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 -VI

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. Dr. Kale Rajendra Devidas** Head, Department of Physics, T. C. College, Baramati.	Chairperson
2	**Dr. Pathan H.M.** Associate Professor, Department of Physics, Savitribai Phule Pune University, Pune	Vice-Chancellor Nominee Subject Expert from SPPU, Pune
3	**Prof. Dr. Patil Vikas Baburao** Professor & Head, Department of Physics, Punyashlok Ahilyadevi Holkar Solapur University, Solapur	Subject Expert from Outside the Parent University
4	**Dr. Patil Umakant Mahadev** Associate Professor, D.Y. Patil University, Kolhapur	Subject Expert from Outside the Parent University
5	**Mr. Bhabale Amar Ramesh** Head - Production Planning at Piaggio Vehicles Pvt. Ltd , Pune	Representative from industry/corporate sector/allied areas
6	**Mr. Mahanavar Balbhim Sahebrao** Assistant Professor, Department of Physics, Dada Patil Mahavidyalaya, Karjat	Member of the College Alumni
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. Shinde Pratik Kishor** Assistant Professor, Department of Physics, T. C. College, Baramati	Member
15	**Mr. Madhare Pratik Laxman** 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-VI**

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/CE P/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**

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

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	Project	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	Project	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 : VI

Course Type : Major Mandatory (Theory)

Course Code : PHY-351-MJM

Course Title : Classical Electrodynamics

No. of Credits : 02

No. of Teaching Hours : 30

Course Objectives:

1. Solve these equations in different regions of space and for various boundary conditions.
2. Study the propagation of electromagnetic waves in free space and in different media.
3. Understand the electric and magnetic field concepts as well as their sources
4. Understand how accelerating charges produce electromagnetic radiation.
5. Study the concepts of permittivity, permeability, and the electric displacement field.
6. Study the concept of the electromagnetic four-potential and the scalar and vector potentials.
7. Study the Lorentz force law and how electromagnetism behaves under Lorentz transformations.

Course Outcomes:

After successful completion of the course student will be able to do the following

CO1. Understanding of electric fields and potentials: Students will be able to explain electric fields, electric potentials, and the behavior of charges in electrostatic equilibrium using concepts like Coulomb's law and Gauss's law etc

CO2. Able to solve electrostatic problems: Students will develop the ability to solve complex electrostatic problems involving conductors, insulators, and dielectrics, including the use of boundary conditions.

CO3. Application of magnetostatics: Students will understand and apply the principles of magnetostatics, including Ampère's law and the Biot-Savart law, to analyze magnetic fields produced by steady currents.

CO4. Understanding wave propagation: Students will be able to derive the wave equation from Maxwell's equations and understand the propagation of electromagnetic waves in free space and in various media.

CO5. Reflection, Refraction, and Dispersion: Students will understand and mathematically describe the phenomena of reflection, refraction, and dispersion of electromagnetic waves at interfaces between different media.

CO6. Understanding Maxwell's Equations: Students will learn to derive and interpret Maxwell's equations in both integral and differential forms, and understand their significance in unifying electric and magnetic fields.

CO7. Application of Maxwell's Equations to Physical Problems: Students will apply Maxwell's equations to solve problems in electromagnetism, including the propagation of electromagnetic waves, and the analysis of time-varying electric and magnetic fields.

Topics and Learning Points

UNIT 1: Electrostatics **(13L)**

1.1. Coulomb's law, Gauss law, Electric field, Electrostatic Potential

1.2. Potential energy of system of charges.

1.3. Statement of Poisson's equation, Boundary Value problems in electrostatics-
Solution of Laplace equation in Cartesian system,

1.4. Method of image charges: Point charge near an infinite grounded conducting
Plane, Point charge near grounded conducting sphere.

1.5. Polarization P, Electric displacement D, Electric susceptibility, and dielectric Constant, bound volume and surface charge densities.

1.6. Electric field at an exterior and interior point of dielectric.

1.7 Problems.

UNIT 2: Magnetostatics **(9L)**

2.1. Magnetic induction, magnetic flux, magnetic field and static magnetic fields

2.2. Magnetic induction due to straight current carrying conductor, Energy density inmagnetic field, magnetization of matter. Relationship between B**,** H and M.

2.3 Biot-Savart's law, Ampere's law for force between two current carrying loops, Ampere's circuital law

2.4 Equation of continuity, Magnetic vector potential A.

2.5. Magnetic susceptibility and permeability, Hysteresis loss, B-H curve.

2.6 Problems.

UNIT 3: Electrodynamics **(8L)**

3.1. Concept of electromagnetic induction, Faradays law of induction, Lenz's law, displacement current, generalization of Amperes' law

3.2. Maxwell's equations (Differential and Integral form) and their physical Significance

3.3 Maxwell's equations in terms of scalar and vector potentials.

3.4. Wave equation and plane waves in free space.

3.5. Poynting theorem & Poynting vector

3.6.Microscopic form of ohm's law ($J=\sigma E$)

3.7. Problems.

References:

1) Introduction to Electrodynamics - By D. J. Griffith
2) Classical Electrodynamics – By J. D. Jackson.
3) Introduction to Electrodynamics - By A. Z. Capri, Panat P. V.
4) Electricity and magnetism – By Reitz and Milford
5) Electrodynamics - By Gupta, Kumar, Singh (PragatiPrakashan)
6) Electromagnetic field and waves - By Paul-Lorrain and Dale R Corson
7) Electricity and magnetism – By Murugeshan (S. Chand)

Mapping of Program Outcomes with Course Outcomes

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

Course: Classical Electrodynamics **Course Code**: PHY-351-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	2	1	1	2	1
CO 2	3	3	1	2	3	1	2	2	2	1	1	2	1
CO 3	3	2	1	2	3	1	2	2	2	1	1	2	1
CO 4	3	2	1	2	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	2	1	2	3	1	3	2	2	1	1	2	1
CO7	3	3	1	3	3	1	3	2	2	1	1	2	1

Justification

PO 1. Comprehensive Knowledge and Understanding – 3

All COs (CO1–CO7) directly build on fundamental principles of electric and magnetic fields, potentials, and Maxwell's equations. Students gain deep conceptual and theoretical understanding, fulfilling this PO strongly.

PO 2. Practical, Professional, and Procedural Knowledge – 2

Though the course is conceptually focused, students apply theoretical principles to solve practical problems involving electrostatics and electromagnetic wave propagation, partially aligning with professional and procedural aspects.

PO 3. Entrepreneurial Mindset and Knowledge – 1

The course indirectly supports innovation and problem-solving approaches but does not explicitly develop business or entrepreneurial skills. The relation is minimal.

PO 4. Specialized Skills and Competencies – 2

CO2, CO3, CO6, and CO7 emphasize analytical and mathematical proficiency required to handle electromagnetic problems. This builds specialized technical competence but not hands-on or leadership skills directly.

PO 5. Capacity for Application, Problem-Solving and Analytical Reasoning – 3

This is a major strength of the course. Through CO2, CO3, CO6, and CO7, students develop analytical and reasoning skills to solve complex field and wave problems, demonstrating critical thinking and creativity.

PO 6. Communication Skills and Collaboration – 1

Although students may present derivations or discuss results, communication and teamwork are not a core part of the learning outcomes. Weak correlation.

PO 7. Research-related Skills – 2

Understanding and applying Maxwell's equations (CO6–CO7) encourages an analytical and investigative mindset useful in research. However, formal research design or data collection is not part of the course.

PO 8. Learning How to Learn Skills – 2

Theoretical and mathematical depth of electromagnetism motivates self-directed learning and conceptual exploration. Students often need to independently relate equations to real-world physics.

PO 9. Digital and Technological Skills – 2

Numerical simulations or computational analysis (if used) support this PO moderately. However, if the course is purely theoretical, the relation remains partial.

PO 10. Multicultural Competence, Inclusive Spirit, and Empathy – 1

No direct relation; the course content is technical and not socially or culturally oriented. Minimal correlation.

PO 11. Value Inculcation and Environmental Awareness – 1

Electromagnetic theory can relate to sustainable technologies (e.g., energy transmission, communication systems), but such applications are typically not covered in depth. Weak relation.

PO 12. Autonomy, Responsibility, and Accountability – 2

Students must independently handle complex derivations and problem-solving tasks, reflecting responsibility in learning and analytical autonomy.

PO 13. Community Engagement and Service – 1

The course does not directly involve community-oriented applications. The link is weak or indirect.

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 : VI

Course Type : Major Mandatory (Theory)

Course Code : PHY-352-MJM

Course Title : Quantum Mechanics

No. of Credits : 02

No. of Teaching Hours : 30

Course Objectives:

1. To introduce the basic principles of quantum mechanics and its necessity
2. To develop understanding of wave–particle duality and Schrödinger's formalism.
3. To apply quantum concepts to simple systems like particle in a box and hydrogen atom
4. Learn how classical concepts break down at microscopic scales and how quantum mechanics replaces them.
5. Understand boundary conditions and normalization of wave functions.
6. Learn basic quantum statistics.
7. Learn about orbital angular momentum, spin angular momentum, and their quantizationn.

Course Outcomes:

After successful completion of the course student will be able to

CO1. Understanding Fundamental Principles: Gain a solid grasp of key quantum mechanics concepts such as wave-particle duality, the Schrödinger equation, quantization, and the Heisenberg uncertainty principle.

CO2. Mathematical Proficiency: Develop the ability to solve quantum mechanical problems using mathematical tools like linear algebra, differential equations, and complex numbers.

CO3. Application of Quantum Theory: Learn to apply quantum mechanics to various systems, including simple models (like the particle in a box, harmonic oscillator and hydrogen atom) and more complex systems.

CO4. Interpretation of Quantum Mechanics: Explore different interpretations of quantum mechanics, such as the Copenhagen interpretation, many-worlds, and pilot-wave theory and understand their philosophical implications.

CO5. Quantum Mechanics in Practice: Gain familiarity with experimental techniques and technologies that rely on quantum mechanics, such as quantum computing, quantum cryptography and spectroscopy.

CO6. Problem-Solving Skills: Develop critical problem-solving skills by working through a variety of quantum mechanics problems and exercises, enhancing your ability to analyze and interpret results.

CO7. Scientific Communication: Improve your ability to communicate complex quantum mechanics concepts and results clearly and effectively, both in written and oral formats.

Topics and Learning Points

UNIT 1: Origin of Quantum Mechanics (10L)

1.1 Historical Background a) Review of Black body radiation.

1.2 Matter waves- De Broglie hypothesis. Davisson and Germer experiment.

1.3 Wave particle duality

1.4 Wave function of a particle having definite momentum

1.5 Concept of wave packet, phase velocity, group velocity and their elations

1.6 Heisenberg's uncertainty principle and different forms of uncertainty.

1.7 Problems

UNIT 2: The Schrodinger Equation (10L)

2.1 Introduction

2.2 Physical interpretation of wave function

2.3 Schrodinger time dependent equation.

2.4 Schrodinger time independent equation.(Steady state equation).

2.5 Probability current density, equation of continuity

2.6 Eigen function and Eigen values, Expectation value–Ehrenfest's theorem

2.7 Problems

UNIT 3: Applications of Schrodinger Steady state equation (12L)

3.1 Free particle.

3.2 Particle in infinitely deep potential well (one-dimension).

3.3 Particle in three-dimension rigid box.

3.4 Step potential

3.5 Potential barrier penetration and tunnelling effect.

3.6 Schrodinger's equation in spherical polar co-ordinate system.

3.7 Harmonic oscillator (one-dimension)

3.8 Hydrogen atom: radial and angular parts of the bound state energy ,energy state functions, Quantum numbers n, l, ml ,ms.

3.9 Problems

References:

1. Quantum Mechanics by Noureddine Zettili, A John Wiley and Sons, Ltd.
2. Modern Quantum Mechanics by J. J. Sakurai.
3. A Textbook of Quantum Mechanics by P. M. Mathews and K. Venkatesan.
4. Quantum mechanics by A. Ghatak and S. Lokanathan.
5. Quantum Mechanics by L. I. Schiff.
6. Quantum Physics by R. Eisberg and R. Resnick.
7. Introduction to Quantum Mechanics by David J. Griffiths.

Mapping of Program Outcomes with Course Outcomes

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

Course: Quantum Mechanics **Course Code**: PHY-352-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	3	3	1	3	2	2	1	1	2	1
CO 2	3	2	1	3	3	1	3	2	2	1	1	2	1
CO 3	3	2	1	3	3	1	3	2	2	1	1	2	1
CO 4	3	1	1	2	2	2	3	3	1	1	1	2	1
CO 5	3	3	1	3	3	2	3	2	2	1	1	2	1
CO 6	3	2	1	3	3	2	3	2	2	1	1	2	1
CO7	3	2	1	2	2	3	2	2	2	1	1	2	1

Justification

PO 1. Comprehensive Knowledge and Understanding – 3

Quantum Mechanics forms the conceptual and theoretical foundation of modern physics. CO1–CO4 directly contribute to developing a profound understanding of fundamental principles, equations, and postulates. Students also gain exposure to advanced theoretical frameworks and interpretations within a broader scientific context.

PO 2. Practical, Professional, and Procedural Knowledge – 2

Through CO5 (Quantum Mechanics in Practice), learners gain insight into experimental and technological applications like quantum computing and spectroscopy, partially fulfilling this PO. However, the emphasis remains theoretical rather than procedural.

PO 3. Entrepreneurial Mindset and Knowledge – 1

Although innovation is implicit in understanding quantum technologies, direct entrepreneurial or business-related knowledge is not covered in this course. Weak relationship.

PO 4. Specialized Skills and Competencies – 3

Quantum mechanics requires specialized analytical and mathematical competence (CO2, CO3, CO6). Students develop strong problem-solving, reasoning, and interpretative abilities that are central to advanced scientific work.

PO 5. Capacity for Application, Problem-Solving, and Analytical Reasoning – 3

Problem-solving is integral to quantum mechanics. Through CO2, CO3, and CO6, students analyze abstract situations, apply mathematical models, and derive physical interpretations — demonstrating advanced analytical reasoning and application skills.

PO 6. Communication Skills and Collaboration – 2

CO7 emphasizes scientific communication. Students learn to express complex theories and derivations clearly in reports or discussions, enhancing their ability to communicate scientific information effectively.

PO 7. Research-related Skills – 3

Quantum mechanics inherently cultivates research-oriented thinking. CO3, CO4, and CO5 enable students to approach modern physical problems with research methodologies, theoretical modeling, and a deep appreciation of experimental validation.

PO 8. Learning How to Learn Skills – 2

The course encourages independent conceptual learning and self-study of abstract ideas. Understanding diverse interpretations (CO4) nurtures intellectual curiosity and adaptability.

PO 9. Digital and Technological Skills – 2

While not the main focus, computational tools may be used for solving Schrödinger equations or simulating systems. Students gain moderate exposure to relevant software and data visualization techniques.

PO 10. Multicultural Competence, Inclusive Spirit, and Empathy – 1

Quantum mechanics is a universal science transcending cultural boundaries, but it does not explicitly engage with multicultural or social dimensions. Weak correlation.

PO 11. Value Inculcation and Environmental Awareness – 1

Ethical considerations in quantum technology (e.g., encryption, quantum computing) may be discussed briefly, but sustainability or moral values are not central. Minimal relation.

PO 12. Autonomy, Responsibility, and Accountability – 2

Through independent study, assignments, and analytical exercises, students demonstrate self-discipline, intellectual autonomy, and accountability for their learning progress.

PO 13. Community Engagement and Service – 1

Quantum mechanics has limited direct societal engagement within the course framework. The focus remains theoretical rather than community-based. Weak link.

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 : VI

Course Type : Major Mandatory (Theory)

Course Code : PHY-353-MJM

Course Title : Thermodynamics and Stastical Physics

No. of Credits : 02

No. of Teaching Hours : 30

Course Objectives:

1. To understand the various concepts of thermodynamics and statistics.
2. To understand the necessity of studying Statistical Mechanics in light of knowledge of classical and quantum mechanics.
3. To understand the behavior of particle under classical and quantum condition.
4. To understand the partition function so that one can easily determine the mean value of internal energy, magnetization etc.
5. Analyze thermodynamic systems using concepts like internal energy, enthalpy, entropy, heat, and work.
6. Understand how statistical mechanics bridges the gap between microscopic particle behavior and macroscopic thermodynamic quantities.
7. Derive and apply the Maxwell-Boltzmann distribution for classical gases

Course Outcomes:

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

CO1**.** Understand the relevant quantities used to describe macroscopic systems, thermodynamic potentials and ensembles.

CO2**.** Understand the concepts of partition functions by taking into account the different types of ensemble.

CO3**.** Describe the consequences in classical and quantum statistics.

CO4**.** Design statistical tools to study thermodynamical interactions in ensembles.

CO5**.** To Compare the MB, BE and FD statistics and classify particles according to them.

CO6**.** Explain the quantum statistics and differentiate between classical and quantum statistics.

CO7**.** Study and apply Bose Einstein Statistics, Fermi Dirac Statistics in problem solving.

Topics and Learning Points

UNIT 1: Thermodynamics and Elementary Concepts of Statistics. (12L)

1.1.Revision of concepts and laws of thermodynamics

1.2. Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function Gibb's function.

1.3. Derivation of Maxwell Relations, Specific heat and latent heat equations

1.4 Probability, distribution functions

1.5 Random Walk and Binomial distribution.

1.6 Calculation of mean values.

1.7 Probability distribution for large-scale N

1.8 Problems.

UNIT 2: Statistical Distribution of System of Particles and Ensembles. (09L)

2.1 Specification of state of system, Microstate and Macrostates

2.2 Basic Postulates, Probability calculations

2.3 Statistical ensembles (Introduction)

2.4 Problems.

UNIT 3: Introduction to Quantum Statistics. (09L)

3.1 Quantum distribution function

3.2 Maxwell-Boltzmann's statistics

3.3 Bose-Einstein Statistics

3.4 Fermi-Dirac Statistics

3.5 Comparison of the M.B. Statistics B.E. Statistics and F.D. Statistics.

3.4 Problems.

References:

1 Statistical and Thermal physics - Lokanathan, R.S. Gambhir,

2. Fundamentals of Statistics and Thermal Physics - F. Reif

3. Perspectives of Modern Physics - A. Beiser

4. Fundamental of Statistical Mechanics - B.B. Laud

5. Statistical Mechanics – Gupta

Mapping of Program Outcomes with Course Outcomes

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

Course: Thermodynamics and Stastical Physics **Course Code**: PHY-353-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	3	3	1	3	2	2	1	1	2	1
CO 2	3	2	1	3	3	1	3	2	2	1	1	2	1
CO 3	3	2	1	3	3	2	3	2	2	1	1	2	1
CO 4	3	2	1	3	3	2	3	2	2	1	1	2	1
CO 5	3	2	1	3	3	2	3	2	2	1	1	2	1
CO 6	3	2	1	3	3	2	3	2	2	1	1	2	1
CO7	3	3	1	3	3	2	3	2	2	1	1	2	1

Justification

PO 1. Comprehensive Knowledge and Understanding – 3

All course outcomes (CO1–CO7) involve the understanding of fundamental thermodynamic quantities, statistical ensembles, and quantum statistics. The course provides a deep theoretical base, linking microscopic and macroscopic descriptions of systems. Hence, it shows a strong alignment with this PO.

PO 2. Practical, Professional, and Procedural Knowledge – 2

tudents apply theoretical knowledge to analyze real physical systems, derive thermodynamic parameters, and interpret statistical behaviors. While largely conceptual, the analytical and procedural skills developed are moderately aligned with professional applications.

PO 3. Entrepreneurial Mindset and Knowledge – 1

The course does not directly involve entrepreneurship or business knowledge. However, the logical reasoning and data analysis skills could indirectly foster innovation in research or technology. Thus, weak correlation.

PO 4. Specialized Skills and Competencies – 3

Statistical mechanics demands strong mathematical and analytical skills. Through CO2, CO4, CO5, and CO7, students develop specialized competencies in applying statistical tools and theoretical models to physical systems. Hence, strong relation.

PO 5. Capacity for Application, Problem-Solving, and Analytical Reasoning – 3

Problem-solving is a central element of this course. Students analyze, model, and predict thermodynamic behavior using mathematical reasoning and statistical tools (CO2–CO7). Thus, this PO has a direct and strong relation.

PO 6. Communication Skills and Collaboration – 2

Students learn to explain thermodynamic and statistical results clearly through reports or presentations. Communication of complex physical ideas improves, though teamwork is not a major component. Moderate relation.

PO 7. Research-related Skills – 3

The course forms a foundation for theoretical and computational research in physics. CO3, CO4, CO6, and CO7 foster skills in model formulation, hypothesis testing, and theoretical exploration — strong relation.

PO 8. Learning How to Learn Skills – 2

Students must independently integrate mathematical methods and physical theories, fostering continuous self-directed learning. Hence, a moderate relation.

PO 9. Digital and Technological Skills – 2

If simulations or computational models are introduced (e.g., ensemble averages, partition function computations), students gain moderate exposure to digital or software-based learning. Otherwise, theoretical.

PO 10. Multicultural Competence, Inclusive Spirit, and Empathy – 1

As a technical subject, the course does not inherently involve cultural or social perspectives. Weak alignment.

PO 11. Value Inculcation and Environmental Awareness – 1

While thermodynamics connects to energy efficiency and sustainability concepts, these are not core learning objectives. Weak relation.

PO 12. Autonomy, Responsibility, and Accountability – 2

Students are expected to approach problems independently and manage their analytical work responsibly. Moderate correlation.

PO 13. Community Engagement and Service – 1

The course does not directly involve societal or community-oriented applications. Weak correlation.

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 : VI

Course Type : Major Mandatory (Theory)

Course Code : PHY-354-MJM

Course Title : Nuclear Physics

No. of Credits : 02

No. of Teaching Hours : 30

Course Objectives:

1.To know the composition of the nucleus in detail and the terms related to the nuclei.

2.The present course is designed to cover all areas of the subject with research and application of nuclear energy.

3.To understand the physics behind nuclear power generation and nuclear weapons.

4.To know the applications of nuclear physics like in medicine, magnetic resonance imaging and radiocarbon dating in geology and archaeology.

5. Learn about nuclear constituents (protons, neutrons), nuclear sizes, binding energy, nuclear stability, and mass defects.

6. Explore nuclear models like the liquid drop model, shell model, and collective model to explain nuclear behavior and structure.

7. Understand real-world applications in nuclear energy, medical imaging/radiotherapy and nuclear instrumentation

Course Outcomes:

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

CO1: The students will understand the fundamental principles and concepts governing classical nuclear and particle physics.

CO2: The students should be able to understand the fundamental constituents of matter and set foundation for the understanding of unsolved questions about dark matter, antimatter, and other research-oriented topics.

CO3: Knowledge of their applications interactions of ionizing radiation with matter the key techniques for particle accelerators the physical processes involved in nuclear power generation.

CO4: The students should be able to understand the interactions of radiations with matter which is the key technique for particle accelerators and nuclear power generators.

CO5: To understand the principle, construction and working of various particle accelerators like Cyclotron and Betatron and their use in new experimentations.

CO6: The students should be able to classify and explain the principle, construction and working of Geiger-Muller counter, Cloud Chamber and the Scintillation counter.

CO7: To classify and categorize the different properties of elementary particles: leptons, hadrons (baryons and mesons), quarks.

Topics and Learning Points

UNIT 1: Basic Properties of Nucleus (10L)

1.1 Composition of nucleus - Charge, Size, Density of nucleus
1.2 Nuclear Magnetic Dipole Moment
1.3 Nuclear angular momentum
1.4 Mass defect and Binding energy, Binding energy per nucleon
1.5 Packing fraction
1.6 Classification of nuclei
1.7 Problems.

UNIT 2: Radioactivity and Nuclear Forces (10L)

2.1 Radioactivity disintegration (concept of natural and artificial radioactivity)
2.2 Properties of α, β, γ rays
2.3 Laws of radioactive decay
2.4 Half-life, mean life, Specific activity and its units
2.5 Meson theory of nuclear forces, Properties of nuclear forces
2.6 Introduction to elementary particles
2.7 Problems

UNIT 3: Nuclear Reactions and Particle Accelerators (10L)

3.1 Introduction to nuclear reactions
3.2 Q value equation
3.3 Exothermic and Endothermic reaction
3.4 Conservation laws, nuclear fission and nuclear fusion
3.5 Particle accelerator
3.6 Types of particle accelerators- Linear Particle Accelerator, Cyclotron
3.7 Problems

References:

1. Nuclear Physics – D.C. Tayal
2. Nuclear Physics – Dr. S.N. Ghoshal
3. Concepts of Nuclear Physics – B.L. Cohen (Tata McGraw Hill co.)
4. Introduction to Nuclear Physics - S. B. Patel
5. Atomic and Nuclear Physics - Shatendra Sharma (Pearson Education,1 st Edition)
6. Introduction to Nuclear Physics - Y.R. Waghmare (Oxford IBH.)

Mapping of Program Outcomes with Course Outcomes

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

Course: Nuclear Physics **Course Code**: PHY-354-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	2	2	1
CO 2	3	2	2	3	3	1	3	3	2	1	1	2	1
CO 3	3	3	1	3	3	1	2	2	3	1	1	3	2
CO 4	3	3	1	3	3	1	2	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	3	2	3	1	1	3	2
CO7	3	2	1	3	3	1	2	2	1	1	1	2	1

Justification

PO1: Comprehensive Knowledge and Understanding

Strong correlation (3) — The course provides deep conceptual understanding of nuclear and particle physics fundamentals (CO1–CO7), helping students grasp the basic forces, particle interactions, and nuclear properties within a multidisciplinary context.

PO2: Practical, Professional, and Procedural Knowledge

Strong to moderate correlation (2–3) — Through the study of particle accelerators, detectors, and radiation–matter interactions (CO3–CO6), students develop procedural and experimental insight applicable in research and industry.

PO3: Entrepreneurial Mindset and Knowledge

Weak to moderate correlation (1–2) — Exposure to nuclear technology, radiation instrumentation, and accelerator applications (CO3–CO5) can foster innovative thinking for technological and research-based ventures.

PO4: Specialized Skills and Competencies

Strong correlation (3) — Students gain specialized analytical and technical skills by learning to interpret particle interactions, operate detectors, and analyze nuclear systems (CO4–CO7).

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

Strong correlation (3) — Solving theoretical and experimental problems in nuclear and particle physics (CO1–CO7) enhances analytical reasoning and critical thinking abilities.

PO6: Communication Skills and Collaboration

Weak to moderate correlation (1–2) — Students develop the ability to present and discuss experimental findings and theoretical concepts effectively, fostering teamwork during practical work and discussions.

PO7: Research-related Skills

Strong correlation (3) — The course involves understanding experimental methods, data analysis, and model building (CO2–CO7), developing observational and inquiry-based research skills.

PO8: Learning How to Learn Skills

Moderate correlation (2) — Students are encouraged to learn independently from research literature and modern developments in particle physics and quantum theories.

PO9: Digital and Technological Skills

Strong correlation (3) — The course promotes proficiency in handling simulation tools, radiation measurement software, and computational modeling (CO3–CO6).

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Weak correlation (1) — Limited relevance, though collaborative learning and team-based projects enhance interpersonal understanding and mutual respect.

PO11: Value Inculcation and Environmental Awareness

Weak correlation (1) — Minimal, though students become aware of ethical and safety concerns in nuclear energy and radiation usage.

PO12: Autonomy, Responsibility, and Accountability

Moderate correlation (2–3) — Students take responsibility for experimental design, data accuracy, and ethical handling of nuclear materials (CO3–CO6).

PO13: Community Engagement and Service

Weak to moderate correlation (1–2) — Understanding nuclear science's societal applications (energy, medicine, environment) fosters awareness and responsibility toward community welfare.

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 : VI

Course Type : Major Mandatory (Practical)

Course Code : PHY-355-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. Resonance pendulum
2. S.T. of soap solution
3. Surface tension of mercury by Fergusson modified method
4. Y by Koenig's method
5. Y by Cornu's spiral
6. Refractive index of glass by Brewster's law
7. Diffraction at a Single Slit
8. Lloyd's single mirror
9. Double refracting prism
10. To design and test an astable multivibrator using IC-555Timer.
11. To design and test monostable multivibrator using IC-555Timer.

Skill Testing Experiments

1. Schuster's method and optical levelling of spectrometer
2. Obtaining Biprism fringes without lateral shift
3. Measurement of distance between two coherent sources in Biprism experiment
4. Study of quantum tunnelling effect using tunnel diode
5. Testing of electronic components
6. Estimation of errors
7. Electrical wiring of bulb, switch and plug.
8. Tracing of given electronic circuit/build the given circuit using breadboard
9. Assembling of given electronic circuit (soldering method)
10. Testing of Home appliances

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- VI) **Subject**: Physics

Course: Major Physics Practical–I **Course Code**: PHY-355-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	1	2	2	2	1	1	3	1
CO 4	3	3	1	3	3	1	2	2	3	1	1	3	1
CO 5	3	3	1	3	3	1	3	2	3	1	1	3	1
CO 6	3	3	1	3	3	1	3	2	3	1	1	3	1
CO7	3	3	1	3	3	1	3	2	3	1	1	3	1

Justification

PO1: Comprehensive Knowledge and Understanding

Strong correlation (3) — All experiments (CO1–CO7) require fundamental understanding of mechanics, optics, and wave phenomena, reinforcing theoretical knowledge through experimental verification.

PO2: Practical, Professional, and Procedural Knowledge

Strong correlation (3) — Students gain hands-on experience in performing precision experiments using devices like Kater’s pendulum, diffraction grating, and interferometers, aligning with professional laboratory standards.

PO3: Entrepreneurial Mindset and Knowledge

Weak correlation (1) — Limited but possible connection, as exposure to optical instrumentation and measurement systems can encourage innovative thinking in technology-based applications.

PO4: Specialized Skills and Competencies

Strong correlation (3) — Experiments build analytical and technical proficiency in measurement, calibration, and interpretation of experimental data, essential for specialized scientific competence.

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

Strong correlation (3) — Problem-solving and analytical reasoning are emphasized in analyzing data (moment of inertia, wavelength determination, diffraction analysis) and comparing results with theory.

PO6: Communication Skills and Collaboration

Moderate correlation (2) — Students discuss, report, and present experimental findings in teams, developing both written and oral communication skills.

PO7: Research-related Skills

Strong correlation (3) — Students design experiments, handle data acquisition, identify errors, and interpret results — foundational research practices (CO4–CO7).

PO8: Learning How to Learn Skills

Moderate correlation (2) — Independent experimental setup and analysis encourage students to explore concepts beyond standard procedures and learn through discovery.

PO9: Digital and Technological Skills

Strong correlation (3) — Use of spectrometers, interferometers, and other digital/optical instruments strengthens familiarity with modern experimental tools and software for data analysis.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Weak correlation (1) — Group laboratory work nurtures teamwork and mutual respect among peers, although cultural inclusivity is not a major focus.

PO11: Value Inculcation and Environmental Awareness

Weak correlation (1) — Ethical practices in laboratory safety and responsible equipment use foster professional and moral responsibility.

PO12: Autonomy, Responsibility, and Accountability

Strong correlation (3) — Students are responsible for precise experimentation, observation, and reporting, developing accountability in scientific practice.

PO13: Community Engagement and Service

Weak correlation (1) — Indirect connection, as understanding of scientific measurement principles contributes to societal applications in technology and education.

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 : VI

Course Type : Major Elective (MJE) (Theory)

Course Code : PHY-356 –MJE (A)

Course Title : Physics of Nanomaterials

No. of Credits : 02

No. of Teaching Hours : 30

Course Objectives:

1. Understand the Fundamental Principles of Nanomaterials Explore the basic concepts, structure, and properties of nanomaterials, including quantum confinement, surface effects, and dimensionality, and how these influence physical behaviors.

2. Analyze the Synthesis Techniques of Nanomaterials Learn about the various methods for synthesizing nanomaterials such as chemical vapor deposition (CVD), sol-gel processes, and mechanical methods, and their impact on the materials' structure and properties.

3. Examine the Electrical, Optical, and Magnetic Properties of Nanomaterials Investigate the unique electrical, optical, and magnetic properties of nanomaterials and how these properties can be tailored for different technological applications.

4. Characterize Nanomaterials Using Advanced Techniques Gain proficiency in characterizing nanomaterials using techniques such as atomic force microscopy (AFM), scanning tunnelling microscopy (STM), and transmission electron microscopy (TEM).

5. Explore the Applications and Impacts of Nanomaterials Evaluate the role of nanomaterials in cutting-edge technologies such as nanotechnology, medicine, electronics, and energy, as well as their societal and environmental implication

6. Explore how quantum effects, surface-to-volume ratio, and confinement influence the electrical, optical, magnetic, and mechanical properties of materials at the nanoscale.

7. Learn about common synthesis techniques (e.g., sol-gel, chemical vapor deposition, self-assembly), characterization methods (e.g., TEM, AFM, XRD), and their applications in electronics, energy, medicine, and materials science.

Course Outcomes:

After successful completion of the course student will be able to –

CO1. Demonstrate an understanding of fundamental principles Students will be able to explain key concepts such as quantum confinement, surface effects, and the influence of dimensionality on the properties of nanomaterials.

CO2. Analyze and compare synthesis techniques Students will critically assess various nanomaterial synthesis techniques (e.g., chemical vapor deposition, sol-gel, mechanical methods) and evaluate their influence on the structure and properties of nanomaterials.

CO3. Evaluate the unique properties of nanomaterials Students will analyze and predict how the electrical, optical, and magnetic properties of nanomaterials differ from bulk materials, and discuss how these properties can be engineered for specific applications.

CO4. Apply quantum mechanical principles to nanoscale systems Students will use quantum mechanical models to explain nanoscale phenomena such as electron confinement, energy band modification, and the behavior of photons and phonons in nanostructures.

CO5. Utilize advanced characterization techniques Students will demonstrate the ability to interpret data from techniques such as AFM, STM, and TEM, applying these tools to characterize the structural and physical properties of nanomaterials.

CO6. Assess the applications and implications of nanomaterials Students will evaluate the use of nanomaterials in various industries, such as electronics, energy, and biomedicine, and critically analyze their environmental, ethical and societal impacts.

CO7. Research design and analysis Develop the ability to design research questions related to nanomaterials, conduct literature reviews, analyze experimental data, and effectively communicate research findings.

Topics and Learning Points

UNIT 1: Introduction to Nanoscience and Nanomaterials (8L)

1.1 Definition and scope of nanoscience and nanotechnology

1.2 Historical background and milestones in nanotechnology

1.3 Classification of nanomaterials: 0D, 1D, 2D, and 3D nanostructures

1.4 Quantum confinement and size effects

1.5 Physical and chemical properties at nanoscale

1.6 Surface-to-volume ratio and its implications

1.7 Overview of major nanomaterials (nanotubes, nanowires, quantum dots, graphene, etc.)

UNIT 2: Synthesis and Fabrication Techniques (8L)

2.1 Top-down and Bottom-up approaches

2.2 Physical methods: Mechanical milling, Laser ablation, Thermal evaporation, Sputtering

2.3 Chemical methods: Sol–gel, Co-precipitation, Chemical vapour deposition (CVD), Hydrothermal synthesis

2.4 Biological methods: Microbial and plant-mediated synthesis

2.5 Self-assembly and templating methods

2.6 Thin film deposition techniques (PVD, CVD, Spin coating)

2.7 Control of size, shape, and morphology in synthesis

2.8 Safety and ethical issues in nanomaterial synthesis

UNIT 3: Characterization of Nanomaterials (8L)

3.1 Importance of characterization in nanoscience

3.2 Structural characterization

A. X-ray diffraction (XRD)
B. Transmission electron microscopy (TEM)
C. Scanning electron microscopy (SEM)
D. Atomic force microscopy (AFM)

3.3 Optical and spectroscopic methods

A. UV–Visible spectroscopy
B. Photoluminescence (PL) spectroscopy
C. Raman spectroscopy

3.4 Surface analysis: BET surface area analysis

3.5 Interpretation of data and typical examples

UNIT 4: Applications and Future Perspectives (6L)

4.1 Nanomaterials in electronics, optoelectronics, and photonics

4.2 Nanomaterials in medicine and biotechnology (drug delivery, biosensors)

4.3 Magnetic and mechanical applications (nanomagnets, nanocomposites)

4.4 Energy-related applications (solar cells, batteries, supercapacitors)

4.5 Environmental and green applications (water purification, catalysts)

4.6 Challenges, risks, and future trends in nanotechnology

References:

1. T. Pradeep, A Textbook of Nanoscience and Nanotechnology, Tata McGraw-Hill.

2. C. P. Poole Jr. & F. J. Owens, Introduction to Nanotechnology, Wiley.

3. G. Cao & Y. Wang, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World Scientific.

4. M. Hosokawa et al., Nanoparticle Technology Handbook, Elsevier.

5. S. Lindsay, Introduction to Nanoscience, Oxford University Press

Mapping of Program Outcomes with Course Outcomes

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

Course: Physics of Nanomaterials **Course Code**: PHY-356 –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	3	3	2	2	2	2	1	1	2	1
CO 2	3	3	1	3	3	2	2	2	3	1	1	2	1
CO 3	3	3	2	3	3	2	2	2	3	1	2	2	1
CO 4	3	2	1	3	3	2	2	2	2	1	1	2	1
CO 5	3	3	1	3	3	2	3	2	3	1	1	3	1
CO 6	3	3	2	3	3	2	2	2	3	2	3	3	2
CO7	3	3	2	3	3	3	3	3	3	2	3	3	2

Justification

PO1: Comprehensive Knowledge and Understanding

Strong correlation (3) — The course builds foundational understanding of nanoscale physics, quantum effects, and materials science principles (CO1–CO4), ensuring conceptual depth and multidisciplinary integration.

PO2: Practical, Professional, and Procedural Knowledge

Strong correlation (3) — Through synthesis (CO2) and characterization techniques (CO5), students gain practical knowledge aligned with modern nanoscience research and industry practices.

PO3: Entrepreneurial Mindset and Knowledge

Moderate correlation (2) — Exposure to nanomaterials' applications (CO6) encourages innovation and entrepreneurial thinking in emerging technologies such as nanoelectronics, energy storage, and medical diagnostics.

PO4: Specialized Skills and Competencies

Strong correlation (3) — Students develop advanced analytical and technical competencies in nanomaterial synthesis, measurement, and modeling (CO2–CO5), fostering expertise relevant to research and industry.

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

Strong correlation (3) — The course emphasizes critical analysis, problem-solving, and interpretation of data across nanoscale systems and experimental results (CO3, CO4, CO7).

PO6: Communication Skills and Collaboration

Moderate correlation (2–3) — Students communicate experimental results and research findings (CO7), enhancing written and oral communication skills through reports, presentations, and teamwork.

PO7: Research-related Skills

Strong correlation (3) — CO7 explicitly develops the ability to formulate research questions, review literature, and analyze nanomaterials data, embedding research ethics and methodologies.

PO8: Learning How to Learn Skills

Moderate to strong correlation (2–3) — Students engage in self-directed exploration of emerging nanotechnology topics (CO6, CO7), cultivating lifelong learning and adaptability.

PO9: Digital and Technological Skills

Strong correlation (3) — Application of nanoscale modeling tools and interpretation of digital data from instruments like AFM, STM, and TEM (CO5) strengthens computational and technical proficiency.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Weak to moderate correlation (1–2) — Collaborative project work and discussions on societal applications of nanotechnology (CO6) promote teamwork and appreciation of diverse perspectives.

PO11: Value Inculcation and Environmental Awareness

Moderate to strong correlation (2–3) — The environmental and ethical implications of nanomaterials (CO6) develop awareness of sustainability and responsible technological advancement.

PO12: Autonomy, Responsibility, and Accountability

Strong correlation (3) — Students conduct independent projects and experiments (CO5, CO7), promoting accountability in research and scientific reporting.

PO13: Community Engagement and Service

Moderate correlation (2) — Discussions on societal and biomedical applications of nanotechnology (CO6) highlight the relevance of scientific innovation to community 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 : VI

Course Type : Major Elective (MJE) (Theory)

Course Code : PHY-356-MJE (B)

Course Title : Solar Energy Conversion Devices

No. of Credits : 02

No. of Teaching Hours : 30

Course Objectives:

1. Define sustainable development including its three pillars.
2. Referring to the energy conversion matrix, identify the conversion steps taken by various renewable energy technologies
3. Learn the physics of solar radiation, photovoltaic effect, and principles of converting solar energy into electricity and heat.
4. Analyze the structure, working, and performance characteristics of different types of solar cells, including silicon-based, thin-film, and emerging PV technologies.
5. Understand the role of semiconductors, conductors, and nanomaterials in enhancing the efficiency and stability of solar energy systems.
6. Learn methods to characterize, model, and optimize the efficiency of solar cells and thermal collectors under various environmental conditions.
7. Study how solar energy devices are integrated into practical systems for residential, industrial, and grid-scale applications, including storage and hybrid systems.

Course Outcomes:

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

CO1: The course providing a basic understanding of theory and practice of various photovoltaic technologies and design concepts.

CO2: To understand the physical principles of the photovoltaic (PV) solar cell

CO3: Discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment.

CO4: Use solar energy for domestic purpose and reduce conventional electricity consumption.

CO5: Take initiation in awareness program for promotion and more use of solar energy for society.

CO6: Can implement ideas and knowledge to replace unnecessary high wattage Electricity source in domestics appliances

CO7: Knowledge should be transferred to society through demonstrations of Solar equipment.

Topics and Learning Points

UNIT 1: Photovoltaic converters (10L)

1.1 Photovoltaic effect,

1.2 Types of solar cell

1.3 Equivalent circuit diagram of a solar cell, determination of series resistance (Rs) and shunt resistance (Rsh), solar cell output parameters: RL, Voc, Isc, Pm, FF, efficiency

1.4 Types of heterojunction, construction of energy band diagram of heterojunction

1.5 Problems

UNIT 2: Materials and Solar cell Technology (10L)

2.1 Fabrication technology of silicon solar cell

2.2 Single, poly and amorphous silicon, GaAs, CdS, Cu_2S, $CuInSe_2$, CdTe etc. technologies for fabrication of single and polycrystalline silicon solar cells

2.3 Solar cell modules, photovoltaic systems

2.4 Dye-sensitized solar cell, perovskite solar cell

2.5 Problems

UNIT 3: Photochemical Converters (10L)

3.1 Semiconductor–electrolyte interface,
Helmholtz double layer, Gouy-Chapman model, Stern model

3.2 Principle of photoelectrochemical solar cells, photoelectrolysis cell, driving force of photoelectrolysis

3.3 Alkaline fuel cell, semiconductor- septum storage cell

3.3 Concept of photocatalysis and photoelectrocatalysis process

3.4 Problems.

References:

1. Solar energy conversion: The solar cell, by Richard C. Neville.

2. Photoelectrochemical solar cells –Suresh Chandra

3. Solar energy conversion – A. E. Dixon and J. D. Leslie.

4. Solar cells– Martin A. Green

5. Heterojunction and metal–semiconductor junctions –A. G. Milnes and D. L. Feucht.

6. Solid state electronic devices- B. G. Streetman.

7. Principles of solar engineering–Frank Kreith and Janf Kreider.

8. Direct energy conversion (4th edition)– Stanley WAngrist

Mapping of Program Outcomes with Course Outcomes

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

Course: Solar Energy Conversion Devices **Course Code**: PHY-356-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	3	2	3	3	2	2	2	3	1	2	2	1
CO 2	3	3	2	3	3	2	2	2	3	1	2	2	1
CO 3	3	2	2	2	3	2	2	2	2	2	3	2	2
CO 4	2	3	3	3	3	2	2	2	3	2	3	3	2
CO 5	2	2	3	2	2	3	2	2	2	3	3	3	3
CO 6	3	3	3	3	3	2	2	2	3	2	3	3	2
CO7	2	2	3	2	2	3	2	2	2	3	3	3	3

Justification

PO1: Comprehensive Knowledge and Understanding

Strong correlation (3) — The course establishes a fundamental understanding of photovoltaic principles, solar cell operation, and energy conversion mechanisms (CO1, CO2), giving students broad multidisciplinary insight into renewable energy systems.

PO2: Practical, Professional, and Procedural Knowledge

Strong correlation (3) — Students gain practical exposure to solar PV system components, design, and performance evaluation (CO1, CO4, CO6), aligning with industry standards and professional practices in renewable energy.

PO3: Entrepreneurial Mindset and Knowledge

Strong to moderate correlation (2–3) — Through project-based learning and awareness campaigns (CO5, CO7), students develop entrepreneurial thinking and recognize opportunities in solar technology sectors such as installation, maintenance, and consultancy.

PO4: Specialized Skills and Competencies

Strong correlation (3) — The course equips learners with specialized skills in PV design, system sizing, and real-world application of solar energy technologies (CO2, CO4, CO6), enhancing technical proficiency and innovation capacity.

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

Strong correlation (3) — Students identify energy challenges and apply solar technology-based solutions for domestic and community purposes (CO3, CO4, CO6), fostering analytical and problem-solving abilities.

PO6: Communication Skills and Collaboration

Moderate to strong correlation (2–3) — Activities like awareness campaigns and public demonstrations (CO5, CO7) improve students' communication and teamwork skills, fostering collaborative learning and leadership.

PO7: Research-related Skills

Moderate correlation (2) — The understanding of PV mechanisms and performance analysis (CO2, CO6) nurtures observational and inquiry-based learning, forming a base for future research in solar energy technologies.

PO8: Learning How to Learn Skills

Moderate correlation (2) — Students engage in independent exploration of solar technologies, adapt to advancements in PV systems, and set self-learning goals through practical and outreach activities (CO4, CO7).

PO9: Digital and Technological Skills

Strong correlation (3) — Use of simulation tools, digital meters, and performance analysis software for PV systems (CO4, CO6) enhances technological literacy and digital competence in renewable energy monitoring.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Moderate correlation (2–3) — By participating in solar awareness initiatives and community engagement (CO5, CO7), students develop empathy, inclusivity, and social awareness.

PO11: Value Inculcation and Environmental Awareness

Strong correlation (3) — The course promotes sustainability, responsible citizenship, and understanding of solar energy's environmental impacts (CO3, CO4, CO5), fostering ethical responsibility toward the planet.

PO12: Autonomy, Responsibility, and Accountability

Strong correlation (3) — Students independently implement solar-based solutions (CO4, CO6), manage small projects, and take accountability for system performance and public outreach activities.

PO13: Community Engagement and Service

Strong correlation (3) — Demonstrations and awareness drives (CO5, CO7) directly involve students in community service, promoting solar adoption and societal well-being through sustainable practices.

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 : VI

Course Type : Major Elective (MJE) (Theory)

Course Code : PHY-356-MJE (C)

Course Title : Sensors and its Applications

No. of Credits : 02

No. of Teaching Hours : 30

Course Objectives:

1.To elucidate sensors and signal conditioning circuits.

2.To introduce different error analysis methods.

3.To familiarize with different sensors and transducers.

4.To explain signal conditioning circuits.

5. Learn the underlying physical principles, working mechanisms, and classifications of various sensors

6. Gain the ability to select appropriate sensors for specific applications, understand signal conditioning, and integrate sensors into electronic systems and IoT platforms.

7. Study the use of sensors in practical fields such as environmental monitoring, healthcare, industrial automation, robotics, automotive systems, and smart devices.

Course Outcomes:

After successful completion of the course student will be able to -

CO1. Apply different methods for the measurement of various physical quantities.

CO2. Ability to Analyse, formulate and select suitable sensor for the given industrial applications.

CO3. Describe signal conditioning circuits.

CO4. Differentiate between different types of smart sensors.

CO5. Identify various optical transducer.

CO6. Design application based instrumentation for demonstration using sensors.

CO7. Use of knowledge in electronics based project work for demonstration.

Topics and Learning Points

UNIT 1: Sensors (8L)

1.1 Definition, Types, Basic principle and applications of Resistive, Inductive, Capacitive, Piezoelectric and their Dynamic performance.

1.2 Fiber optic sensors, Bio-chemical sensors, Hall-Effect, Photo emissive, Photo Diode/ Photo Transistor, Photovoltaic, LVDT, Strain Gauge

1.3 Digital transducers: Principle, Construction, Encoders, Absolute and incremental encoders, Silicon micro transducers.

UNIT 2: Signal Conditioning (8L)

2.1 Operational Amplifiers: application in instrumentation, Charge amplifier, Carrier amplifier

2.2 Introduction to active filters, Classification, Butterworth, Chebyshev, First order, Second order and higher order filters

2.3 Voltage to frequency and frequency to voltage converters.

UNIT 3: Optical Transducers (8L)

3.1 Theory of photo emission

3.2 classification of photo electric devices

3.3 vacuum photo tube, Gas photo tube, Photo multiplier tube, photo conductive cell, photo diode, photo transistor

3.4 Opto-coupler and their applications,

3.5 Optical Fibre sensors.

UNIT 4: Smart Sensors and Its Applications (6L)

1.1 Introduction, Definition,

1.2 Block Diagram of Smart Sensors,

1.3 Difference between non smart Sensors & Smart Sensors,

1.4 Smart Transducers,

1.5 Introduction to Internet of Things (IoT) Sensors and actuators

References:

1. Doebelin, E.O. and Manic, D.N., Measurement Systems: Applications and Design, McGraw Hill (2004).
2. Sawhney, A.K. and Sawhney, P., A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai (2008).
3. Murthy, D.V.S., Transducers and Instrumentation, Prentice Hall of India (2003).
4. Nakra, B.C. and Chaudhry, K.K., Instrumentation, Measurement and Analysis, TMH (2003)

Mapping of Program Outcomes with Course Outcomes

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

Course: Sensors and its Applications **Course Code**: PHY-356-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	3	2	3	3	2	2	2	3	1	2	2	1
CO 2	3	3	3	3	3	2	2	2	3	1	2	2	1
CO 3	3	3	2	3	3	2	2	2	3	1	2	2	1
CO 4	3	3	3	3	3	2	2	2	3	1	2	2	1
CO 5	3	3	2	3	3	2	2	2	3	1	2	2	1
CO 6	3	3	3	3	3	3	2	2	3	2	2	3	2
CO7	3	3	3	3	3	3	2	2	3	2	2	3	3

Justification

PO1: Comprehensive Knowledge and Understanding

Strong correlation (3) — Students acquire a solid foundation in the principles of sensor operation, measurement techniques, and instrumentation systems (CO1–CO5). This reflects a profound understanding of core concepts within a multidisciplinary context of physics, electronics, and engineering.

PO2: Practical, Professional, and Procedural Knowledge

Strong correlation (3) — The course emphasizes practical applications of sensors and transducers, focusing on calibration, industrial measurement systems, and data acquisition techniques (CO1, CO2, CO6), ensuring alignment with real-world professional practices.

PO3: Entrepreneurial Mindset and Knowledge

Moderate to strong correlation (2–3) — By designing and demonstrating sensor-based systems (CO6, CO7), students develop innovative thinking and recognize opportunities for industrial automation and product development in the sensor technology domain.

PO4: Specialized Skills and Competencies

Strong correlation (3) — Learners gain specialized competencies in selecting appropriate sensors, understanding signal conditioning circuits, and integrating systems for specific industrial and laboratory applications (CO2–CO6).

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

Strong correlation (3) — The design and analysis of measurement systems (CO2, CO6) encourage problem-solving, critical thinking, and the ability to apply learned concepts to practical instrumentation challenges.

PO6: Communication Skills and Collaboration

Moderate correlation (2–3) — Through experimental design, documentation, and project demonstrations (CO6, CO7), students develop collaborative and communication skills, essential for multidisciplinary teamwork in the instrumentation field.

PO7: Research-related Skills

Moderate correlation (2) — The course builds basic research and inquiry abilities through sensor performance analysis, data interpretation, and system optimization activities (CO3, CO6).

PO8: Learning How to Learn Skills

Moderate correlation (2) — Students engage in self-directed exploration of new sensor technologies and applications (CO4, CO7), promoting continuous learning and adaptability to technological advancements.

PO9: Digital and Technological Skills

Strong correlation (3) — Students utilize digital tools, data acquisition systems, and microcontrollers for sensor interfacing and real-time measurements (CO3, CO6), enhancing ICT and technological competence.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Low to moderate correlation (1–2) — Collaboration in diverse project teams during practical demonstrations (CO7) helps students appreciate inclusive teamwork and respect for varied perspectives.

PO11: Value Inculcation and Environmental Awareness

Moderate correlation (2) — Understanding the role of sensors in environmental monitoring, automation, and sustainable practices (CO5, CO6) helps instill ethical and responsible engineering values.

PO12: Autonomy, Responsibility, and Accountability

Strong correlation (3) — Students undertake mini-projects and demonstrations (CO6, CO7) independently, showing responsibility, accountability, and project management capabilities.

PO13: Community Engagement and Service

Strong correlation (3) — Through practical demonstrations, workshops, and exhibitions of sensor-based projects (CO7), learners contribute to public understanding of technology, aligning with social and community engagement goals.

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 : VI

Course Type : Minor (MJE) (Theory)

Course Code : PHY-361-MN

Course Title : Waves and Optics

No. of Credits : 02

No. of Teaching Hours : 30

Course Objectives:

1. To understand the properties of waves
2. The course aims at developing a clear understanding of the fundamental concepts in waves and the application in real life oscillatory, sound, and optical systems, in communication and other applications.
3. Learn about wave motion, including transverse and longitudinal waves, wave speed, frequency, wavelength, and the principle of superposition.
4. Study phenomena such as interference, diffraction, reflection, refraction, standing waves, and resonance in different media.
5. Understand ray optics, including laws of reflection and refraction, image formation by mirrors and lenses, and optical instruments.
6. Examine wave optics concepts such as interference (Young's double slit), diffraction (single/multiple slit), and polarization of light.
7. Use the knowledge of waves and optics in practical applications like fiber optics, lasers, optical sensors, and communication technologies.

Course Outcomes:

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

CO1. Understand the mathematical description of travelling and standing waves.

CO2. Recognize the one-dimensional classical wave equation and its solutions.

CO3. Calculate the phase velocity of a travelling wave.

CO4. Explain in qualitative terms how frequency, amplitude, and wave shape affect the pitch, intensity, and quality of tones produced by musical instruments.

CO5. Understand the operation of many modern optical devices that utilize wave optics.

CO6. Perform optical experiments and do measurements of optical parameters.

CO7. Solve application oriented problems

Topics and Learning Points

UNIT 1: Wave Motion (12 L)

1.1 Introduction ,Concept of wave motion.

1.2. Electromagnetic wave and frequency

1.3. Wavelength and wave equation

1.4. Amplitude and period

1.5. Transverse waves on a string

1.6. Travelling and standing waves on a string

1.7. Normal modes of a string

1.8. Plane waves and spherical waves

1.9. Problems

UNIT 2: Geometrical optics (10 L)

2.1 Introduction to lenses

2.2 Sign conventions

2.3 Thin lenses: Lens equation for single convex lens

2.4 Lens maker's formula

2.5 Concept of magnification, deviation and power of a thin lens

2.6 Equivalent focal length of two thin lenses,

2.7 Problems

UNIT 3: Optical Instruments (8 L)

3.1 Introduction to optical instruments

3.2 Types of optical instruments

3.2 Simple Microscope

3.3 Compound Microscope

3.4 Eyepiece: Huygens eye piece

3.5 Problems.

References:

1. The physics of waves and oscillations, N. K. Bajaj, Tata McGraw- Hill, Publishing co. ltd.
2. Fundamentals of vibration and waves, SPPuri,Tata McGraw-Hill Publishing co. ltd.
3. Waves and Oscillations, R.N. Chaudhari, New age international (p) ltd.
4. University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986.Addison-Wesley
5. Sound, Mee, Heinmann, Edition – London
6. A Textbook of Optics - N. Subhramanyam, Brijlal, M.N. Avadhanulu, S. Chand Publication.
7. Physical Optics - A.K. Ghatak, McMillan, New Delhi
8. Fundamental of Optics - F.A. Jenkins, H.E.White, McGraw-Hilll International edition
9. Principles of Optics - D.S. Mathur, Gopal Press, Kanpur

Mapping of Program Outcomes with Course Outcomes

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

Course: Waves and Optics **Course Code**: PHY-361-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	3	3	1	2	2	2	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	2	3	3	2	2	2	2	2	1	2	1
CO 5	3	3	2	3	3	2	2	2	3	2	2	3	1
CO 6	3	3	2	3	3	3	3	2	3	2	2	3	2
CO7	3	3	2	3	3	2	2	2	3	1	2	3	2

Justification

PO1: Comprehensive Knowledge and Understanding

Strong correlation (3) – The course builds deep theoretical understanding of wave motion, optics, and their mathematical foundations (CO1–CO5). Students acquire conceptual clarity of core physical principles that underpin modern technologies.

PO2: Practical, Professional, and Procedural Knowledge

Strong correlation (3) – Through hands-on optical experiments (CO6) and problem-solving sessions, learners develop the procedural knowledge needed for professional scientific or laboratory work.

PO3: Entrepreneurial Mindset and Knowledge

Low to moderate correlation (1–2) – Students gain awareness of optical technologies (CO5) that have commercial and innovation potential, laying groundwork for entrepreneurship in photonics and instrumentation.

PO4: Specialized Skills and Competencies

Strong correlation (3) – The course equips students with technical and analytical skills, including the design and interpretation of wave and optical experiments (CO3–CO6).

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

Strong correlation (3) – Learners apply theoretical knowledge to solve real-world wave and optics problems, demonstrating analytical reasoning and mathematical modeling (CO1–CO7).

PO6: Communication Skills and Collaboration

Moderate correlation (2) – Laboratory teamwork (CO6) and presentation of experimental results help improve students' communication and collaboration abilities.

PO7: Research-related Skills

Moderate correlation (2–3) – Experimental investigations (CO6) foster observational, analytical, and inquiry-based skills necessary for research in physics and applied optics.

PO8: Learning How to Learn Skills

Moderate correlation (2) – The study of abstract wave and optical concepts (CO1–CO4) encourages self-learning and adaptability to new physical models and technologies.

PO9: Digital and Technological Skills

Strong correlation (3) – The use of optical instruments, sensors, and data analysis software (CO6) enhances technological competence and digital literacy.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Low correlation (1–2) – Group work during lab sessions (CO6) promotes teamwork and appreciation of diverse perspectives in collaborative scientific inquiry.

PO11: Value Inculcation and Environmental Awareness

Moderate correlation (2) – Understanding the role of optical systems in sustainable technologies and environmental sensing (CO5) helps integrate ethical awareness and responsible practice.

PO12: Autonomy, Responsibility, and Accountability

Strong correlation (3) – Individual laboratory tasks (CO6, CO7) cultivate independent learning, precision, and accountability in performing and reporting experiments.

PO13: Community Engagement and Service

Moderate correlation (2) – Students can apply wave and optics principles in educational demonstrations and outreach programs (CO7), promoting science literacy in the community.

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 : VI

Course Type : Minor (Practical)

Course Code : PHY-362-MN

Course Title : Minor Physics Practical - I

No. of Credits : 02

No. of Teaching Hours : 60

Course Objectives:

1. Gain practical experience using optical benches, lenses, mirrors, diffraction gratings, lasers, and wave generators.
2. Experimentally confirm the laws of geometrical optics using mirrors and lenses.
3. Perform experiments like Young's double-slit, Newton's rings, and single/multi-slit diffraction to understand wave superposion.
4. Use instruments like diffraction gratings and Michelson interferometers to calculate the wavelength of light accurately.
5. Understand and demonstrate the polarization of light using polarizers and analyzers.
6. Use setups like vibrating strings and tuning forks to study standing wave patterns and resonance frequencies.
7. Record experimental data accurately, analyze results using graphs and calculations, and prepare clear, concise lab reports with error analysis.

Course Outcomes:

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

CO1. Application of Oscillatory Motion: Students will understand and experimentally verify the principles of simple harmonic motion (SHM) and damped and forced oscillations

CO2. Wave Propagation and Speed Determination: Students will be able to experimentally measure the speed of sound in different media and demonstrate the relationship between wave speed, frequency, and wavelength

CO3. Mastery of Optical Instruments: Students will develop hands-on skills with optical instruments, including microscopes, spectrometers etc, for the precise measurement of optical properties

CO4. Light Phenomena Experimentation: Students will conduct experiments on interference, diffraction, and polarization of light, gaining a deeper understanding of wave nature and principles of light.

CO5. Circuit Design and Logic Implementation: Students will design and implement basic digital circuits, using logic gates to create functional systems that perform binary operations such as addition, subtraction, and logic switching

CO6. Use of Measurement Tools: Students will learn to use multimeter, oscilloscopes and function generators for digital and analog signal measurements in the context of electronics experiments.

CO7. Problem-Solving Skills: Students will develop the ability to troubleshoot and solve problems that arise during experimental setups in the fields of waves, optics and electronics.

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

1. Study of coupled oscillators comprising two simple pendulum (Mechanical) and determination ofCouplingstrength
2. ‘g’ by simple pendulum.
3. Measurement of coefficient of absorption of sound for different materials (cork, thermocol, mica, Teflon, paper etc.).
4. Velocity of sound by Phase shift method.
5. Double refracting prism.
6. Dispersive power of glass prism.
7. GONIOMETER-I to find the equivalent focal length
8. GONIOMETER-II to find Cardinal points
9. Refractive index (R.I.) of material of prism using sodium light.
10. Determining the focal lengths of lenses using collimated light.
11. Refractive index of water using concave mirror.
12. Logarithmic decrement (in air and water).
13. Ultrasonic Interferometer.

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- VI) **Subject**: Physics

Course: Minor Physics Practical - I **Course Code**: PHY-362-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	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	2	3	3	2	3	2	3	1	2	3	1
CO 4	3	3	2	3	3	2	3	2	3	2	2	3	1
CO 5	3	3	2	3	3	2	2	2	3	1	1	3	1
CO 6	3	3	2	3	3	3	3	2	3	1	2	3	1
CO7	3	3	2	3	3	2	3	2	3	1	2	3	2

Justification

PO1: Comprehensive Knowledge and Understanding

Strong correlation (3) – The course provides a solid understanding of oscillations, waves, optics, and electronics. Students learn fundamental physical laws, experimental principles, and their mathematical basis through CO1–CO5.

PO2: Practical, Professional, and Procedural Knowledge

Strong correlation (3) – The laboratory emphasizes procedural learning and experimental skills using optical and electronic instruments (CO3, CO5, CO6). Students also follow professional lab practices and safety standards.

PO3: Entrepreneurial Mindset and Knowledge

Low to moderate correlation (1–2) – Exposure to instrumentation and circuit design (CO3, CO5) fosters awareness of innovation and potential technological applications relevant to entrepreneurship.

PO4: Specialized Skills and Competencies

Strong correlation (3) – Students develop specialized experimental and analytical skills using tools such as oscilloscopes, spectrometers, and multimeters (CO3–CO6), along with interpretation of data and precision measurement techniques.

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

Strong correlation (3) – Learners apply theory to practice, troubleshoot experimental setups, and analyze data effectively to interpret physical phenomena (CO1, CO2, CO7).

PO6: Communication Skills and Collaboration

Moderate correlation (2) – Lab work encourages teamwork, data presentation, and report writing, improving both oral and written communication (CO6, CO7).

PO7: Research-related Skills

Moderate to strong correlation (2–3) – Students engage in observation, hypothesis formulation, and experimental verification (CO1–CO4), aligning with the methodology of scientific research.

PO8: Learning How to Learn Skills

Moderate correlation (2) – The self-directed nature of experiments and analysis promotes independent learning and adaptability to new methods (CO1–CO7).

PO9: Digital and Technological Skills

Strong correlation (3) – The use of oscilloscopes, digital multimeters, function generators, and logic circuits (CO5, CO6) enhances ICT and technological competence.

PO10: Multicultural Competence, Inclusive Spirit, and Empathy

Low correlation (1) – Collaborative lab environments encourage respect for diverse viewpoints and shared responsibilities during group experiments.

PO11: Value Inculcation and Environmental Awareness

Low to moderate correlation (1–2) – Students develop a sense of scientific ethics, safety, and responsible use of resources during experiments (CO6, CO7).

PO12: Autonomy, Responsibility, and Accountability

Strong correlation (3) – Each student independently conducts experiments, maintains records, and ensures accuracy, fostering responsibility and accountability (CO6, CO7).

PO13: Community Engagement and Service

Low to moderate correlation (1–2) – Learners can apply experimental demonstrations and basic circuit projects in outreach or school programs (CO7), contributing to scientific literacy in the community.

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 : VI

Course Type : On Job Training (Project)

Course Code : PHY-385-OJT

Course Title : On Job Training

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-Sixth Semester) students **On Job Training (OJT)** for **TWO (2)** credits i.e. **50 Marks**. The total time allocation for the student to carry out On Job Training project is **60 hours**. The actual field work should be carried out after college hours or on holidays.

To carry out the On Job Training 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 **On Job Traning 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
On Job Traning / Fieldwork	25	20
Analysis	10	05
Report writing	20	10
Oral Presentation	-	10
Total	60	50