial Mindset and Knowledge

- CO7: Awareness campaigns require initiative and innovation → 3
- CO1–CO6: Exposure to opportunities in energy sector → 2

PO4: Specialized Skills and Competencies

- CO2, CO3, CO5, CO6: Applying energy technologies, problem-solving, system selection → 3
- CO1, CO4, CO7: Partial demonstration of competencies → 2

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- CO1–CO6: Solving energy application problems and understanding environmental impact → 3
- CO7: Partial problem-solving in campaign planning → 2

PO6: Communication Skills and Collaboration

- CO7: Campaigns and awareness require collaboration and communication → 3
- CO1–CO6: Limited communication activities → 2

PO7: Research-related Skills

- CO1, CO5: Understanding energy trends and evaluating environmental impacts → 3
- CO2–CO4, CO6, CO7: Partial exposure to data and analysis → 2

PO8: Learning How to Learn Skills

- CO1–CO6: Self-directed learning to understand energy systems → 3
- CO7: Partial learning in organizing campaigns → 2

PO9: Digital and Technological Skills

- CO2, CO6: Use of energy system tools, simulations, or monitoring devices → 3
- CO1, CO3–CO5: Limited digital application → 2
- CO7: Minimal digital relevance → 1

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- CO7: Awareness campaigns target community inclusion → 3
- CO1–CO6: Understanding diverse energy needs → 2

PO11: Value Inculcation and Environmental Awareness

- All COs emphasize sustainable energy and environmental balance → 3

PO12: Autonomy, Responsibility, and Accountability

- CO2, CO3, CO5, CO6: Implementing energy systems responsibly → 3
- CO1, CO4, CO7: Partial independence → 2

PO13: Community Engagement and Service

- CO7: Direct engagement via awareness campaigns → 3
- CO2–CO6: Indirect relevance → 2
- CO1, CO4: Low direct engagement → 1

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Elective (Practical)
Course Code	: PHY-308-MJE (A)
Course Title	: Major Elective Practical-I
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

1. To enable students to identify classify and differentiate, metals, ceramics, polymers, and composites based on their physical and mechanical properties.
2. To study crystal structures, grain boundaries and microstructures of materials using microscopic examination techniques.
3. To conduct standard mechanical tests such as tensile test, hardness test, Impact test etc.
4. To evaluate mechanical, thermal, electrical, and magnetic properties and understand how they influence material selection in engineering applications.
5. To perform and analyse heat treatment methods such as annealing, normalizing, hardening, and tempering, and observe their effects on material properties.
6. To prepare material samples (cutting, mounting, grinding, polishing, etching) and examine their microstructure using optical microscopy.
7. To apply experimental results in selecting appropriate materials for specific engineering applications based on performance requirements.

Course Outcomes:

After completion of this course the student will be able to

CO1: Identify and classify different engineering materials (metals, ceramics, polymers, and composites) based on their properties and applications.

CO2: Prepare metallographic specimens using standard laboratory procedures including cutting, mounting, grinding, polishing, and etching.

CO3: Examine and interpret microstructures of materials using optical microscopy.

CO4: Perform mechanical tests such as tensile, hardness, and impact tests following standard procedures.

CO5: Analyse stress–strain curves and determine mechanical properties such as yield strength, ultimate tensile strength, and ductility.

CO6: Conduct heat treatment processes (annealing, normalizing, hardening, tempering) and evaluate their effects on material properties.

CO7: Interpret experimental results and recommend suitable materials for specific engineering applications based on performance criteria.

List of Experiments: (Students have to perform Any 8 Experiments)

1. Study of Crystal Structure using Models
Identification of SC, BCC, FCC, and HCP structures using ball-and-stick models; calculation of packing factor.
2. Determination of Lattice Parameters using XRD Data (Graphical Method)
Indexing simple cubic diffraction peaks and calculating lattice constant.
3. Verification of Bragg's Law using X-ray Diffraction (XRD)
Experimental verification of Bragg condition for crystalline materials.
4. Study of Microstructure of Metals using Optical Microscope
Observation of grain boundaries in annealed and cold-worked samples.
5. Determination of Young's Modulus vibration method.
Measurement of elastic properties of metallic strips.
6. Measurement of Electrical Resistivity using Four Probe Method
Determination of resistivity of semiconductor or metal sample.
7. Determination of Band Gap of Semiconductor using PN Junction Diode
Evaluation of energy band gap from temperature variation.
8. Study of Dielectric Constant of Materials
Measurement of dielectric constant using capacitance method.
9. Thermal Conductivity of Poor Conductor using Lee's Disc Method
Determination of thermal conductivity of bad conductors.
10. Study of Magnetic Hysteresis using B–H Curve Apparatus
Determination of coercivity and retentivity of ferromagnetic material.
11. Synthesis of Nanomaterials by Sol–Gel Method
Preparation of ZnO/TiO₂ nanoparticles and basic characterization.
12. Determination of Particle Size using Scherrer Formula
Estimation of crystallite size from XRD peak broadening.

13. Measurement of Optical Absorption and Band Gap using UV–Vis Spectroscopy
Determination of band gap of thin film/nanomaterial.
14. Study of Phase Diagram (Pb–Sn System Model)
Interpretation of eutectic system and lever rule calculations.

2. Student Involvement (Any one equivalent to two experiments)

1. Mini Projects

Group of 4 students should carry out mini project with the report.

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

OR

2. Industrial Visit /Study Tour / Field Visit

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Major Elective Practical-I**Course Code:** PHY-308-MJE(A)**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	3
PO2	2	3	3	3	3	3	3
PO3	1	1	1	1	1	1	2
PO4	2	3	3	3	3	3	3
PO5	3	2	3	3	3	3	3
PO6	2	2	2	2	2	2	3
PO7	2	2	2	2	3	3	3
PO8	2	2	2	2	2	2	3
PO9	2	3	3	2	2	2	2
PO10	1	1	1	1	1	1	2
PO11	2	2	2	2	2	3	3
PO12	2	3	3	3	3	3	3
PO13	1	1	1	1	1	1	1

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO7: Understanding material types, microstructures, mechanical behavior, and heat treatment → 3

PO2: Practical, Professional, and Procedural Knowledge

- CO2–CO6: Hands-on metallography, mechanical testing, and heat treatment → 3
- CO1, CO7: Partial exposure to procedures → 2

PO3: Entrepreneurial Mindset and Knowledge

- CO7: Recommending materials for applications involves innovation → 2

- CO1–CO6: Primarily technical tasks → 1

PO4: Specialized Skills and Competencies

- CO2–CO6: Laboratory skills, analysis, and interpretation of results → 3
- CO1, CO7: Partial development of competencies → 2

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- CO1, CO3–CO7: Applying knowledge to select materials, analyze microstructures, stress–strain curves, and heat treatment effects → 3
- CO2: Following standard procedures involves less problem-solving → 2

PO6: Communication Skills and Collaboration

- CO7: Communicating material recommendations and collaborating in lab → 3
- CO1–CO6: Partial communication in lab reports → 2

PO7: Research-related Skills

- CO5–CO7: Experimental analysis, interpreting data, linking properties to performance → 3
- CO1–CO4: Observation and inquiry in labs → 2

PO8: Learning How to Learn Skills

- CO7: Independent learning for material selection → 3
- CO1–CO6: Guided lab exercises → 2

PO9: Digital and Technological Skills

- CO2–CO3: Using microscopes, instruments, and data acquisition → 3
- CO1, CO4–CO7: Moderate digital use → 2

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- CO7: Minimal relevance → 2
- CO1–CO6: Low relevance → 1

PO11: Value Inculcation and Environmental Awareness

- CO6: Heat treatment energy use, environmental considerations → 3
- CO1–CO5, CO7: Moderate awareness → 2

PO12: Autonomy, Responsibility, and Accountability

- CO2–CO7: Independent lab work, accurate reporting, responsible handling → 3

- CO1: Observational tasks → 2

PO13: Community Engagement and Service

- CO7: Applying knowledge for societal applications (material selection) → 2
- CO1–CO6: Minimal → 1

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Major Elective (Practical)
Course Code	: PHY-308-MJE (B)
Course Title	: Major Elective Practical-II
No. of Credits	: 02
No. of Teaching Hours	: 60

Course Objectives:

- 1.To provide practical understanding of different renewable energy systems such as solar and biomass energy.
- 2.To demonstrate the working principles of renewable energy devices including solar panels, solar thermal collectors and biogas plants.
- 3.To measure and analyse performance parameters of renewable energy systems such as efficiency, output power and energy conversion rates.
- 4.To conduct experiments on solar photovoltaic (PV) systems, including I–V characteristics, maximum power point tracking, and efficiency calculations.
- 5.To study energy storage systems such as batteries and evaluate their charging and discharging characteristics.
- 6.To evaluate environmental and economic aspects of renewable energy systems through practical data analysis.
- 7.To develop skills in system installation, testing, troubleshooting, and maintenance of small-scale renewable energy setups.

Course Outcomes:

At the end of the course, students will be able to:

CO1: Demonstrate the working principles of various renewable energy systems such as solar PV, solar thermal and biomass

CO2: Perform experiments on solar photovoltaic systems and determine I–V characteristics, maximum power point, fill factor and efficiency.

CO3: Measure and analyse the performance of renewable energy devices such as solar collectors under different operating conditions.

CO4: Evaluate the charging and discharging characteristics of energy storage systems such as batteries used in renewable applications.

CO5: Calculate system efficiency, output power and energy conversion parameters using experimental data.

CO6: Analyse environmental and economic feasibility of renewable energy systems based on laboratory results.

CO7: Troubleshoot, test, and recommend suitable renewable energy solutions for small-scale practical applications.

List of Experiments: (Students have to perform Any 8 Experiments)

1. I-V Characteristics of Solar Cell: Series Combination
2. I-V Characteristics of Solar Cell: Parallel Combination
3. Performance evaluation of box type and concentrating type solar cooker
4. Recording the amount of sunlight receives throughout a day using Sunshine Recorder
5. Utilizing the latent heat released by the condensing water steam using Solar Still
6. Plotting of charge–discharge curves for Battery
7. Plotting of charge–discharge curves for Supercapacitor
8. Solar Constant
9. Find out the kinetics of photocatalytic reaction
10. Study and use of Luxmeter

2. Student Involvement (Any one equivalent to two experiments)

1. Mini Projects

Group of 4 students should carry out mini project with the report.

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

OR

2. Industrial Visit /Study Tour / Field Visit

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Major Elective Practical-II**Course Code:** PHY-308-MJE(B)**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	3
PO2	2	3	3	3	3	2	3
PO3	1	1	1	1	1	2	3
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PO5	3	3	3	3	3	3	3
PO6	2	2	2	2	2	2	3
PO7	2	2	2	2	3	3	3
PO8	2	2	2	2	2	3	3
PO9	2	3	3	2	3	2	3
PO10	1	1	1	1	1	2	2
PO11	3	2	3	2	3	3	3
PO12	2	3	3	3	3	3	3
PO13	1	2	2	2	2	3	3

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO7: Understanding renewable energy principles, performance analysis, and system design → 3

PO2: Practical, Professional, and Procedural Knowledge

- CO2–CO5, CO7: Lab experiments, measurements, troubleshooting → 3
- CO1, CO6: Mostly theoretical concepts → 2

PO3: Entrepreneurial Mindset and Knowledge

- CO7: Recommending suitable energy solutions → 3

- CO6: Evaluating economic feasibility → 2
- CO1–CO5: Mostly technical → 1

PO4: Specialized Skills and Competencies

- CO2–CO7: Hands-on technical skills, problem-solving, and performance evaluation → 3
- CO1: Understanding principles → 2

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- CO1–CO7: Application of theory to experiments, troubleshooting, efficiency calculations → 3

PO6: Communication Skills and Collaboration

- CO7: Communicating recommendations, teamwork → 3
- CO1–CO6: Lab reporting and partial collaboration → 2

PO7: Research-related Skills

- CO5–CO7: Data analysis, feasibility studies, experimental evaluation → 3
- CO1–CO4: Observation, experimental procedure → 2

PO8: Learning How to Learn Skills

- CO6–CO7: Independent evaluation of renewable energy systems → 3
- CO1–CO5: Guided experiments → 2

PO9: Digital and Technological Skills

- CO2–CO5, CO7: Using instrumentation, data logging, software for analysis → 3
- CO1, CO6: Partial digital applications → 2

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- CO6–CO7: Awareness of societal and environmental impacts → 2
- CO1–CO5: Low relevance → 1

PO11: Value Inculcation and Environmental Awareness

- CO1, CO3, CO5, CO6, CO7: Environmental sustainability awareness → 3
- CO2, CO4: Moderate relevance → 2

PO12: Autonomy, Responsibility, and Accountability

- CO2–CO7: Independent lab work, ethical energy practices → 3

- CO1: Theoretical comprehension → 2

PO13: Community Engagement and Service

- CO6–CO7: Promoting sustainable energy solutions for societal benefit → 3
- CO1–CO5: Partial engagement → 1–2

**CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics
(2024 Pattern)**

Name of the Programme	: B.Sc. Physics
Programme Code	: USPH
Class	: T.Y.B.Sc.
Semester	: V
Course Type	: Minor (Theory)
Course Code	: PHY-310-MN
Course Title	: Electricity and Magnetism
No. of Credits	: 02
No. of Teaching Hours	: 30

Course Objectives:

1. To introduce the basic mathematical concepts related to electromagnetic vector fields.
2. To impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications.
3. To impart knowledge on the concepts of magnetostatics, magnetic flux density, scalar and vector potential and its applications.
4. To impart knowledge on the concepts of Faraday's law, induced emf and Maxwell's equations.
5. To impart knowledge on the concepts of Concepts of electromagnetic waves and Transmission lines.
6. To introduce various co-ordinate system and review of Maxwell's equations.
7. To identify, formulate and solve fields and electromagnetic waves propagation Problem

Course Outcomes:

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

CO1. Demonstrate and understand the electric force, field, potential and related concepts for stationary charges.

CO2. Calculate electrostatic field and potential of simple charge distributions using Coulomb's law and Gauss's law.

CO3. Demonstrate and understand the dielectrics and effect of dielectric on electric field.

CO4. Demonstrate and understand the magnetic field for steady currents using Biot-Sarvat's and Ampere's law.

CO5. Understand the concept of magnetization of materials.

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

CO7. Understand the basic mathematical concepts related to electromagnetic vector fields.

Topics and Learning Points

UNIT 1: Electrostatics (10L)

1.1 Introduction (Electric charge, Coulombs law, potential, electric field, electric flux)

1.2 Superposition Principle

1.3 Electric field due to an electric dipole

1.4 Revision of Gauss's Law

1.5 Coulomb's Law from Gauss's Law

1.6 Application of Gauss's Law

1.7 Problems

UNIT 2: Dielectrics (12L)

2.1 Introduction

2.2 Electric Dipole

2.3 Electric Dipole and Dipole Moment

2.4 Electric Potential and Intensity at any point due to Dipole

2.5 Polar and non-polar molecules

2.6 Electric polarization of dielectric material

2.7 Gauss's Law in Dielectrics

2.8 Problems

UNIT 3: Magnetization (8L)

3.1 Introduction to Magnetization

3.2 Magnetic materials

3.3 Types of Magnetic Materials

3.3.1 Diamagnetic materials

3.3.2 Paramagnetic materials

3.3.3 Feragnetic materials

3.4 Applications of mromaterials

3.5 Problems

References:

1. Basic Electrical Engineering by D.C. Kulshreshtha
2. Electricity and Magnetism, D. C. Tayal, **1988**, Himalaya Publishing House.
3. University Physics, Ronald Lane Reese, **2003**, Thomson Brooks/Cole.
4. Fundamentals of Physics: **8th** Edition, Halliday Resnik and Walker

Mapping of Program Outcomes with Course Outcomes**Class:** T.Y.B.Sc, Semester-V**Subject:** Physics**Course:** Electricity and Magnetism**Course Code:** PHY-310-MN**Weightage:** 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

Programme Outcomes (PO)	Course Outcomes (CO)						
	CO1	CO2	CO3	CO4	CO5	CO6	CO7
PO1	3	3	3	3	3	3	3
PO2	2	2	2	2	2	2	2
PO3	1	1	1	1	1	1	1
PO4	2	3	2	3	2	3	2
PO5	3	3	3	3	3	3	3
PO6	2	2	2	2	2	2	2
PO7	2	2	2	2	2	2	2
PO8	2	2	2	2	2	2	3
PO9	2	2	2	2	2	2	2
PO10	1	1	1	1	1	1	1
PO11	2	2	2	2	2	2	2
PO12	2	2	2	2	2	3	2
PO13	1	1	1	1	1	1	1

Justification**PO1: Comprehensive Knowledge and Understanding**

- CO1–CO7: Understanding electric and magnetic fields, dielectrics, and vector field concepts requires deep knowledge of physics fundamentals → 3

PO2: Practical, Professional, and Procedural Knowledge

- CO1–CO7: Laboratory demonstrations and applying laws like Coulomb's, Gauss's, Biot–Savart → 2 (moderate, as focus is mainly on understanding principles rather than professional procedures)

PO3: Entrepreneurial Mindset and Knowledge

- CO1–CO7: Low direct relevance to entrepreneurship → 1

PO4: Specialized Skills and Competencies

- CO2, CO4, CO6: Problem-solving, calculations, quantitative analysis → 3
- CO1, CO3, CO5, CO7: Understanding concepts → 2

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning

- CO1–CO7: Applying laws to solve problems and calculate fields → 3

PO6: Communication Skills and Collaboration

- CO1–CO7: Writing reports and explaining concepts → 2

PO7: Research-related Skills

- CO1–CO7: Formulating observations and applying experimental methods → 2

PO8: Learning How to Learn Skills

- CO7: Developing self-directed learning for vector fields → 3
- CO1–CO6: Guided understanding of concepts → 2

PO9: Digital and Technological Skills

- CO1–CO7: Using simulation tools or software for EM problems → 2

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

- CO1–CO7: Low relevance → 1

PO11: Value Inculcation and Environmental Awareness

- CO1–CO7: Understanding responsible use of electrical systems → 2

PO12: Autonomy, Responsibility, and Accountability

- CO6: Independent problem solving → 3
- CO1–CO5, CO7: Partial relevance → 2

PO13: Community Engagement and Service

- CO1–CO7: Minimal direct relation → 1