Anekant Education Society's

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

Four Year B.Sc. Degree Program in Physics

(Faculty of Science & Technology)

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

(2023 Pattern)

(As Per NEP 2020)

To be implemented from Academic Year 2025-2026

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, 2023 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 third 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), NCrF, 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 the third year 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. Kalange Ashok Eknath** Head & Professor, 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. Kale Rajendra Devidas** Associate Professor, Department of Physics, T. C. College, Baramati	Member
8	**Dr. Sapkal Ramchandra Tukaram** Associate Professor, Department of Physics, T. C. College, Baramati	Member
9	**Dr. Kulkarni Sachin Babasaheb** Assistant Professor, Department of Physics, T. C. College, Baramati	Member

10	**Mr. Kakade Sandip Bhimrao** Assistant Professor, Department of Physics, T. C. College, Baramati	Member
11	**Dr. Mohite Vijay Sampat** Assistant Professor, Department of Physics, T. C. College, Baramati	Member
12	**Mrs. Bhosale Shubhangi Eknath** Assistant Professor, Department of Physics, T. C. College, Baramati	Member
13	**Mr. Thorat Sopan Muralidhar** Assistant Professor, Department of Physics, T. C. College, Baramati	Member
14	**Mr. Lalge Vikrant Prakash** Assistant Professor, Department of Physics, T. C. College, Baramati	Member
15	**Miss. Pawar Aishwarya Chandrakant** Assistant Professor, Department of Physics, T. C. College, Baramati	Member
16	**Miss. Jadhav Sai Vikas**	UG Student
17	**Miss. Phadtare Dnyaneshwari Rajendra**	PG Student

Department of Physics **T.Y.B.Sc. Semester-V**

Credit Distribution Structure for Three/Four Year Honours/Honours with Research Degree Programme
With Multiple Entry and Exit options as per National Education Policy (2024 Pattern as per NEP-2020)

Level/ Difficulty	Sem	Subject DSC-1				Subject DSC-2	Subject DSC-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(T)	--	22
	II	2(T)+2(P)				2(T)+2(P)	2(T)+2(P)	2(P)	2 (T/P)	--	2(T)	2(T)	2(T)	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/Internship OR Continue with Major and Minor **Continue option**: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and other as minor and third subject will be dropped.														
Level/ Difficulty	**Sem**	**Credits Related to Major**				**Minor**	--	**GE/OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
		Major Core	**Major Elective**	**VSC**	**FP/OJT/CEP/RP**									
5.0/200	III	4(T)+2(P)	--	2 (T/P)	2(FP)	2(T)+2(P)	--	2(T)	--	2(T)	2(T)	--	2(T)	22
	IV	4(T)+2(P)	--	2 (T/P)	2(CEP)	2(T)+2(P)	--	2(P)	2 (T/P)	--	2(T)	--	2(T)	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4credits core NSQF course/Internship OR Continue with Major and Minor														
5.5/300	V	8(T)+4(P)	2(T)+2(P)	2 (T/P)	2(FP/CEP)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T)+4(P)	2(T)+2(P)	2 (T/P)	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 3Years		**44**	**8**	**8**	**10**	**18**	**8**	**8**	**6**	**4**	**8**	**4**	**6**	**132**
Exit option: Award of **UG Degree in Major** with 132 credits OR Continue with Major and Minor														
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)	--	6(RP)	--	--	--	--	--	--	--	--	22
Total 4Years		**64**	**16**	**8**	**22**	**22**	**8**	8	**6**	**4**	**8**	**4**	**6**	**176**
Four Year **UG Honours with Research Degree** in Major and Minor with 176 credits														
6.0/400	VII	10(T)+4(P)	2(T)+2 (T/P)	--	--	4(RM) (T)	--	--	--	--	--	--	--	22
	VIII	10(T)+4(P)	2(T)+2 (T/P)	--	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 4Years		**72**	**16**	**8**	**14**	**22**	**8**	8	**6**	**4**	**8**	**4**	**6**	**176**
Four Year **UG Honours Degree** in Major and Minor with176 credits														

T = Theory **P** = Practical **DSC** = Discipline Specific Course **OE** = Open Elective **SEC** = Skill Enhancement Course

IKS = Indian Knowledge System **AEC** = Ability Enhancement Course **VEC** = Value Education Course **CC** = Co-curricular Course **VSC**= Vocational Skill Course

OJT= On Job Training **CEP**= Community Engagement Project **FP**= Field Project **RP**= Research Project

Course Structure for F.Y.B.Sc. (2023 Pattern) as per NEP-2020

Sem	Course Type	Course Code	Course Name	Theory / Practical	Credits
I	Major Mandatory	PHY-101-MJM	Mechanics & Properties of Matter	Theory	2
	Major Mandatory	PHY-102-MJM	Electromagnetics	Theory	2
	Major Mandatory	PHY-103-MJM	Physics Practical-I	Practical	2
	Open Elective (OE)	PHY-116-OE	Astronomy-I [आकाशाशीजडलेनाते – भाग १]	Theory	2
	Open Elective (OE)	PHY-117-OE	Astronomy-I [आकाशाशीजडलेनाते – भाग १] Practical	Practical	2
	Vocational Skill Course (VSC)	PHY-121-VSC	Physics Workshop Skills-I	Theory	2
	Skill Enhancement Course (SEC)	PHY-126-SEC	Applications of Internet of Things-I	Practical	2
	Ability Enhancement Course (AEC)	ENG-131-AEC	Functional English-I	Theory	2
	Value Education Course (VEC)	PHY-135-VEC	Environmental Science	Theory	2
	Indian Knowledge System (IKS)	PHY-137-IKS	Knowledge System of Bharata	Theory	2
	Co-curricular Course (CC)	-	To be Selected from the Basket	Theory	2
				Total Credits Semester-I	**22**
II	Major Mandatory	PHY-151-MJM	Heat & Thermodynamics	Theory	2
	Major Mandatory	PHY-152-MJM	Physics Principles & its Application	Theory	2
	Major Mandatory	PHY-153-MJM	Physics Practical-II	Practical	2
	Minor	PHY-161-MN	Basic Physics	Theory	2
	Open Elective (OE)	PHY-166-OE	Astronomy-II [आकाशाशीजडलेनाते – भाग २]	Theory	2
	Open Elective (OE)	PHY-167-OE	Astronomy-II [आकाशाशीजडलेनाते – भाग २] Practical	Practical	2
	Vocational Skill Course (VSC)	PHY-171-VSC	Physics Workshop Skills-II	Practical	2
	Skill Enhancement Course (SEC)	PHY-176-SEC	Applications of Internet of Things-II	Practical	2
	Ability Enhancement Course (AEC)	ENG-181-AEC	Functional English-II	Theory	2
	Value Education Course (VEC)	PHY-185-VEC	Value Education & Physics	Theory	2
	Co-curricular Course (CC)	-	To be Selected from the Basket	Theory	2
				Total Credits Semester-II	**22**
				Cumulative Credits Semester I + Semester II	**44**

Course Structure for S.Y.B.Sc. (2023 Pattern) as per NEP-2020

Sem	Course Type	Course Code	Course Title	Theory / Practical	Credits
III	Major Mandatory	PHY-201-MJM	Mathematical Methods in Physics	Theory	02
	Major Mandatory	PHY-202-MJM	Analog Electronics	Theory	02
	Major Mandatory	PHY-203-MJM	Basic Optics	Theory	02
	Major Mandatory	PHY-204-MJM	Practical –III	Practical	02
	Minor	PHY-241-MN	Thermometry	Theory	02
	Minor	PHY-242-MN	Minor Practical	Practical	02
	Open Elective (OE)	PHY-216-OE	Astronomy-III	Theory	02
	Vocational Skill Course (VSC)	PHY-221-VSC	Data Analysis and Graphing Software	Theory	02
	Ability Enhancement Course (AEC)	MAR-231-AEC HIN-231-AEC SAN-231-AEC	भाषिक उपयोजन व लेखन कौशल्ये हिंदी भाषा : सृजन कौशल प्राथमिक संभाषण कौशल्यम्	Theory	02
	Field Project (FP)	PHY-235-FP		Practical	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/ NCC-239-CC	To be selected from the Basket	Theory	02
				Total Credits Semester-III	**22**
IV	Major Mandatory	PHY-251-MJM	Waves and Oscillations	Theory	02
	Major Mandatory	PHY-252-MJM	Digital Electronics	Theory	02
	Major Mandatory	PHY-253-MJM	Advanced Optics	Theory	02
	Major Mandatory	PHY-254-MJM	Practical-IV	Practical	02
	Minor	PHY-261-MN	Atoms and Molecules	Theory	02
	Minor	PHY-262-MN	Practical	Practical	02
	Open Elective (OE)	PHY-266-OE	Astronomy-III	Practical	02
	Skill Enhancement Course (SEC)	PHY-276-SEC	Python Programming in Physics	Practical	02
	Ability Enhancement Course (AEC)	MAR-281-AEC HIN-281-AEC SAN-281-AEC	लेखननिर्मिती व परीक्षण कौशल्ये हिंदी भाषा : संप्रेषण कौशल प्रगत संभाषण कौशल्यम्	Theory	02
	Community Engagement Project (CEP)	PHY-285-CEP		Practical	02
	Co-curricular Course (CC)	YOG/PES/CUL/NSS/ NCC-289-CC	To be selected from the Basket	Theory	02
				Total Credits Semester-IV	**22**
				Cumulative Credits Semester III + Semester IV	**44**

Course Structure for T.Y.B.Sc. (2023 Pattern) as per NEP-2020

Sem	Course Type	Course Code	Course Title	Theory/ Practical	Credits
V (5.5)	Major Mandatory	PHY-301-MJM	Mathematical Methods in Physics	Theory	02
	Major Mandatory	PHY-302-MJM	Solid State Physics	Theory	02
	Major Mandatory	PHY-303-MJM	Classical Mechanics	Theory	02
	Major Mandatory	PHY-304-MJM	Atomic and Molecular Physics	Theory	02
	Major Mandatory	PHY-305-MJM	Major Physics Practical–I	Practical	02
	Major Elective (MJE)	PHY-306-MJE (A)	Elements of Material Science	Theory (Any two)	04
	Major Elective (MJE)	PHY-306-MJE (B)	Renewable Energy Sources		
	Major Elective (MJE)	PHY-306-MJE (C)	Biophysics		
	Minor	PHY-311-MN	Electricity and Magnetism	Theory	02
	Minor	PHY-312-MN	Minor Physics Practical - I	Practical	02
	Vocational Skill Course (VSC)	PHY-321-VSC	Major Physics Practical–II	Practical	02
	Field Project (FP)	PHY-335-FP	Field Project	Practical	02
				Total Credits Semester-V	**22**
VI (5.5)	Major Mandatory	PHY-351-MJM	Classical Electrodynamics	Theory	02
	Major Mandatory	PHY-352-MJM	Quantum Mechanics	Theory	02
	Major Mandatory	PHY-353-MJM	Thermodynamics and Stastical Physics	Theory	02
	Major Mandatory	PHY-354-MJM	Nuclear Physics	Theory	02
	Major Mandatory	PHY-355-MJM	Major Physics Practical–I	Practical	02
	Major Elective(MJE)	PHY-356-MJE (A)	Physics of Nanomaterials	Theory (Any two)	04
	Major Elective(MJE)	PHY-356-MJE (B)	Solar Energy Conversion Devices		
	Major Elective(MJE)	PHY-356-MJE (C)	Sensors and its applications		
	Minor	PHY-361-MN	Waves and Optics	Theory	02
	Minor	PHY-362-MN	Minor Physics Practical - I	Practical	02
	On Job Training (OJT)	PHY-385-OJT	On Job Training	Practical	04
				Total Credits Semester-VI	**22**
				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.

PO 2. 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.

PO 3. Entrepreneurial Mindset and Knowledge

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

PO 4. 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.

PO 5. 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.

PO 6. 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.

PO 7. 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.

PO 8. 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.

PO 9. Digital and Technological Skills

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

PO 10. 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.

PO 11. 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.

PO 12. Autonomy, Responsibility, and Accountability

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

PO 13. 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 (2023 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-MJM
Course Title : Mathematical Methods in Physics
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

1. To learn mathematical tools required to solve physical problem.
2. To understand mathematical concepts related to physics.
3. To understand generalized coordinate system
4. To equip students with the essential mathematical tools needed to solve problems in theoretical physics.
5. Students will learn and apply core mathematical techniques like vector calculus, special functions
6. The course aims to enhance students' ability to apply mathematical concepts to solve physics problems, including those in areas like electromagnetism and statistical mechanics.
7. Students will gain a deeper understanding of the mathematical principles underlying various physics theories, preparing them for more advanced studies in theoretical physics.

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 vvarious (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 (8L)

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

1.2 Transformation equations, General Curvilinear co-ordinate system

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

1.4 Orthogonal Curvilinear co-ordinate system

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

UNIT 2: Differential Equations (8L)

2.1 Partial differential equations

2.2 Degree, order, linearity, and homogeneity (Revision)

2.3 Method of separation of variables, 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 (8L)

3.1Generating function for Legendre, Hermite Polynomials

3.2 Recurrence relations, differential equations, and properties of special functions

3.3 Bessel function of first kind and their properties

3.4 Problems

UNIT 4: Special Theory of Relativity (6L)

4.1 Introduction of Special Theory of Relativity and its limitations

4.2 Newtonian relativity Galilean transformation equation

4.3 Lorentz transformations

4.4 Length contraction, Transformation of velocities

4.5 Variation of mass with velocity, Mass-energy relation

4.6 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. Introduction to special relativity, Robert Resnick, Willyeastrn Ltd.
5. Mathematical Physics, B. D. Gupta
6. Mathematical Physics, H. K. Dass

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Mathematical Methods in Physics **Course Code**: PHY-301-MJM

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	2	1	2	3	1	1	2	2	1	1	2	1
CO 2	3	2	1	2	3	1	1	2	2	1	1	2	1
CO 3	3	2	1	2	3	1	1	2	2	1	1	2	1
CO 4	3	2	1	3	3	2	1	2	2	1	1	2	1
CO 5	3	2	1	3	3	2	1	2	2	1	2	2	1
CO 6	3	3	2	3	3	2	2	3	3	1	2	3	2
CO7	3	3	1	3	3	2	2	2	3	1	2	3	1

Justification

PO1: Comprehensive Knowledge and Understanding

Strong relation (3) across all COs, as they develop foundational mathematical knowledge necessary to understand physical and engineering concepts.

PO2: Practical, Professional, and Procedural Knowledge

Moderate to strong (2–3) alignment, especially in CO6 and CO7, which involve applying methods to real-world and probabilistic problems.

PO3: Entrepreneurial Mindset and Knowledge

Low (1) relevance; although CO6 touches on problem-solving and modeling, entrepreneurial content is not directly addressed.

PO4: Specialized Skills and Competencies

Moderate to strong (2–3) in CO4–CO7, reflecting the development of analytical and modeling skills critical for professional work.

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

Strong (3) relation in all COs due to their direct focus on problem-solving, modeling, and analytical techniques.

PO6: Communication Skills and Collaboration

Low to moderate (1–2) relevance, mainly seen in CO4–CO7 where students might discuss or collaborate on complex problems.

PO7: Research-related Skills

Low to moderate (1–2); CO6 and CO7 involve approaches that are research-like (error analysis, modeling), aligning partially with research skills.

PO8: Learning How to Learn Skills

Moderate (2–3) across COs, as independent problem-solving and exploring multiple methods support self-directed learning.

PO9: Digital and Technological Skills

Moderate (2–3) relevance, particularly in CO6–CO7, where numerical/approximate solutions often require software or coding.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Low (1); mathematical problem-solving is mostly independent of cultural aspects, unless applied in diverse teams or contexts.

PO11: Value Inculcation and Environmental Awareness

Low to moderate (1–2); though not directly addressed, CO5–CO7 could support modeling environmental systems or sustainable processes.

PO12: Autonomy, Responsibility, and Accountability

Moderate to strong (2–3); students solve problems independently and take responsibility for their learning outcomes.

PO13: Community Engagement and Service

Low (1); the course does not explicitly involve community service or engagement.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics (2023 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-MJM
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 analyze solids (crystalline, amorphous, polycrystalline) and their lattice structures, including Miller indices, interplanar 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 (6L)

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 (6L)

3.1 Intrinsic semiconductor

3.2 Conductivity, Carrier concentrations, Donor and Acceptor impurities

3.3 Extrinsic Semiconductor

3.4 Charge densities in a Semiconductorr

3.5 Diffusion, Carrier lifetime, the p-n junction as a diode

3.6 Volt-Ampere characteristics

3.7 Problems

UNIT 4: Magnetism (8L)

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 (Sem- V) **Subject**: Physics

Course: Solid State Physics **Course Code**: PHY-302-MJM

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	2	1	2	3	1	1	2	2	1	1	2	1
CO 2	3	3	1	2	3	1	1	2	3	1	1	2	1
CO 3	3	3	1	3	3	1	1	2	3	1	1	2	1
CO 4	3	3	1	3	3	1	1	2	2	1	1	2	1
CO 5	3	3	1	3	3	1	2	2	3	1	1	2	1
CO 6	3	3	1	3	3	2	2	2	3	1	1	3	1
CO7	3	3	2	3	3	2	2	3	3	1	2	3	2

Justification

PO1: Comprehensive Knowledge and Understanding – Strong (3)

All COs contribute significantly to foundational knowledge in solid-state physics, including atomic and electronic structure, crystal geometry, and material behavior.

PO2: Practical, Professional, and Procedural Knowledge – Moderate to Strong (2–3)

Students learn how to apply physical concepts in real-world scenarios, like understanding semiconductor devices, magnetic materials, and structural analysis, which are foundational in materials science and electronics.

PO3: Entrepreneurial Mindset and Knowledge – Weak to Moderate (1–2)

While not directly about entrepreneurship, CO7's emphasis on applying knowledge in technology fields suggests a moderate alignment (rated 2), encouraging innovation.

PO4: Specialized Skills and Competencies – Strong (3)

CO3–CO7 involve advanced concepts in magnetism, semiconductor behavior, and device applications—skills that are highly technical and essential in research and development.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Strong (3)

All COs, especially CO5–CO7, emphasize problem-solving using theoretical and practical tools, such as analyzing carrier concentrations, magnetic behaviors, and electronic transport.

PO6: Communication Skills and Collaboration – Weak to Moderate (1–2)

Not a primary focus of the course, though group problem-solving and discussions may foster limited collaboration, especially in CO6 and CO7.

PO7: Research-related Skills – Weak to Moderate (1–2)

Basic observational and analytical skills are developed through problem-solving and conceptual understanding in CO5–CO7, which lay the groundwork for research activities.

PO8: Learning How to Learn – Moderate to Strong (2–3)

CO6 and CO7 require students to connect interdisciplinary concepts independently, supporting life-long learning and adaptability.

PO9: Digital and Technological Skills – Moderate to Strong (2–3)

Simulations, analysis tools, and software are often used to understand physical phenomena, especially in CO5–CO7, which deal with device applications and data interpretation.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy – Weak (1)

This PO is not directly addressed by the course content.

PO11: Value Inculcation and Environmental Awareness – Weak to Moderate (1–2)

CO7 may touch upon materials with environmental impact (e.g., sustainable semiconductors), though this is implicit.

PO12: Autonomy, Responsibility, and Accountability – Moderate to Strong (2–3)

CO6 and CO7 particularly require students to independently solve problems and analyze complex systems, fostering responsible learning and professional behavior.

PO13: Community Engagement and Service – Weak to Moderate (1–2)

While direct engagement isn't part of the course, CO7’s application-oriented nature could be relevant in societal contexts, such as energy devices or sensor technology.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics (2023 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-MJM
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

1.2 Newton's laws of motion, Limitations of Newton's Laws, Applications of Newton's laws of motion

1.3 Projectile motion in various mediums, Motion of a charged particle in constant electric, magnetic and electromagnetic field

1.4 System of particles

1.5 Centre of mass

1.6 Conservation of linear momentum, angular momentum, energy of system of particles (statements only)

1.7 Problems

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

2.1 Types of forces: Forces of Gravitation, Lorentz force, Hooks Force

2.2 Frictional Force

2.3 Fundamental Forces of Nature, Central force

2.4 Equivalent one body problem

2.5 General features of motion

2.6 Equation of orbit, Kepler's laws of planetary motion (statements only)

2.7 Problems

UNIT 3: Scattering Theory of Particles (10L)

3.1 Introduction

3.2 Elastic and Inelastic Scattering

3.3 Laboratory and Cente of mass system

3.4 Relation between scattering angles in Lab and CM system

3.5 Inelastic scattering

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,TataMc-Graw Hill Publishing Company limited, New Delhi.
3. Classical Mechanics by P.V.Panat, Narosapublishing Home, NewDelhi.
4. Classical Mechanics by Kumar,Gupta,Sharma.
5. Classical Mechanics by H.Goldstein,Narosa Publishing Home, NewDelhi.
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 (Sem- V) **Subject**: Physics

Course: Classical Mechanics **Course Code**: PHY-303-MJM

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	2	1	2	3	1	1	2	1	1	1	2	1
CO 2	3	2	1	2	3	1	1	2	2	1	1	2	1
CO 3	3	2	1	2	3	1	1	2	1	1	1	2	1
CO 4	3	2	1	2	3	1	1	2	2	1	1	2	1
CO 5	3	2	1	2	3	1	1	2	1	1	1	2	1
CO 6	3	3	1	3	3	1	2	2	2	1	1	2	1
CO7	3	3	1	3	3	1	2	2	2	1	1	2	1

Justification

PO1: Comprehensive Knowledge and Understanding – Strong (3)

All COs focus on the foundational laws and principles of classical mechanics, including Newton's laws, conservation laws, and central force motion—forming the backbone of physical sciences.

PO2: Practical, Professional, and Procedural Knowledge – Moderate to Strong (2–3)

Mechanics concepts like motion in fields, system of particles, and scattering are highly applicable in physics labs and real-world engineering systems, giving moderate procedural exposure.

PO3: Entrepreneurial Mindset and Knowledge – Weak (1)

While this course provides problem-solving skills, direct development of entrepreneurial knowledge or innovation is minimal.

PO4: Specialized Skills and Competencies – Moderate to Strong (2–3)

Students build analytical and problem-solving skills through force modeling, particle dynamics, and energy conservation, forming a key part of specialized physical science competency.

PO5: Capacity for Application, Problem-Solving, and Analytical Reasoning – Strong (3)

All COs require students to analyze motion, apply laws to solve problems, and model physical situations—exemplifying critical thinking and practical application.

PO6: Communication Skills and Collaboration – Weak (1)

Not directly emphasized, although problem discussions and group tasks may offer limited collaborative opportunities.

PO7: Research-related Skills – Weak to Moderate (1–2)

Some elements (e.g., CO6 and CO7) include modeling and interpretation of physical data, forming a base for research, but full research methodology is not covered.

PO8: Learning How to Learn Skills – Moderate (2)

The course promotes independent learning and concept application—especially in modeling forces, orbits, and motion under constraints.

PO9: Digital and Technological Skills – Weak to Moderate (1–2)

Although not software-focused, problems may involve computational approaches or simulations in advanced settings (especially CO6–CO7).

PO10: Multicultural Competence and Empathy – Weak (1)

No direct connection to multicultural or inclusive contexts.

PO11: Value Inculcation and Environmental Awareness – Weak (1)

Not explicitly related to ethics or environmental issues.

PO12: Autonomy, Responsibility, and Accountability – Moderate (2)

Problem-solving fosters accountability in academic tasks and builds independence in applying physics to defined problems.

PO13: Community Engagement and Service – Weak (1)

This course doesn’t directly promote engagement with community-based projects or societal issues.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics (2023 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-MJM
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 analyze 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 antisymmetric 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 analyze spectra.

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

Topics and Learning Points

UNIT 1: 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 Problems

UNIT 2: 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

UNIT 3: 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

UNIT 4: 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 for 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 (Sem- V) **Subject**: Physics

Course: Atomic and Molecular Physics **Course Code**: PHY-304-MJM

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	2	1	2	3	1	2	2	1	1	1	2	1
CO 2	3	2	1	3	3	1	2	2	2	1	1	2	1
CO 3	3	2	1	3	3	1	2	2	2	1	1	2	1
CO 4	3	2	1	3	3	1	2	2	2	1	1	2	1
CO 5	3	2	1	2	3	1	2	2	2	1	1	2	1
CO 6	3	3	1	3	3	1	2	2	2	1	1	2	1
CO7	3	3	1	3	3	2	3	2	2	1	1	2	1

Justification

PO1: Comprehensive Knowledge and Understanding – Strong (3)

All COs involve deep theoretical concepts such as quantum mechanics, atomic structure, vector atom model, and spectroscopy—forming a strong knowledge base in atomic and molecular physics.

PO2: Practical, Professional, and Procedural Knowledge – Moderate to Strong (2–3)

The application of these concepts in spectroscopy and magnetic interactions (e.g., Zeeman effect) reflects procedural knowledge relevant to experimental and professional practices in physics labs and technology.

PO3: Entrepreneurial Mindset and Knowledge – Weak (1)

This course primarily emphasizes theory and application rather than business innovation or entrepreneurial strategies.

PO4: Specialized Skills and Competencies – Moderate to Strong (2–3)

Students gain analytical and technical skills for interpreting atomic behavior and spectra, enhancing their specialization in physics and related applied fields.

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning – Strong (3)

Every CO promotes critical thinking through application of theory to atomic models, spectral data, and molecular systems—essential for analytical reasoning.

PO6: Communication Skills and Collaboration – Weak to Moderate (1–2)

Mostly limited unless students are required to present interpretations or write reports. CO7 (data evaluation) may involve slightly higher communication efforts.

PO7: Research-related Skills – Moderate to Strong (2–3)

Several COs (e.g., CO6 and CO7) support observation, analysis, and reporting of spectral data—key components of research methodology.

PO8: Learning How to Learn Skills – Moderate (2)

The course fosters continuous learning through quantum mechanics and spectroscopy—fields that evolve and require self-driven exploration.

PO9: Digital and Technological Skills – Moderate (2)

COs involving spectral analysis and data evaluation suggest moderate use of digital tools and software, especially in CO6–CO7.

PO10: Multicultural Competence and Empathy – Weak (1)

Course content is scientific and technical, with little to no direct link to cultural or interpersonal dimensions.

PO11: Value Inculcation and Environmental Awareness – Weak (1)

Not explicitly focused on values or environmental aspects.

PO12: Autonomy, Responsibility, and Accountability – Moderate (2)

Independent data analysis and problem-solving throughout the course foster accountability and autonomous learning.

PO13: Community Engagement and Service – Weak (1)

No direct component of societal or community engagement is addressed through this course.

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-MJM
Course Title : Major Physics Practical-I
No. of Credits : 02
No. of Teaching Hours : 60

Course Objectives:

1. It aims to develop experimental skills, data analysis, and problem-solving abilities, alongside fostering a scientific attitude and understanding of physics concepts through hands-on experiments and projects.
2. To understand the principles of rotational dynamics and oscillatory motion in suspended systems.
3. To examine how parameters such as the geometry of the object, length of suspension threads, and distance between threads influence the period of oscillation and moment of inertia.
4. To develop data analysis and critical thinking skills in interpreting experimental results and sources of error.
5. To experimentally determine Young's modulus by studying the transverse vibrations of a wooden scale or beam.
6. To understand the relationship between mechanical vibrations and elastic properties such as stiffness and modulus of elasticity.
7. To apply the theory of elastic vibrations in beams and relate frequency measurements to material properties.

Course Outcomes:

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

CO1.Determine the moment of inertia of a given object using the bifilar suspension method and analyze the factors affecting rotational motion.

CO2. Calculate the acceleration due to gravity and radius of gyration using Kater's pendulum and compare the results with theoretical values.

CO3. Determine Young's modulus (Y) of the material of a wooden scale by analyzing its vibrations and understanding the elastic properties of materials.

CO4. Evaluate the resolving power of a diffraction grating and understand its significance in distinguishing closely spaced spectral lines.

CO5. Determine the wavelength of light using Michelson's interferometer and analyze the interference patterns generated by coherent light sources.

CO6. Measure the wavelength of light using a constant deviation spectrometer and understand the principles of spectral dispersion.

CO7. Analyze diffraction patterns using a reflection grating (metal ruler) and study the relationship between wavelength and diffraction angles.

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

1. Moment of Inertia by Bifilar suspension
2. Katter's pendulum
3. Y by vibration of wooden scale
4. Determination of Resolving Power of grating
5. Determination of wavelength of light by Michelson's interferometer
6. Determination of wavelength by Constant deviation spectrometer
7. Study of diffraction using a reflection grating (metal ruler)
8. Determination of wavelength of given source by Newton's rings
9. Energy gap of a semiconductor
10. Study of solar cell characteristics
11. PV-IV characteristics of solar cell
12. Resistivity by Four probe method

Additional Activities

1. Demonstrations (Any two demonstrations equivalent to two experiments)
2. Computer aided demonstrations using computer simulations or animations (Any one demonstrations equivalent to two experiments) / Virtual lab

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 (Sem- V) **Subject**: Physics

Course: Major Physics Practical–I **Course Code**: PHY-305-MJM

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	3	1	3	3	2	2	2	2	1	1	3	1
CO 2	3	3	1	3	3	2	2	2	2	1	1	3	1
CO 3	3	3	1	3	3	2	2	2	2	1	1	3	1
CO 4	3	2	1	2	2	2	2	2	2	1	1	2	1
CO 5	3	3	1	3	3	2	3	2	2	1	1	3	1
CO 6	3	3	1	3	3	2	3	2	2	1	1	3	1
CO7	3	3	1	3	3	2	2	2	2	1	1	3	1

Justification

PO1: Comprehensive Knowledge and Understanding – Strong (3)

All COs involve core concepts of classical mechanics, optics, and wave physics—demonstrating a strong foundation in fundamental physics.

PO2: Practical, Professional, and Procedural Knowledge – Strong (3)

Each CO is built around hands-on experiments using standard instruments (e.g., Kater's pendulum, interferometer), supporting the development of procedural competence and experimental best practices.

PO3: Entrepreneurial Mindset and Knowledge – Weak (1)

Although the experiments develop analytical skills, they don't explicitly engage entrepreneurial activities such as innovation or business-oriented problem solving.

PO4: Specialized Skills and Competencies – Strong (3)

Students develop specific technical and analytical abilities by working with real instruments and interpreting experimental data.

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning – Strong (3)

All COs encourage real-world application of theory, requiring students to critically analyze and interpret physical data.

PO6: Communication Skills and Collaboration – Moderate (2)

While the course does not directly train communication, experimental work may include lab reports or collaborative projects that promote communication and teamwork.

PO7: Research-related Skills – Moderate to Strong (2–3)

Experiments like those involving diffraction and interference demand inquiry-based learning and data analysis—key aspects of research skills.

PO8: Learning How to Learn Skills – Moderate (2)

Students are required to understand and internalize principles of classical and modern physics through self-guided experimentation.

PO9: Digital and Technological Skills – Moderate (2)

Although the emphasis is on manual experimentation, students may use software or digital tools for analysis and reporting results.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy – Weak (1)

No direct component of cultural or interpersonal learning is included in this lab-oriented course.

PO11: Value Inculcation and Environmental Awareness – Weak (1)

Ethical practices in experimentation may be inferred, but sustainability or environmental consciousness is not a direct focus.

PO12: Autonomy, Responsibility, and Accountability – Strong (3)

Students must independently perform experiments, document outcomes, and be accountable for accurate reporting and error analysis.

PO13: Community Engagement and Service – Weak (1)

The course does not include direct community-oriented or service-learning activities.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics (2023 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Major Elective (MJE) (Theory)
Course Code : PHY-306-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 (Sem- V) **Subject**: Physics

Course: Elements of Material Science **Course Code**: PHY-306-MJE (A)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	2	1	2	2	1	2	2	2	1	2	2	1
CO 2	3	2	1	2	2	1	2	2	2	1	2	2	1
CO 3	3	3	1	3	3	2	3	2	3	1	2	3	1
CO 4	3	3	1	3	3	2	2	2	3	1	2	3	1
CO 5	3	3	1	3	3	2	3	2	3	1	2	3	1
CO 6	3	3	1	3	3	2	3	2	3	1	2	3	1
CO7	3	3	1	3	3	2	3	2	3	1	2	3	1

Justification

PO1: Comprehensive Knowledge and Understanding – Strong (3)

All COs involve core principles of materials science including structure-property relationships, characterization methods, and engineering fundamentals.

PO2: Practical, Professional, and Procedural Knowledge – Strong (3 or 2)

Lab-based learning and material testing (CO3, CO5, CO6, CO7) provide practical exposure and align with industrial procedures and professional practices.

PO3: Entrepreneurial Mindset and Knowledge – Weak (1)

While knowledge of materials may support innovation, this course doesn't directly target business or entrepreneurial training.

PO4: Specialized Skills and Competencies – Strong (3 or 2)

Students gain analytical, design, testing, and interpretation skills that are highly specialized and applicable in technical and engineering roles.

PO5: Capacity for Application, Problem-Solving and Analytical Reasoning – Strong (3 or 2)

Problem-solving through material selection, characterization, and experimentation is integral to COs, especially CO3–CO7.

PO6: Communication Skills and Collaboration – Moderate (2)

Experimental analysis and reporting help develop communication skills. Teamwork might also be involved during lab work.

PO7: Research-related Skills – Strong (3 or 2)

CO3, CO5–CO7 develop inquiry-based skills like hypothesis testing, data analysis, and interpretation, crucial for research.

PO8: Learning How to Learn Skills – Moderate (2)

Independent lab work and integration of theory with hands-on learning foster adaptability and self-directed learning.

PO9: Digital and Technological Skills – Strong (3 or 2)

Characterization techniques and data analysis often involve the use of instruments and software, contributing to digital competence.

PO10: Multicultural Competence and Empathy – Weak (1)

The technical focus of this course doesn't directly contribute to multicultural understanding.

PO11: Value Inculcation and Environmental Awareness – Moderate (2)

Sustainable material use and ethical handling of lab procedures could be touched upon, especially in discussions of material impact.

PO12: Autonomy, Responsibility, and Accountability – Strong (3 or 2)

Lab activities demand precision, ownership, and responsibility from students, reinforcing PO12.

PO13: Community Engagement and Service – Weak (1)

There is limited to no direct link to community service or engagement in this technical course.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics (2023 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Major Elective (MJE) (Theory)
Course Code : PHY-306-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 Wind 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, Wind 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 Characteristics of solar cell

1.4 Geneartions of solar cell

1.5 Large solar PV system

1.6 Solar PV power system for space station

1.7 Problems

UNIT 2: Energy Storage System **(8L)**

2.1 Introduction

2.2 Battery Energy Storage Systems

2.3 Lead-Acid Battery

2.4 Lithium-ion Battery

2.5 Advanced Batteries

2.6 Applications

UNIT 3: Biomass energy **(10L)**

3.1 Introduction

3.2 Biomass conversion technologies

3.3 Classification of biogas plants

3.4 Types of biogas plants

3.5 Materials used for Bio gas generation

3.6 Applications

References:

1. Biomass Renegerable 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 (Sem- V) **Subject**: Physics

Course: Renewable Energy Sources **Course Code**: PHY-306-MJE (B)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	2	2	2	3	2	2	2	2	2	3	2	2
CO 2	3	3	2	2	3	2	2	2	3	2	3	3	2
CO 3	3	3	2	2	3	2	2	2	2	2	2	3	2
CO 4	3	2	2	2	2	2	2	2	2	2	3	2	2
CO 5	3	2	2	2	3	2	2	2	2	2	3	3	2
CO 6	3	3	2	2	3	2	2	2	3	2	3	3	3
CO7	2	2	2	2	2	3	2	2	2	3	3	3	3

Justification

PO1 – Comprehensive Knowledge and Understanding (3)

All COs involve understanding foundational principles of renewable energy sources and their role in energy systems and environmental balance.

PO2 – Practical, Professional, and Procedural Knowledge (2–3)

Several COs (e.g., CO2, CO3, CO6) involve understanding applications and systems like solar panels and wind turbines, aligning with professional and procedural knowledge.

PO3 – Entrepreneurial Mindset and Knowledge (2)

COs such as CO2, CO4, and CO7 promote innovation and application of renewable energy concepts which support entrepreneurial ideas in green energy.

PO4 – Specialized Skills and Competencies (2)

Although theoretical in nature, COs require analytical skills and technical knowledge to evaluate and propose renewable energy solutions.

PO5 – Capacity for Application, Problem Solving, and Analytical Reasoning (3)

Renewable energy problem-solving and practical applications (CO2, CO5, CO6) reflect strong alignment with this PO.

PO6 – Communication Skills and Collaboration (2–3)

CO7 particularly emphasizes awareness campaigns, which involve communication and teamwork.

PO7 – Research-related Skills (2)

While not heavily research-based, many COs involve analysis and evaluation of energy systems, supporting basic research skills.

PO8 – Learning How to Learn (2)

COs emphasize self-driven understanding of emerging technologies and sustainable practices.

PO9 – Digital and Technological Skills (2–3)

COs involving solar, wind, and biomass energy use modern tools and systems, contributing to digital literacy.

PO10 – Multicultural Competence, Inclusive Spirit, and Empathy (2–3)

Promoting energy access in domestic and rural regions (CO6, CO7) encourages empathy and inclusive practices.

PO11 – Value Inculcation and Environmental Awareness (3)

All COs strongly support environmental ethics and sustainability, especially CO1, CO5, and CO7.

PO12 – Autonomy, Responsibility, and Accountability (2–3)

Applying renewable energy principles in real-life scenarios requires independent thinking and responsibility.

PO13 – Community Engagement and Service (2–3)

CO7 and CO6 promote direct outreach and application in community and rural areas, supporting PO13.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics (2023 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Major Elective (MJE) (Theory)
Course Code : PHY-306-MJE (C)
Course Title : Biophysics
No. of Credits : 02
No. of Teaching Hours : 30

Course Objectives:

1. It aims to equip students with a foundational understanding of the physical principles underlying biological phenomena, including molecular and cellular processes, biophysical techniques, and their applications, while also fostering scientific communication and critical thinking skills.
2. To provide a foundational understanding of how physical laws and mathematical models apply to biological systems at the molecular, cellular, and organismal levels.
3. To study the physical properties of proteins, nucleic acids, lipids, and carbohydrates, and how their structure relates to biological function.
4. To apply the laws of thermodynamics and energy transfer to biological processes such as metabolism, membrane transport, and enzyme kinetics.
5. To introduce key experimental and computational techniques such as X-ray crystallography, NMR, spectroscopy, electrophoresis, and molecular dynamics simulations.
6. To explore the mechanical properties of cells and tissues, including elasticity, viscosity, and fluid dynamics in circulatory and respiratory systems.
7. To analyze nerve conduction, bioelectric potentials, electrophysiology, and the role of electromagnetic fields in biological systems.

Course Outcomes:

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

CO1. Understand Basic Structure of Cell
CO2. Identify Biophysical Techniques
CO3. Properties and their significance
CO4.Working of Nervous System

CO5. Apply the knowledge of Physics in Living things.

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

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

Topics and Learning Points

UNIT 1: Introduction of Biophysics (8L)

1.1 History of Biophysics, Concept of Biophysics and Physical properties applied to biology- Surface tension and Viscosity

1.2 Cell: Animal and plant cell, types of cell, Functional aspects of cell membrane, cytoplasm, nucleus, mitochondria and chloroplast Protein structure (Primary and Secondary)

1.3 Photosynthesis process: - electron transport, Gibbs's free energy, Redox couple, Redox potential, Oxidation and reduction

UNIT 2: Bio-Potentials (8L)

2.1 Bioelectric signals: structure of neuron and resting potential

2.2 Nernst equation Bio-electrodes- Half-cell potential

2.3 Polarizable and non-polarizable electrodes

UNIT 3: Bio-instruments (8L)

3.1 Basic principle, Construction and working of colorimeter

3.2 Spectrophotometer and Centrifuge measurement

3.3 Electron Microscope: SEM, TEM.

UNIT 4: Radiation Biophysics (6L)

4.1 Definition, Units of Radioactivity and radiation doses, Types of radiation

4.2 Applications: PET (Positron Emission Tomography)

4.3 NMR (Nuclear Magnetic Resonance)

4.4 MRI (Magnetic Resonance Imaging Techniques)

References:

1. Introduction to Biophysics - by P. Narayanan.New Age P.
2. Medical Instrumentation - by Khandpur, TMH
3. Laboratory Manuals of Biophysics Instruments - by P.B. Vidyasagar
4. Biophysics -by Vatsala Piramal, Dominant Publisher and Distributors, New Delhi-110002
5. Textbook of Biophysics - by R.N. Roy
6. Photosynthesis - by Hall and Rao.
7. Introduction to Biomedical Equipment Technology (Fourth Edition) by-Joseph J.Carr
8. Text Book of Bio-medical Electronics-by S.S. Agrawal

Mapping of Program Outcomes with Course Outcomes

Class: T.Y.B.Sc (Sem- V) **Subject**: Physics

Course: Biophysics **Course Code**: PHY-306-MJE (C)

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	2	1	2	2	1	2	2	2	1	2	2	1
CO 2	3	3	1	2	3	2	2	2	3	1	2	2	1
CO 3	3	2	1	2	2	1	2	2	2	1	2	2	1
CO 4	3	2	1	3	3	2	2	2	2	2	2	2	1
CO 5	3	3	1	3	3	2	2	2	2	2	3	2	1
CO 6	3	3	1	3	3	2	2	2	3	2	2	2	1
CO7	3	2	1	3	3	2	3	2	2	2	2	2	2

Justification

PO1 – Comprehensive Knowledge and Understanding (3)

All COs require a deep understanding of biophysics principles, especially CO1, CO4, CO5, and CO6. These involve foundational knowledge in biology, physics, and interdisciplinary science.

PO2 – Practical, Professional, and Procedural Knowledge (2–3)

CO2 and CO5 involve application of physical methods in biology, including laboratory and procedural expertise.

PO3 – Entrepreneurial Mindset and Knowledge (1)

Although less emphasized, some COs (like CO5) could spark innovation in medical devices or biotechnology, justifying a minimal relation.

PO4 – Specialized Skills and Competencies (2–3)

CO4 to CO7 involve understanding and analyzing biological systems using physics, fostering technical and analytical competency.

PO5 – Application, Problem-Solving, and Analytical Reasoning (2–3)

Especially relevant in CO2, CO5, CO6, and CO7, where critical analysis and application of theoretical concepts in biological systems is needed.

PO6 – Communication Skills and Collaboration (1–2)

Most COs involve individual learning; however, collaboration may occur in CO2 and CO7 during experiments or interdisciplinary studies.

PO7 – Research-related Skills (2–3)

CO2 and CO7 directly involve analytical instrumentation and understanding experimental data, which aligns with research skills.

PO8 – Learning How to Learn (2)

Continuous learning is necessary to integrate concepts from physics and biology, relevant to all COs.

PO9 – Digital and Technological Skills (2–3)

CO2 and CO6 involve usage of instruments and digital analysis tools, such as in electrophysiology and imaging.

PO10 – Multicultural Competence and Empathy (1–2)

Some content (like sensory studies in CO7) may involve understanding biological diversity and cultural perspectives in medicine.

PO11 – Values and Environmental Awareness (2)

Understanding biology and health from a physics lens supports responsible science and ethical application.

PO12 – Autonomy and Accountability (2)

Most COs require independent study and responsible experimentation.

PO13 – Community Engagement (1–2)

Indirectly relevant in CO7 when applied in sensory studies or health-based awareness.

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics (2023 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Minor (MJE) (Theory)
Course Code : PHY-311-MN
Course Title : Electricity and Magetism
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 Savart’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 (10 Lectures)

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 Problem Solving

UNIT 2: Dielectrics (12 Lectures)

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 Problem Solving

UNIT 3: Magnetization (8 Lectures)

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 Ferromagnetic materials
- 3.3.4 Antiferromagnetism materials

3.4 Applications of materials

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 (Sem- V) **Subject**: Physics

Course: Electricity and Magnetism **Course Code**: PHY-311-MN

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	3	2	1	2	2	1	1	2	1	1	2	2	1
CO 2	3	3	1	2	3	2	2	2	2	1	2	2	1
CO 3	2	3	1	2	2	2	2	2	2	1	2	2	1
CO 4	3	3	1	3	3	2	2	2	2	1	2	2	1
CO 5	3	2	1	2	3	2	2	2	2	1	3	2	1
CO 6	3	3	2	2	2	2	1	2	2	1	2	2	1
CO7	3	2	2	2	3	2	2	2	2	2	3	2	2

Justification

PO1 – Comprehensive Knowledge and Understanding (3)

All COs, particularly CO1, CO2, and CO4, build foundational knowledge in electricity, electrical circuits, and renewable energy, essential for understanding broader interdisciplinary applications.

PO2 – Practical, Professional, and Procedural Knowledge (2–3)

CO3 and CO4 involve hands-on use of electrical instruments and component analysis, reflecting direct professional relevance and procedural accuracy.

PO3 – Entrepreneurial Mindset and Knowledge (1–2)

CO6 and CO7 touch on innovations and emerging technologies (renewables and efficient appliances), offering potential for entrepreneurial exploration.

PO4 – Specialized Skills and Competencies (2–3)

CO2 through CO6 develop analytical, technical, and diagnostic skills essential for practical electrical engineering tasks.

PO5 – Application, Problem-Solving and Analytical Reasoning (2–3)

CO2, CO5, and CO7 especially require analysis, calculation, and solution strategies that mirror real-world problem-solving.

PO6 – Communication Skills and Collaboration (1–2)

Students engage in technical discussions and documentation when using tools (CO3) or explaining appliance functions (CO6), developing moderate communication skills.

PO7 – Research-related Skills (1–2)

Applied lightly—CO3 and CO7 may require experimentation or basic inquiry into technologies like solar panels or wind turbines.

PO8 – Learning How to Learn (2)

Understanding electrical systems and renewable technologies requires adaptability and continuous self-directed learning in all COs.

PO9 – Digital and Technological Skills (2–3)

Strongly present in CO3 and CO6, where measuring instruments and digital systems are explored.

PO10 – Multicultural Competence, Inclusive Spirit, and Empathy (1–2)

Particularly in CO7, students consider the social implications and global necessity of renewable energy, fostering inclusive perspectives.

PO11 – Value Inculcation and Environmental Awareness (2–3)

Strongly aligned with CO5 and CO7 where sustainability, energy conservation, and environmental consciousness are core.

PO12 – Autonomy, Responsibility, and Accountability (2)

Students are expected to carry out calculations, conduct experiments, and draw conclusions responsibly across all COs.

PO13 – Community Engagement and Service (1–2)

CO7 involves analyzing and promoting renewable energy for societal benefit, contributing to awareness and public service.

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 (Practical)
Course Code : PHY-312-MN
Course Title : Minor Physics Practical - I
No. of Credits : 02
No. of Teaching Hours : 60

Course Objectives:

1. Assemble Simple Electrical Circuits: Demonstrate the ability to assemble basic electrical circuits using resistors, batteries, and switches with proper connections and safety precautions.
2. Measure Electrical Quantities Accurately: Use a multimeter to measure voltage, current, and resistance in various electrical circuits with precision and interpret the results effectively.
3. Analyze Power Consumption: Measure and analyze power consumption in different types of electrical loads, including resistive and inductive loads, using appropriate formulas.
4. Apply Electrical Safety Practices: Demonstrate safe handling of electrical appliances and systems through practical safety demonstrations and safety checks to prevent electrical hazards.
5. Determine Capacitance Experimentally: Experimentally determine the capacitance of a parallel plate capacitor and understand its behavior in different circuit configurations.
6. Design and Analyze DC Circuits: Set up and analyze simple DC circuits to understand current flow, voltage distribution, and the effect of various components.
7. Apply Kirchhoff's Laws: Utilize Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) to analyze and solve complex electrical circuits effectively.

Course Outcomes:

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

CO1. Demonstrate Proficiency in Circuit Assembly: Students will be able to assemble simple electrical circuits using resistors, batteries, and switches with correct wiring and safety practices.

CO2. Accurately Measure Electrical Quantities: Students will measure voltage, current, and resistance accurately using a multimeter and interpret the results in various circuits.

CO3. Analyze Power Consumption: Students will calculate and analyze power consumption in

different types of electrical loads, including resistive and inductive, using appropriate formulas.

CO4. Apply Electrical Safety Procedures: Students will demonstrate proper safety procedures when handling electrical appliances and systems, including conducting safety checks to prevent hazards.

CO5. Experimentally Determine Capacitance: Students will determine the capacitance of a parallel plate capacitor experimentally and understand the factors influencing capacitance.

CO6. Design and Analyze Simple DC Circuits: Students will set up and analyze simple DC circuits, understanding the relationship between current, voltage, and resistance.

CO7. Solve Complex Circuits Using Kirchhoff's Laws: Students will apply Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL) to analyze and solve complex electrical circuits.

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

1. Study of LCR series circuit
2. Study of Kirchhoff's laws
3. Diode characteristics
4. Measurement of voltage, current, and resistance using a Multimeter
5. Frequency of A.C.mains
6. Study of CRO
7. Zener diode as a voltage regulator
8. Thevenin's and Norton's theorem.
9. Maximum power transfer theorem.
10. Inverting and non-inverting amplifier.
11. To study electromagnetic damping

Additional Activities

1. Demonstrations (Any two demonstrations equivalent to two experiments)
2. Computer aided demonstrations using computer simulations or animations (Any one demonstrations equivalent to two experiments) / Virtual lab

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 (Sem- V) **Subject**: Physics

Course: Minor Physics Practical - I **Course Code**: Minor Physics Practical - I

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	2	3	1	3	2	2	1	2	2	1	2	3	1
CO 2	2	3	1	2	3	2	1	2	3	1	2	3	1
CO 3	3	3	1	2	3	2	2	2	2	1	2	2	1
CO 4	2	3	1	2	3	2	1	2	2	1	3	3	2
CO 5	3	2	1	2	2	1	2	2	2	1	2	2	1
CO 6	3	3	1	3	3	2	2	2	2	1	2	3	1
CO7	3	3	1	3	3	2	2	2	2	1	2	3	1

Justification

PO1 – Comprehensive Knowledge and Understanding

CO3, CO5, CO6, and CO7 are heavily theory-based and involve understanding key electrical principles, such as power analysis and Kirchhoff's laws. **(3 for CO3, CO6, CO7; 2 for CO1, CO2, CO4, CO5)**

PO2 – Practical, Professional, and Procedural Knowledge

All COs emphasize hands-on skills, accurate measurements, safety procedures, and systematic circuit design—central to industry-standard practices. **(3 for CO1–CO4, CO6, CO7)**

PO3 – Entrepreneurial Mindset and Knowledge

While the COs don't directly promote entrepreneurship, basic understanding of electrical efficiency and safety can indirectly support innovation in energy solutions. **(1 for all COs)**

PO4 – Specialized Skills and Competencies

The COs build technical proficiency in assembling, analyzing, and solving circuits, particularly in CO1, CO6, and CO7. **(3 for CO1, CO6, CO7; 2 for others)**

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

CO2, CO3, CO4, CO6, and CO7 involve circuit solving, power analysis, and safety evaluation—strong applications of reasoning. **(3 for CO2–CO4, CO6, CO7)**

PO6 – Communication Skills and Collaboration

Some COs like CO1 and CO2 involve presenting circuit setup or data, enhancing communication. Teamwork may also be involved in lab settings. **(2 for CO1–CO4, CO6, CO7)**

PO7 – Research-related Skills

CO3, CO5, CO6, and CO7 require hypothesis-driven experiments, data interpretation, and applying experimental knowledge—developing basic research capabilities. **(2 for CO3, CO5–CO7)**

PO8 – Learning How to Learn

All COs encourage iterative problem-solving and reflection, supporting independent learning and adaptability. **(2 for all COs)**

PO9 – Digital and Technological Skills

Instruments like multimeters and simulation software may be used in CO2, CO3, CO6, and CO7. **(3 for CO2; 2 for others)**

PO10 – Multicultural Competence, Inclusive Spirit, and Empathy

Not a primary focus but may be marginally involved via teamwork or ethical considerations in CO4. **(1 for all COs)**

PO11 – Value Inculcation and Environmental Awareness

CO4, CO5, and CO7 touch on electrical safety and energy conservation, which promotes responsible citizenship. **(3 for CO4; 2 for others)**

PO12 – Autonomy, Responsibility, and Accountability

CO1, CO2, CO4, CO6, and CO7 particularly emphasize individual responsibility in lab tasks and circuit safety. **(3 for CO1, CO2, CO4, CO6, CO7)**

PO13 – Community Engagement and Service

CO4 has the strongest link here, as it deals with safety practices that directly benefit society. **(2 for CO4; 1 for others)**

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 : Vocational Skill Course (VSC) (Practical)
Course Code : PHY-321-VSC
Course Title : Minor Physics Practical - II
No. of Credits : 02
No. of Teaching Hours : 60

Course Objectives:

1. Use various instruments and equipment.
2. Design experiments to test a hypothesis and/or determine the value of an unknown quantity.
3. Investigate the theoretical background to an experiment.
4. Set up experimental equipment to implement an experimental approach.
5. Analyze data, plot appropriate graphs and reach conclusions from your data analysis.
6. Work in a group to plan, implement and report on a project/experiment.
7. Experimental Models for easy understanding and explanation Physics concepts.

Course Outcomes:

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

CO1. Acquire technical and manipulative skills in using laboratory equipment, tools and materials.

CO2. Demonstrate an ability to collect data through observation and/or experimentation and interpreting data.

CO3. Demonstrate an understanding of laboratory procedures including safety and scientific methods.

CO4. Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.

CO5. Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.

CO6.Use of experiment to analyse various experimental parameters concerning their

application .

CO7. Experimental Models for easy understanding and explanation Physics concepts.

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

1. Calculation of particle size using the XRD spectrum of any material.
2. Characteristics of the G.M. tube.
3. e/m by the Thomson method.
4. Study of Gaussian distribution using the G.M. tube.
5. Frank-Hertz experiment.
6. Specific heat of graphite.
7. Thermal conductivity of a rubber tube.
8. Study of thermocouples/Thermistor
9. Thickness of a thin wire by laser diffraction.
10. Rigidity modulus of brass by electromagnetic vibration.
11. 'Y' by flexural vibration of a steel bar.
12. Dead time of GM tube

Additional Activities

1. Demonstrations (Any two demonstrations equivalent to two experiments)
2. Computer aided demonstrations using computer simulations or animations (Any one demonstrations equivalent to two experiments) / Virtual lab

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 (Sem- V) **Subject**: Physics

Course: Major Physics Practical–II **Course Code**: PHY-321-VSC

Weightage: 1= weak or low relation, 2= moderate or partial relation, 3= strong or direct relation

	Programme Outcomes (POs)												
Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13
CO 1	2	3	1	3	2	2	1	2	3	1	2	3	1
CO 2	2	2	1	2	3	2	3	2	2	1	2	2	1
CO 3	2	3	1	2	2	2	2	2	2	1	3	3	1
CO 4	3	2	1	2	2	1	2	2	2	1	2	2	1
CO 5	1	2	1	2	2	3	1	2	1	2	1	2	2
CO 6	2	3	1	3	3	2	2	2	2	1	2	3	1
CO7	3	2	1	2	2	1	2	2	2	1	2	2	1

Justification

PO1 – Comprehensive Knowledge and Understanding

CO4 and CO7 directly support conceptual understanding through visualization and models. CO1–CO3, CO6 also help reinforce foundational physics knowledge.
High for CO4, CO7 (3), Moderate for others (2)

PO2 – Practical, Professional, and Procedural Knowledge

All COs involve hands-on laboratory skills, understanding protocols, and instrument usage—critical for practical expertise.
Strong for CO1, CO3, CO6 (3), Moderate for others (2)

PO3 – Entrepreneurial Mindset and Knowledge Low relevance (1 for all)

Though indirectly related, experimental and model-based understanding (CO6, CO7) can support innovation.

PO4 – Specialized Skills and Competencies

CO1 and CO6 involve technical skills; CO2–CO5 contribute to analysis, communication, and teamwork.
High for CO1, CO6 (3), Moderate for others (2)

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

CO2 and CO6 involve data analysis and interpretation. CO4 and CO7 encourage reasoning through model-based abstraction.
Strong for CO2, CO6 (3), Moderate for others (2)

PO6 – Communication Skills and Collaboration

CO5 emphasizes teamwork, while others (CO1–CO3, CO6) involve sharing observations or results.
High for CO5 (3), Moderate for others (2), Low for CO4, CO7 (1)

PO7 – Research-related Skills

CO2, CO3, CO6, and CO7 involve data collection, analysis, and the scientific method.
High for CO2 (3), Moderate for CO3, CO6, CO7 (2)

PO8 – Learning How to Learn Skills

All COs encourage hands-on exploration and reflective learning through lab-based experiences.
Moderate for all (2)

PO9 – Digital and Technological Skills

CO1, CO2, and CO6 involve using lab instruments and possibly simulation tools.
Strong for CO1 (3), Moderate for others (2)

PO10 – Multicultural Competence, Inclusive Spirit, and Empathy

Group activities like CO5 promote collaboration and exposure to diverse perspectives.
Moderate for CO5 (2), Low for others (1)

PO11 – Value Inculcation and Environmental Awareness

CO3 includes safety protocols and responsible behavior; CO6 and CO7 may involve sustainability-related experiments.
High for CO3 (3), Moderate for others (2), Low for CO5 (1)

PO12 – Autonomy, Responsibility, and Accountability

Most COs (especially CO1, CO3, CO6) require students to work independently and responsibly in the lab.
Strong for CO1, CO3, CO6 (3), Moderate for others (2)

PO13 – Community Engagement and Service

CO5 may involve group tasks with community relevance; CO3, CO6 may relate to safety and real-life applications.
Moderate for CO5 (2), Low for others (1)

CBCS Syllabus as per NEP 2020 for T.Y.B.Sc Physics (2023 Pattern)

Name of the Programme : B.Sc. Physics
Programme Code : USPH
Class : T.Y.B.Sc.
Semester : V
Course Type : Field Project (Practical)
Course Code : PHY-335-FP
Course Title : Field Project
No. of Credits : 02
No. of Teaching Hours : 60

Guidelines for Field Project (FP)

In NEP 2020 (2023 Pattern) we are offering to UG (Third Year-Fifth Semester) students **Field Project (FP)** for **TWO (2)** credits i.e. **50 Marks**. The total time allocation for the student to carry out field project is **60 hours**. The actual field work should be carried out after college hours or on holidays.

To carry out the field project work following guidelines should be used:

1. Field-based learning: Students should participate in field-based learning/projects under the supervision of faculty.
2. A minimum of **30 hours of learning per credit** in a semester is required.
3. Assignment of project topics to individual student or groups of students (2 or 3 students in one group/ Commerce faculty can have 5 students per group) and one faculty member from the department will act as GUIDE for the student or group of students.
4. If the project is related to survey type work, then prepare questionnaire (20 -30 questions or more) related to their project topic (in Marathi or English). If the project is related to work that does not involve SURVEY work, then the questionnaire part can be replaced accordingly.
5. The departmental coordinator/guide should check the questions and finalize the questionnaire. The question that may create unnecessary complications should be avoided. The questions should be qualitative as well as quantitative. If the project is related to other type work (e.g. Data collection, sample collection etc.), then the guide should discuss with student and finalise the methodology for the same.
6. Students should go to their chosen field with the questionnaire and collect the information regarding the questions asked to the concerned people. Collect as much information as possible

by collecting 25 or more questionnaires or enough number of samples or reasonable amount of data. The more the data, the better it will be for analysis.

7. The student should compile all the relevant data and carry out its analysis.
8. Write a project report in the standard format (2 Copies): Index, Chapter-1, Chapter-2, ….. Conclusion, References etc. The report should mention the clear **OUTPUT** drawn from the study. The typed project report should have minimum 25 pages (excluding title, Certificate, index and acknowledgement pages etc.), in Times New Roman with font size 12, and line spacing of 1.5.
9. Submit the project report with the Guide's signature to the department.
10. The Oral presentation for all the projects in the department should be arranged in the department. To evaluate the project, TWO examiners should be appointed by HoD (The details about appointment of examiners, weightage to internal and external marks etc. will be provided by examination section).
11. The total project work including preparation of questionnaire or sample/data collection to oral presentation should be evaluated for 2 credits (50 Marks).The details about the allocation of time, marks and scheme of examination for field project is given in Table. The departmental FP coordinator/HoD should submit the marks as per regular procedure to the examination section.
12. Since it is a compulsory subject in our syllabus, passing students in this **field project** is **MUST** to complete their degree.

Typical Time and marks allocation for the different stages of the field project is:

Step of Project	**Individual students work in hours**	**Marks**
Topic Selection/ Study Design	05	05
Survey preparation / Fieldwork	25	20
Analysis	10	05
Report writing	20	10
Oral Presentation		10
Total	60	50