Savitribai Phule Pune University

(Formerly University of Pune)

Second Year B.Sc. Program in Physics

(Faculty of Science & Technology)

S.Y.B.Sc. (Physics)

To be implemented from Academic Year 2025-2026

Table of Contents

Abbreviations Used

- PO : Programme Outcomes
- PS : Programme Structure
- TLP : Teaching-Learning Process
- AM : Assessment Method
- DSC : Discipline Specific Core
- DSE : Discipline Specific Elective
- OE : Generic Electives
- OP : Open Electives
- VSC : Vocational Skill Courses
- SEC : Skill Enhancement Courses
- VSC* : Vocational Skill Courses

(Can be given as advanced practical course related to major)

- AEC : Ability Enhancement Courses
- IKS : Indian Knowledge System
- VEC : Value Education Courses
- OJT : On Job Training (Internship/ Apprenticeship)
- FP : Field projects
- CEP : Community engagement program
- CC : Co-curricular Courses
- RM : Research Methodology
- RP : Research Project

1) Introduction to Undergraduate Degree Course in Physics:

As per the recommendations of UGC-F-2022, the undergraduate (UG) degree course in Physics is a 6-semester course spread over 3-academic years **OR** 8-semester course spread over 4-academic years. The Teaching Learning Process (TLP) is students' centric. It involves both theory and practical components. It offers a flexibility of programme structure while ensuring that the student gets a strong foundation in the subject and gains in-depth knowledge. Besides the DSCs (Major Core), a student has options courses from the syllabus comprising of DSEs (Electives), Minor, OE/GEs, SECs, AECs, RPs, RMs, OJT, FP, CEP, IKSs, VECs, CCs and VSCs. Hence, this will be bring out the interdisciplinary as well as multidisciplinary approach and adherence to innovative ways within the curriculum framework. It also allow a students' maximum flexibility in pursuing his/her studies at the undergraduate (UG) level to the extent of having the liberty to eventually design the degree with multiple exit options. Students have these exits options depending upon the needs and aspirations of the student in terms of his/her goals of life, without compromising on the teaching learning, both in qualitative and quantitative terms. This will suit the present day needs of students in terms of securing their paths towards higher studies or employment.

2) Programme Duration and Exit Options:

The minimum credit to be earned by a student per semester is 18-credits and the maximum is 26 credits. However, students are advised to earn 22-credits per semester. This provision is meant to provide students the comfort of the flexibility of semester-wise academic load and to learn at his/her own pace. However, the mandatory number of credits which have to be secured for the purpose of award of Undergraduate Certificate/Undergraduate Diploma/Appropriate Bachelor's Degree in Physics are listed in Table-1.

Table-1: List of award of Undergraduate Certificate/ Undergraduate Diploma/Appropriate Bachelor's Degree in Physics

S. No.	Type of Award	Stage of Exit	Mandatory Credits to be Secured for the Award
1	Undergraduate Certificate in Physics	After successful completion of Semester II	**44** and an additional 4 credits core NSQF Course/Internship
2	Undergraduate Diploma in Physics	After successful completion of Semester IV	**88** and an additional 4 credits core NSQF Course/Internship
3	Bachelor of Science Physics	After successful completion of Semester VI	**132**

4	Bachelor of Science Physics (Honours)	After successful completion of Semester VIII	**176**
5	Bachelor of Science Physics (Honours with Research)	After successful completion of Semester VIII with minimum 28 GE credits in Discipline-2 (Minor)	**176**

a) Major Discipline (Physics) : A student pursuing four-year undergraduate programme in Physics (Core course) shall be awarded B.Sc. Honours degree with Major in Physics on completion of VIII Semester, if he/she secures in Physics at least 50% of the total credits i.e., at least 88 credits in Physics out of the total of 176 credits. He/she shall study 20 DSCs and at least 2 DSEs of Physics in eight semesters.

b) Minor Discipline (Discipline-2): A student of B.Sc. (Hons.) Physics may be awarded Minor in a discipline, other than Physics, on completion of VIII Semester, if he/she earns minimum 28 credits from seven GE courses of that discipline

3) Programme Objectives :

The undergraduate (UG) degree course in Physics aims to provide:

a) Knowledge and skills to undertake higher studies/research in physics and related interdisciplinary areas thereby enabling students' employment/entrepreneurship.
b) Critical and analytical thinking, scientific reasoning, problem-solving skills, communication skills and teamwork.
c) Competence and skill in solving both theoretical and applied physics problems.
d) In-depth knowledge in physics through understanding of key physical concepts, principles, theories and their manifestations.
e) Exposure to the latest advances in physics, allied disciplines and research.
f) A conducive learning environment to ensure cognitive development of students.
g) Sufficient subject matter competence and enable students to prepare for various competitive examinations such as UGC-CSIR NET/JRF, GATE, GRE, IIT-JAM, and Civil Services Examinations.
h) Moral and ethical awareness, leadership qualities, innovation and life-long learning.
i) Multicultural competence and multilinguism.

4) Program Outcomes :

The learning outcomes of the undergraduate degree course in physics are as follows:

a) Role of Physics :

The students will develop awareness and appreciation for the significant role played by physics in current societal and global issues. They will be able to address and contribute to such issues through the skills and knowledge acquired during the programme. They will be able identify/mobilize appropriate resources required for a project, and managing a project through to completion, while observing responsible and ethical scientific conduct, safety and laboratory hygiene regulations and practices.

b) Research skills :

The course provides an opportunity to students to hone their research and innovation skills through internship/apprenticeship/project/community-outreach/dissertation/Entrepreneurship/Academic-Project. It will enable the students to demonstrate mature skills in literature survey, information management skills, and data analysis and research ethics.

c) Hands-on/ Laboratory Skills :

Comprehensive hands-on/ laboratory exercises will impart analytical, computational and instrumentation skills. The students will be able to demonstrate mature skills for the collation, evaluation, analysis and presentation of information, ideas, concepts as well as quantitative and/or qualitative data.

d) In-depth disciplinary knowledge :

The student will acquire comprehensive knowledge and understanding of the fundamental concepts, theoretical principles and processes in the main and allied branches of physics. The core papers will provide in-depth understanding of the subject. A wide choice of elective courses offered to the student will provide specialized understanding rooted in the core and interdisciplinary areas.

e) Communication and IT Skills :

Various DSCs, DSEs, SECs, GEs and AECs have been designed to enhance student's ability to write methodical, logical and precise reports. The courses will, in addition, guide the student to communicate effectively through oral/poster presentations, writing laboratory/ project reports and dissertations. Several IT based papers in DSCs, DSEs, SECs and AECs will enable students to develop expertise in general and subject specific computational skills.

f) Critical and Lateral Thinking :

The programme will develop the ability to apply the underlying concepts and principles of physics and allied fields beyond the classrooms to real life applications, innovation and creativity. A student will be able to distinguish between relevant and irrelevant facts and information, discriminate between objective and biased information, apply logic to arrive at definitive conclusions, find out if conclusions are based upon sufficient evidence, derive correct quantitative results, make rational evaluations, and arrive at qualitative judgments according to established rules.

5) Programme Structure :

The detailed Credit framework of undergraduate degree programme in Physics is provided in Table 2.

Table-2: Credit framework of undergraduate degree programme in Physics.

Level /Difficulty	Sem	Subject-1	Subject-2	Subject-3	GE/ OE	SEC	IKS	AEC	VEC	CC	Total
4.5/100	I	2(T)+2(P)	2(T)+2(P)	2(T)+2(P)	2(T)	2(T/P)	2(T) Generic	2(T)	2	-	22
	II	2(T)+2(P)	2(T)+2(P)	2(T)+2(P)	2(P)	2(T/P)	-	2(T)	2	2	22
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 another as minor **and** third subject will be dropped.											

Level /Difficulty	Sem	Credits related to major				Minor		GE/ OE	SEC	IKS	AEC	VEC	CC	Total
		Discipline Specific Core (DSC) **Major Core**	Discipline Specific Elective (DSE) **Major Elective**	VSC	FP/ OJT /CEP									
5.0/200	III	4(T)+2(P)	-	2(T/P)	2 (FP)	2(T)+2(P)	-	2(T)	-	2(T) Major Subject Specific	2(T)	-	2	22
	IV	4(T)+2(P)	-	2(T/P)	2(CEP)	2(T)+2(P)	-	2(P)	2(T/P)	-	2(T)	-	2	22
Exit Option: Award of UG Diploma in Major and Minor with 88 credits **and** an additional 4 credits core NSQF Course/Internship **OR** Continue with Major and Minor.														

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 3 Years		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(P)	-	4(RP)	4(T)(RM)	-	-	-	-	-	-	-	22
	VIII	6(T)+4(P)	2(T)+2(P)	-	8(RP)	-	-	-	-	-	-	-	-	22
Total 4 Years		64	16	8	22	22	8	8	6	4	8	4	6	176
Exit Option: Award of UG Honours with Research Degree in Major and Minor with 176 credits. **-OR-**														
6.0/400	VII	10(T)+4(P)	2(T)+2(P)	-	-	4(T)(RM)	-	-	-	-	-	-	-	22
	VIII	10(T)+4(P)	2(T)+2(P)	-	4(OJT)	-	-	-	-	-	-	-	-	22
Total 4 Years		72	16	8	14	22	8	8	6	4	8	4	6	176
Exit Option: Award of UG Honours Degree in Major and Minor with 176 credits.														

6) Teaching-Learning Process :

a) The undergraduate programme in Physics is designed to provide students with a sound theoretical background, practical training in all aspects of physics and research.
b) It will help them develop an appreciation of the importance of physics in different contexts.
c) The programme includes foundational as well as in-depth courses that span the traditional sub disciplines of physics.
d) Along with the DSCs there are DSEs, GEs, SECs, AECs and VACs which address the need of the hour.
e) Physics courses will be delivered through the conventional chalk and talk method, laboratory work, projects, case studies, field work, seminars, hands-on training/workshops in a challenging, engaging, and inclusive manner that accommodates a variety of learning styles and ICT enabled teaching-learning tools (PowerPoint presentations, audio visual resources, e-resources, models, software, simulations, virtual labs, etc.).
f) Students will be encouraged to carry out short term projects and participate in industrial and institutional visits and outreach programmes.
g) Students will be introduced to scientific reasoning and discovery, innovative problem-solving methodologies, online quizzes, surveys, critical analysis etc. to develop convergent and divergent thinking abilities.
h) The laboratory training complements the theoretical principles learned in the classroom and includes hands-on experience with modern instruments, computational data analysis, modelling, error estimation and laboratory safety procedures.
i) Different pedagogies such as experiential learning, participative learning, project-based learning, inquiry-based learning and ICT pedagogy integration instruction (blended and flipped learning) will be adopted wherever possible.
j) Students will be encouraged to work in groups to develop their interpersonal skills like communication and team work.
k) Students' diligent and active participation/ engagement in industrial visits / internships / academic projects / dissertations will lay a strong foundation for a successful career in academics, industry, research, entrepreneurship and community outreach.

7) Assessment Methods :

The primary objective of assessment will be to assess the learning outcomes of the course in tune with the broad outcomes of strengthening core theoretical knowledge base, practical laboratory skills, and research. Assessment will be based on continuous evaluation (MCQs, Short Questions (SQ), Class Test (CT), Seminar, Presentation (PPT), Group Discussion (GD), Quiz, Assignment, Tutorials, etc.) and end of semester examination of Savitribai Phule Pune University, Pune.

(i) Internal Assessment or Continuous Evaluation:

During a semester, students' mastery of the various learning outcomes as described in the syllabus will be assessed through MCQs, Short Questions (SQ), Class Test (CT), Seminar, Presentation (PPT), Group Discussion (GD), Quiz, Assignment, Tutorials, etc. Each theory paper and practical paper will have 15 marks for internal assessment. The critical analysis of internal assessment or continuous evaluation outcomes will provide opportunities to improve the teaching-learning process by focusing on the areas that need conceptual strengthening, laboratory exposure or design of new experiments, and research.

(ii) End of Semester University Examinations:

The summative end-semester university examinations will be conducted for both theory and practical courses. Besides internal assessment, each theory paper and each practical paper will be of 35 marks for end of semester examination of the university.

8) Scheme of Examination :

The total marks for a 2-credits course is 50.

- Theory Paper of 02 Credits:
    - Internal Exam (15 M) + University Theory Exam (35 M) = Total 50 M
    - Duration: For Internal exam = 40 Min. and for University Exam = 02 hours.
- Practical Paper of 2 Credits:
    - Internal Exam (15 M) + University Practical Exam (35 M) = Total 50 M
    - Duration: For Internal exam = 40 Min. and for University Exam = More than 04 hours.

Internal exam will be conducted by particular college/institutes at the end of each semester.

External exam will be conducted by Savitribai Phule Pune University, Pune at the end of each semester.

Note:

a) Each semester comprises of 15 weeks.
(12 weeks Actual Teaching + 3 weeks for Continuous Internal Evaluation).

b) One Credit of the Theory is equal to15 clock hours (Teaching 1 hour per week for each credit).
(12 hours Actual Teaching + 3 hours Continuous Internal Evaluation – Assignments, Tutorials, Practice, Problem solving sessions, Group discussion, Seminars and Unit Tests.)

c) One Credit of Practical = 30 clock hours (2 Contact hours per credit per week)
(24 hours' Actual Table work + 6 hours for journal competition, and Continuous Internal Evaluation of each practical).

d) Practical for each course comprises of 02 Credits = 60 clock hours.

- Minimum 12 laboratory/ Filed sessions of 04 clock hours must be conducted in one semester.
- In case of short practical, two practical's should be conducted in one session.
- Each practical of 04 clock hours in the laboratory should consist of table performance for concerned practical, careful observations, calculation, writing results and conclusion, and submission of practical in written form.
- Pre-laboratory reading and post laboratory assignments should be given on each practical as a part of continuous internal evaluation.

Pattern for Internal Theory Assessment: (15 Marks)

Que-1: Choose correct option (MCQs) (10-MCQs with Multiple Options) – 5 marks

Que-2: Answer the following questions (Short answer questions) (any 5 out of 7) – 5 marks

Que-3: Answer the following questions (Short answer Definition/Problems/Diagram) (any 5 out of 7)–5 marks

Pattern for External Theory Assessment: (35 Marks)

Que-1: Answer the following questions (Short answer/Definition/Problems/Diagram, etc.) (any 5 out of 7)–**5 marks**

Que-2: A) Answer the following questions (Long answer questions) – **6 marks**

i) ----------

ii) ----------

B) Answer the following questions (Long answer questions/Problems) – **4 marks**

i) ----------

ii) ----------

Que-3: A) Answer the following questions (Long answer questions) – **6 marks**

i) ----------

ii) ----------

B) Answer the following questions (Long answer questions/Problems) – **4 marks**

i) ----------

ii) ----------

Que-4: Write a short notes on following. (any 4 out of 6) –**10 marks**

a) ----------

b) ----------

c) ----------

d) ----------

e) ----------

f) ----------

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List of Courses

Note: Every subject has 2 credits.

9) List of Discipline Specific Core (DSC) Courses (Major Core)

Major Core (Semester-I) (4 Credits) (2T+2P)

Semester I

PHY-101-T : Fundamental of Physics-I
PHY 102-P : General Physics Lab-I

Major Core (Semester-II) (4 Credits) (2T+2P)

Semester II

PHY-151-T : Fundamental of Physics-II
PHY-152-P : General Physics Lab-II

Major Core (Semester-III) (6 Credits) (4T+2P)

Semester III

PHY 201 MJ : Mathematical Physics-I
PHY 202(A) MJ : Electronics
PHY 202(B) MJ : Instrumentation
PHY 203 MJP : General Physics Lab-III

Major Core (Semester-IV) (6 Credits) (4T+2P)

Semester IV

PHY 251 MJ : Oscillation, Waves and Sound
PHY 252 MJ : Optics
PHY 253 MJP : General Physics Lab-IV

Major Core (Semester-V) (12 Credits) (8T+4P)

Semester V

PHY 301 MJ : Mathematical Physics-II
PHY 302 MJ : Solid State Physics-I
PHY 303 MJ : Electrodynamics-I
PHY 304 MJ : Classical Mechanics
PHY 305 MJP : General Physics Lab-V
PHY 306 MJP : General Physics Lab-VI

Major Core (Semester-VI) (12 Credits) (8T+4P)

Semester VI

PHY 351 MJ : Atomic and Molecular Physics-I
PHY 352 MJ : Quantum Mechanics-I
PHY 353 MJ : Statistical Mechanics-I
PHY 354 MJ : Nuclear Physics-I
PHY 355 MJP : General Physics Lab-VII
PHY 356 MJP : General Physics Lab-VIII

Major Core (Semester-VII) (10 Credits) (6T+4P)

Semester VII

PHY 401 MJ : Atomic and Molecular Physics-II
PHY 402 MJ : Solid State Physics-II
PHY 403 MJ : Electrodynamics-II
PHY 404 MJP : General Physics Lab-IX
PHY 405 MJP : General Physics Lab-X

Major Core (Semester-VIII) (10 Credits) (6T+4P)

Semester VIII

PHY 451 MJ : Quantum Mechanics-II
PHY 452 MJ : Statistical Mechanics-II
PHY 453 MJ : Nuclear Physics-II
PHY 454 MJP : General Physics Lab-XI
PHY 455 MJP : General Physics Lab-XII

10) List of Discipline Specific Electives (DSE) Courses (Major Electives)

Semester V : **4 Credits. (2T+2P)**

PHY 310 MJ : Thin films Technology
PHY 311 MJP : Special Physics Lab-I

Semester VI : **4 Credits. (2T+2P)**

PHY 360 MJ : Lasers Technology
PHY 361 MJP : Special Physics Lab-II

Semester VII : **4 Credits. (2T+2T/P)**

PHY 410 MJ : Radiation Physics
PHY 411 MJP : Special Physics Lab-III

Semester VIII : **4 Credits. (2T+2T/P)**

PHY 460 MJ : Energy Studies
PHY 461 MJP : Special Physics Lab-IV

11) List of Vocational Skill Courses (VSC): (Each semester: 2 Credits) (P)

Semester-III :

PHY 221 VSC P: Introduction to Computational Physics-I

Semester-IV :

PHY 271 VSC P: Introduction to Computational Physics-II

Semester-V :

PHY 321 VSC P: Solar PV System: Installation, Repairing, and Maintenance

Semester-VI :

PHY 371 VSC : Electric Vehicle Technology

12) List of Indian Knowledge System (IKS) Courses : (Each semester:2 Credits) (T)

Semester I :

As per university circular

Semester III :

PHY 201 IKS : India's Contribution to Physics

13) List of Minor (MN) Courses :

Semester-III : (4 Credits) (2T+2P)

PHY 241 MN : Applied Physics-I

PHY 242 MNP : Applied Physics Lab-I

Semester-IV : (4 Credits) (2T+2P)

PHY 291 MN : Applied Physics-II

PHY 292 MNP : Applied Physics Lab-II

Semester-V : (2 Credits) (T)

PHY 341 MN : Concepts of Modern Physics

Semester-VII : (4 Credits) (T)

PHY 441 MN : Research Methodology

14) List of Generic Elective (GE)/Open Elective (OE) Courses :

As per University Circular (see basket)

Semester-I : Select any **one** subject for **2-credits (T)**

OE-101-PHY : Physics of Daily Life

OE-102-PHY : Biological Physics

Semester-II : Select any **one** subject for **2-credits (P)**

OE-151-PHY : LED Light Repairing and Maintenance

OE-152-PHY : Maintenance and Repairing of Physics Lab equipment

Semester-III : 2-credits (T)

OE-221-PHY : Eco-friendly Energy for Modern Living

Semester-IV : 2-credits (P)

OE-271-PHY: Li-Battery - Repairing and Maintenance

15) List of Skill Enhancement Courses (SECs) :

Note : **Each semester** for **2(P)**-credits

Semester-I : Select any **one (P)**

SEC-101-PHY : Experimental Skills in Physics

SEC-102-PHY : Physics of Water Filtration Systems

SEC-103-PHY : Renewable Energy and Energy Harvesting

SEC-104-PHY : Programming for Physical Applications (C++ / Python)

Semester-II : Select any **one (P)**

SEC-151-PHY : Numerical Techniques in Physics

SEC-152-PHY : Introduction to Laser and Fibre Optics

SEC-153-PHY : Radiation Safety

SEC-154-PHY : Basic Lab Electric devices and Circuits

Semester-IV: Select any **one (P)**

SEC-251-PHY : Basic Instrumentation Skills

SEC-252-PHY : Sensors and Detection Technology

SEC-253-PHY : Introduction to Physics of Devices

SEC-254-PHY : Technical Design and Drawing of Electronic Circuit

16) List of Value Education Courses (VEC): 2-Credits (T)

Semester-I

As per University Circular (see basket)

Semester-II

As per University Circular (see basket)

17) List of Ability Enhance Courses (AEC): 2-Credits (T)

Semester-I: Select any **one**

AEC-101-ENG English

Semester-II: Select any **one**

AEC-151-ENG English

Semester-III: Select any **one**

As per University Circular

AEC-231-HIN Hindi

AEC-232-MAR Marathi

Semester-IV: Select any **one**

As per University Circular

AEC-281-HIN Hindi

AEC-282-MAR Marathi

18) List of Co-Curricular Courses (CC): 2-Credits

Semester-II: Select any **one**

As per University Circular (see basket)

Semester-III: Select any **one**

As per University Circular (see basket)

Semester-IV: Select any **one**

As per University Circular (see basket)

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Syllabus of Courses

19) Syllabus of Discipline Specific Core (DSC) Courses (Major Core)

Major Core (Semester III) (6 Credits) (4T+2P)

Note: Every subject has 2 credits

Semester-III

S.Y.B.Sc. (Physics) (Sem-III)

PHY-201-MJ : Mathematical Physics-I

Lectures: 30 hrs **(Credits-02)**

A) Course Objectives: - This course aims to acquire the mathematical abilities needed to solve problems in theoretical and practical physics.

1) To study the fundamental aspects of Mathematical tools to analyse and solve problems in Physics.
2) To impart knowledge about complex numbers, vector calculus and differential equations.

B) Learning Outcomes (CO): - Upon completion of the course, the student will be able to,

1) Understand Complex algebra useful in Physics domain.
2) Identify application of the concept of vector calculus to understand various physical quantities.
3) Understand the concept of divergence and gradient of scalar field and curl of vector fields and their significance.
4) Perform the calculations in vector identities.
5) Apply the knowledge of these mathematical techniques applicable to theoretical and practical physics.

C) Instructional Design: -

1) Lecture method
2) Tutorial method
3) Seminars
4) Use of Multimedia
5) Creation of online resources

D) Evaluation Strategies

1) Descriptive written exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents: -

Lectures: 30 hrs

Module - 01	**Complex Numbers**	**10 H**
	1.1 Introduction to Complex Numbers 1.2 Rectangular, Polar and Exponential forms of a complex numbers 1.3 De-Moivre's Theorem 1.4 Power, Root and Logarithm of Complex number 1.5 Trigonometric, Exponential and Hyperbolic Functions 1.6 Applications of Complex Numbers in Physics Numerical Problems	
Module - 02	**Partial Differentiation**	**08 H**
	2.1 Introduction of Partial Differentiation 2.2 Successive, Total and Exact Differentiation 2.3 Chain Rule 2.4 Theorems of Differentiation 2.5 Implicit and explicit functions 2.6 Applications of Partial differentiation in Physics Numerical Problems	
Module - 03	**Scalar and Vector Algebra**	**12 H**
	3.1 Introduction to Scalars and Vectors 3.2 Scalar and Vector product of two vectors 3.3 Scalar Triple Product 3.4 Vector Triple Product 3.5 Scalar and Vector Fields 3.6 Laplacian operator 3.7 Gradient of Scalar field and its physical significance 3.8 Divergence of scalar field and its physical significance 3.9 Curl of vector field and its significance 3.10 Vector Identities Numerical Problems	

Activities: Conduct **any one** classroom activity during class lecture for each module.

Module 1: Complex Numbers :

Activity 1: Practice Addition, Subtraction, multiplication and division of Complex numbers.

Activity 2: Use and study to represent the state of a physical system in quantum theory.

Module 2: Partial Differentiation :

Activity 1: Practice partial differentiation of mathematical functions with more than one variables.

Activity 2: Use the partial derivative to find the slope in either the x or y direction.

Module 3: Scalar and Vector Algebra

Activity 1: Study various applications of scalar and vector algebra such as projectile motion, roller coaster etc.

Reference Books:

1) Complex Variables and Applications: Brown and Churchill (2013)

2) Methods of Mathematical Physics: Laud, Takwale and Gambhir

3) Mathematical Methods in Physical Science: Mary and Boas (2006)

4) Vector analysis 2nd Edition: Spiegel and Murrey (2017)

5) Mathematical Physics 4th Edition: B.D.Gupta (2010)

6) Fundamentals of Mathematical Physics: A.B.Gupta (2009)

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S.Y.B.Sc. (Physics) (Sem-III)

PHY-202(A)-MJ : Electronics

Lectures: 30 hrs **(Credits-02)**

A) Course Objectives: - This course aims to introduce basic electronics.

1) To study the basic concepts regarding Analog and Digital electronics and their usefulness.

2) To impart knowledge about the importance of day-to-day electronics.

B) Learning Outcomes (CO): - Upon completion of the course, the student will be able to,

1) Understand the parameters, characteristics, and workings of transistors.

2) Identify and use various electronic devices like transistors, FET, and op-amp.

3) To understand the electronic circuits and their significance.

4) Define performance parameters Logic gates and its families.

5) Apply the knowledge of analog and digital electronics.

C) Instructional Design: -

1) Lecture method **2)** Tutorial method **3)** Seminars/ Demo kits.

4) Use of Multimedia **5)** Creation of online resources.

D) Evaluation Strategies

1) Descriptive written examinations 2) MCQ's based examination 3) Assignments

4) Experiential Learning based activity. 5) Seminars, Orals, and Viva

E) Course Contents: - **Lectures: 30 hrs**

Module - 01	**Semiconductor Devices**	**10 H**
	1.1. Introduction to Diodes 1.2. Transistors: Symbol, Construction, and its types **1.3. Bipolar Junction Transistor (BJT):** 1.3.1. Operation of NPN Transistor 1.3.2. PNP Transistor (Diagram and Symbol only) 1.3.3. Transistor Circuit Configuration: a) Common-Base Configuration (CB) (basic only), b) Common-Emitter Configuration (CE), c) Common-Collector Configuration (CC) (basic only), d) Relation between α, and β 1.3.4. Input and Output Characteristics of CE 1.3.5. Transistor Biasing a) Voltage Divider Bias Method (Q-Point and Load Line Concept only) **1.3.6. Applications:** a) Transistor as a Switch (without derivation) b) Transistor as an amplifier (without derivation) **1.4. Unijunction Transistor (UJT):** 1.4.1. Symbol, Types, Construction, and Working	

	1.4.2. Application of UJT (states the list) **Numerical Problems**	
Module - 02	**Operational Amplifiers**	**10 H**
	2.1. Introduction to OP-amp: 2.1.1. Symbol and Internal Block Diagram of an Op-amp, 2.1.2. Op-amp Parameters, 2.1.3. Pin configuration, feedback (meaning and name only), and operation. 2.1.4. Characteristics of an Ideal Op-amp (List only) **2.2. Concept of:** 2.2.1. Virtual ground, 2.2.2. Real ground, 2.2.3. Difference between virtual and real ground. **3.3.Applications of Op-Amp:** 3.3.1. Inverting Amplifier, 3.3.2. Non-Inverting Amplifier, 3.3.3. Op-Amp as an Adder, 3.3.4. Op-Amp as subtractors, **Numerical Problems**	
Module - 03	**Digital Electronics**	**10 H**
	3.1. Introduction to Analog and Digital Signals: 3.1.1. Logic Levels and 3.1.2. Digital Waveforms **3.2. Number System and Interconversion:** 3.2.1. Binary, 3.2.2. Decimal, 3.2.3. Octal, and 3.2.4. Hexadecimal **3.3. Binary Arithmetic:** 3.3.1. Addition 3.3.2. Subtraction (1's and 2's complement only) **3.4. Boolean Algebra and Logic Gates:** 3.4.1. Basic Operations: AND, OR, NOT. 3.4.2. Truth Tables 3.4.3. Boolean Algebra Laws 3.4.4. Universal Gates (NAND, NOR, EXOR, EXNOR) **3.5 De Morgan Theorem (**First and Second**)** **Numerical Problems**	

Activities: Conduct **any one** classroom activity during class lecture for each module.

Module 1: Transistor:

Activity 1: Demonstration of Transistor.

Identification of terminals and connections with different types of transistor.

Activity 2: Demonstration of applications of transistor.

Amplifier, switch, etc.

Activity 3: Demonstration of Unijunction Transistor

Identification of terminals and connections with different types of UJT.

Module 2: Operational Amplifier:

Activity 1: Demonstration of OP-AMP.

Identification of terminals and connections of OP-AMP.

Module 3: Digital Electronics:

Identification of terminals and connections of IC7400and its family.

Reference Books:

1) Basic Electronics: Solid State, B. L. Theraja, S. Chand Limited (2006).
2) Linear Integrated Circuits, D.Roy Choudhry, Shail Jain, New Age International Pvt. Ltd., 5th Edition, (2018).
3) OP-AMP and Linear Integrated Circuit, Ramakant A. Gayakwad, 4th Edition, Prentice Hall / Pearson Education (2015).
4) Operational Amplifiers, George Clayton and Steve Winder, 5th Edition, Newnes (an imprint of Butterworth-Heinemann Ltd); 5th Edition (2003).
5) DIGITAL PRINCIPLES and APPLICATIONS, Albert Paul Malvino, Donald P. Leach. McGraw-Hill, (1986)
6) Integrated Electronics Analog Digital Circuits, Jacob Millman and D. Halkias, McGraw-Hill.
7) Principles of Electronics-V.K. Mehta and R. Mehta, 12th Edition, S. Chand publication (2020).
8) Fundamentals of Electronic Devices & Circuits (Sachan), V. K. Sachan, Independently published (2019)

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S.Y.B.Sc. (Physics) (Sem-III)

PHY-202(B)-MJ : Instrumentation

Lectures: 30 hrs **(Credits-02)**

A) Course Objectives: - This course aims to introduction of instrumentation which

1) Explain the concept of fundamental of measurements, calibration methods, etc.
2) Describe the statics and dynamics properties of measurements, etc.
3) Introduce measurements of errors.
4) How to measure of pressure and temperature.
5) Explain the Transducer and its types.

B) Learning Outcomes (CO): - Upon completion of this course student will able to

1) Understand the fundamental of measurements.
2) Understood the concept of error.
3) Measurement and calculate error.
4) Measurement of pressure and temperature.
5) Describe Transducer and its types

C) Instructional Design: -

1) Lecture method 2) Tutorial method 3) Use of Computer

D) Evaluation Strategies

1) Descriptive written exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents: - **Lectures: 30 hrs**

Module - 01	**Fundamentals of Measurement**	**08 H**
	1.1 Aims of measurement 1.2 Functional elements of typical measurement system (block diagram and its explanation) 1.3 Standard measurements and types of calibration methods 1.4 Static characteristics (accuracy, precision, sensitivity, linearity, repeatability, reproducibility, drift, hysteresis, resolution, range, span, dead zone) 1.5 Dynamic characteristics: concepts, first and second order systems, examples of first-order resistance thermometer and thermal element, examples of second order: U-tube manometer and seismic motion 1.6 Errors in measurement Numerical Problems	
Module – 02	**Transducers**	**09 H**
	2.1 Classification of Transducers and its characteristics 10) Displacement Transducer a. Resistive Type: Linear and Angular (Rotary) Potentiometer, Strain Gauge: Bonded and Unbonded	

	b. Inductive Type: Self inductive: Variable number of turns, Variable Reluctance Mutual Inductive: LVDT c. Piezoelectric Type: Quartz Crystal 2.3 Force Transducer: Cantilever beam, Column type devices	
Module – 03	**Measurement of Pressure and Temperature**	**12 H**
	11) Unit of pressure, concept of vacuum, absolute gauge, and differential pressure 3.2 Elastic transducer – diaphragm, corrugated diaphragm, bellows, Bourdon tube 3.3 Electric type – strain gauge. 3.4 Pressure transducer – calibration by dead weight tester method. 3.5 Temperature Measurement Scales for temperature: Celsius, Kelvin and Fahrenheit Temperature Measurement Techniques a. Non-electrical: Liquid filled thermometer and bimetallic thermometer b. Electrical Methods: i) Platinum Resistance Thermometer ii) Thermistor: PTC and NTC with characteristics iii) Thermocouple: Seebeck effect and Peltier effect, iv) Types of Thermocouple Numerical Problems.	

Activities: Conduct **any one** classroom activity during class lecture for each module.

Module 1: Fundamental of Measurement:

Activity 1: How to measure temperature in first order and second order.

Module 2: Transducer :

Activity 2: Demonstration of different types of transducer.

Module 3: Measurement of Pressure :

Activity 3: How to measure pressure using transducer.

Reference Books:

1. A course in Electrical and Electronic Instrumentation [19th edition, 2012], A. K. Sawhney (Dhanpat Rai & Co. Pvt. Ltd., New Delhi)
2. Instrumentation devices and systems :- Rangan, Sarma, Mani [Tata Mc Graw Hill]
3. Instrumentation Measurement and Analysis – Nakra, Choudhari [Tata Mc Graw Hill]
4. Electronics Instrumentation – H. S. Kalsi [Tata Mc Graw Hill]
5. Sensor and Transducers – Patranabis [PHI]
6. Fundamental of Industrial Instrumentation- Alok Barua [Wiley India]

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S.Y.B.Sc. (Physics) (Sem-III)

PHY-203-MJP : General Physics Lab-III

Lectures: 60 hrs **(Credits-02)**

Course Contents: - **Practical: 60 hrs**

Section I: Electronics and Instrumentation (Any-10)

Sr. No.	Title of the Experiments
1	To study the characteristic of a transistor in the CE configuration and determine the current gain, input impedance and output impedance
2	To study the characteristic of a transistor in the CB configuration and determine the current gain, input impedance and output impedance
3	To study the BJT as Switch
4	To study the BJT as Amplifier
5	To study the I-V Characteristics of UJT
6	To study the UJT as Relaxation Oscillator
7	To construct an inverting amplifier using IC-741 and determine its voltage gain
8	To construct a non-inverting amplifier using IC-741 and determine its voltage gain
9	OP-AMP as an adder and subtractor
10	To study of Wein Bridge / Phase Shift Oscillator using IC-741
11	To verify the truth tables of NOT, OR and AND logic gates and verification of de Morgan's theorems
12	To study of LVDT characteristics
13	To determine Boltzmann constant using V-I characteristics of p-n junction diode.
14	To convert Boolean expression into logic circuit and design it using basic logic gate
15	To minimize a given logic circuit design using NAND gates
16	Measurement of Displacement using potentiometer
	Measurement of Displacement using variable capacitor
17	To verify the truth tables of NAND, NOR and Ex-NOR logic gates and verification of de Morgan's theorems
18	To study of Thermocouple for temperature measurement
19	Derive Maxwell equation by exact differentiation method

Section II: MMP using Computer (Any-2)

Sr. No.	Title of the experiments
1	Plotting of various trigonometric functions using spread sheet/any graphic software viz. Microsoft Excel OR Origin: sin (θ), cos(θ), tan(θ),e^x, e^{-x}, log (x), ln (x), x_n
2	Plotting of conic sections using spreadsheet /any graphic software viz. Microsoft Excel, Origin: circle, ellipse, parabola, hyperbola
3	Multiplication of two matrices and Inverse of a matrix, using Microsoft Excel

4	Determinant of a matrix and solution of linear equations using Microsoft Excel
5	Determination of Curl of two vectors using Microsoft Excel
6	Determination of Diversions of two vectors using Microsoft Excel
7	Determination of Laplace's Equation using Microsoft Excel

Section III: Additional Activities to be conducted during the semester (Any-1)

1. Mini Projects with report (Minimum 10 pages).
2. Study tour / Industrial visit / Field visit with report.
3. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student in the semester).
4. Any two computer aided demonstrations (Using computer simulations or animations on YouTube).
5. Demonstrations – Any one demonstrations of other experiments.

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 2-experiments signed by study tour co-ordinator and HOD of Department..

Note: Students have to perform total **12-**experiments (10-experiments from Section-I and 2 experiments from Section-II)

OR

Participated in Additional any **one** activity equivalent to **2-experiments** with 10-experiments (8-experiments from Section-I and 2-experiments from Section-II) mentioned above. Total laboratory work with additional **one** activity should be **12**-experiments.

References:

1) B. L. Flint and H.T. Worsnop, "Advanced Practical Physics for students", Asia Publishing House, (1971)

2) Michael Nelson and Jon M. Ogborn, "Advanced level Physics Practical", 4th Edition, Heinemann Educational Publishers, reprinted (1985)

3) Prakash and Ramakrishna, "A Text Book of Practical Physics", 11th Edition, Kitab Mahal, (2011)

4) D. P. Khandelwal, "A Laboratory Manual of Physics for undergraduate classes", Vani Publication, (1985)

5) A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011,Kitab Mahal

6) Electronic Devices & circuit Theory, R.L.Boylestad& L.D.Nashelsky, 2009, Pearson

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Semester-IV

Major Core (Semester-IV) (6 Credits) (4T+2P)

Note: Every subject has 2 credits

S.Y.B.Sc. (Physics) (Sem-IV)

PHY-251-MJ : Oscillation, Waves and Sound

Lectures: 30 hrs **(Credits-02)**

A) Course Objectives: -

While learning about waves and Oscillations, the primary objectives are to

1) Understand the fundamentals of Oscillations, identify different types of Oscillations like free Oscillations, damped Oscillations and forced Oscillations
2) Understand the mathematical representation (like differential equation, its solution and characteristics) of these Oscillations
3) Apply this knowledge to real-world examples like musical instruments, clocks, car suspension system, radio tuning etc.
4) Understand the concept of coupled oscillations, normal modes and beat formation
5) Understand energy transfer phenomenon in coupled systems.
6) Apply this knowledge to real-world examples in the field of engineering and biology
7) Understand wave, its types (transverse and longitudinal) and their characteristics.
8) Apply this knowledge to real-world examples of transverse and longitudinal waves
9) Understand seismic waves, gravitational waves and standing waves
10) Apply this knowledge to real-world examples of seismic waves, gravitational waves and standing waves
11) Understand sound wave, its types
12) Understand the Doppler Effect and its real-world examples

B) Learning Outcomes (CO): On completion of this course, the learner will be able to:

1) Understand the physics and mathematics of oscillations.
2) Solve the equations of motion for simple harmonic, damped, and forced oscillators.
3) Formulate these equations and understand their physical content in a variety of applications.
4) Describe oscillatory motion with graphs and equations, and use these descriptions to solve problems of oscillatory motion.
5) Explain oscillation in terms of energy exchange, giving various examples.
6) Solve problems relating to undamped, damped and force oscillators and superposition of oscillations.
7) Understand the qualitative description of different types of waves.
8) Understand the real life applications of these waves in real life examples
9) Understand the real life applications of Doppler Effect

C) Instructional Design: -

1) Lecture Method 2) Tutorial Method 3) Seminars 4) Use of Multimedia 5) Creation of online resources

D) Evaluation Strategies

1) Descriptive written exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents: - **Lectures: 30 hrs**

Module – 01	Oscillation	12 H
	12) Undamped (Free) Oscillation ○ Introduction ○ Simple Harmonic Motion (SHM) and its Properties ○ Differential equation for undamped oscillations and its solution ○ Applications of SHM in Day-to-Day Life Examples: Simple Pendulum, Springs (Clocks, Musical Instruments, etc.) ○ Composition of two SHM ○ Lissajous figures and its application **2. Damped Oscillation** ○ Introduction ○ Differential equation for damped oscillations and its solution ○ Applications of damped oscillations in Day-to-Day Life **a) Forced Oscillations** ○ Differential Equation for a Forced Oscillator and Its Solution ○ Coupled Oscillation **b) Resonance** ○ Types of Resonance ○ Applications of Resonance in Daily Life **c) Log decrement** Numerical Problems	
Module – 02	**Wave Motion**	**10 H**
	4.1 Introduction to Wave Motion ○ Definition of Waves ○ Longitudinal and Transverse Waves ○ Characteristics of Waves **4.2 Applications of Longitudinal and Transverse Waves in Day-to-Day Life** **4.3 Seismic Waves** ○ Qualitative Discussion ○ Applications **4.4 Gravitational Waves** ○ Qualitative Discussion ○ Applications **4.5 Standing Waves** ○ Qualitative Discussion ○ Applications: • Structural Engineering (Vibrations in Buildings and Bridges) • Microwaves in Ovens	

	• Musical Instruments (Strings and Air Columns) Numerical Problems	
Module – 03	**Sound and Doppler Effect**	**08H**
	5.1 Introduction to Sound ○ Definition of Sound ○ Types of Sound Waves: ▪ Audible ▪ Infrasonic ▪ Ultrasonic ○ Musical Sound vs. Noise **5.2 Concept of Reverberation Time and Reverberation in a Hall** **5.3 Sabine's Formula** **5.4 Doppler Effect** ○ Explanation of the Doppler Effect ○ Applications: • Red Shift and Blue Shift • Medical Imaging • Radar and Speed Trap Guns Numerical Problems	

Activities: Conduct **any one** classroom activity during class lecture for each module.

Module 1 : Oscillation :

Activity 1: Perform an activity to understand the concept of waves and oscillation:

Activity 2: Perform an activity to explain the concept of SHM:

Activity 3: Perform an activity to explain the concept of dampening:

Activity 4: Perform an activity to explain the concept of coupled oscillation:

Module 2: Wave Motion :

Activity 1: Perform an activity to explain the applications of waves:

Module 3: Sound and Doppler Effect :

Activity 1: Perform an activity to explain the concept of Doppler effect:

Reference Books:

1. **Waves and Oscillations** by Stephenson.
2. **The Physics of Waves and Oscillations** by N. K. Bajaj, Tata McGraw-Hill Publication.
3. **Fundamentals of Vibrations and Waves** by S. P. Puri, Tata McGraw-Hill Publication.
4. **A Textbook of Sound** by Subramanyam and Brijlal, Vikas Prakashan.
5. **Sound** by Mee, Heinmann Edition, London.
6. **Waves and Oscillations** by R. N. Chaudhari, New Age International (P) Ltd.
7. **A Textbook on Oscillations, Waves and Acoustics** by M. Ghosh and D. Bhattacharya, S. Chand and Company Ltd.

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S.Y.B.Sc. (Physics) (Sem-IV)

PHY-252-MJ : Optics

Lectures: 30 hrs **(Credits-02)**

A) Course Objectives: - This course aims to introduce optics to the students.

Syllabus typically aims to provide students with a comprehensive understanding of the principles, theories, and applications of optics. The general objectives include:

Fundamental Understanding of Optics :

- Introduce the basic principles of geometrical and physical optics.
- Develop a strong foundation in wave optics, light propagation, and optical phenomena.

Practical Skills and Experimental Techniques:

- Train students in experimental setups and techniques in optics laboratories.
- Develop skills in handling optical instruments like lenses, mirrors, prisms, spectrometers, and lasers.

Study of Advanced Optical Phenomena:

- Explore advanced topics such as polarization, dispersion, interference, and diffraction.
- Understand the concept of optical coherence and its implications.

Introduction to Modern Optics:

- Provide insights into modern optical technologies, including lasers, fiber optics, and holography.
- Discuss the applications of optics in telecommunications, imaging, and medical technology.

Development of Analytical and Critical Thinking:

- Foster problem-solving abilities by analyzing optical systems.
- Encourage the derivation of physical laws related to optics.

Interdisciplinary Approach:

- Highlight the interdisciplinary nature of optics and its integration with physics, engineering, and other sciences.
- Discuss the role of optics in modern-day research and industries.

Career and Research Preparedness:

- Prepare students for further studies in physics, optical sciences, or related fields.
- Introduce research methodologies and applications of optics in real-world problems.

B) Learning Outcomes (CO): It is focused on ensuring that students achieve both theoretical understanding and practical competency in optics. These outcomes are typically aligned with the objectives of the course and may include the following:

Conceptual Understanding :

- Students will gain a thorough understanding of fundamental optical phenomena such as reflection, refraction, interference, diffraction, and polarization.
- They will learn the principles behind geometrical optics and wave optics.

Analytical Skills:

- Develop the ability to apply mathematical methods and models to solve optical problems.
- Analyze and interpret the behavior of light in various mediums and under different conditions.
- Laboratory and Experimental Skills

- Gain hands-on experience with optical instruments such as spectrometers, polarimeters, and diffraction gratings.
- Perform experiments to verify theoretical principles and analyze experimental results critically.

Practical Applications of Optics:

- Understand the real-world applications of optics, including lasers, fiber optics, and holography.
- Learn the working of modern optical devices and their relevance in industries like communication, imaging, and medical technology.

Problem-Solving and Critical Thinking:

- Develop the ability to solve complex problems related to optical systems using an interdisciplinary approach.
- Critically evaluate optical systems and propose improvements or solutions.

Preparation for Advanced Studies:

- Build a strong foundation for pursuing higher education in physics, optical sciences, or related fields.
- Acquire the skills and knowledge necessary to participate in research or academic projects in optics.

Technological Awareness:

- Be aware of technological advancements in the field of optics, including quantum optics and nanophotonics.
- Understand the role of optics in emerging technologies and industries.

Career Readiness:

- Equip students with the skills required for careers in optical design, optical engineering, telecommunications, and other related fields.
- Prepare students for roles in research and development, particularly in organizations focusing on optical innovations.

C) Instructional Design: -

1) Lecture Method 2) Tutorial Method 3) Seminars 4) Use of Multimedia 5) Creation of online resources

D) Evaluation Strategies

i. Descriptive written exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents: - **Lectures: 30 hrs**

Module – 01	**Geometrical Optics**	**12 H**
	1.1 Introduction to lenses and sign conventions. 1.2 Thin lenses: lens equation for convex lens 1.3 Lens maker equation 1.4 Magnification, deviation and power of thin lens 1.5 Concept of Equivalent focal length and cardinal points 1.6 Aberration and its types 1.7 Types of Monochromatic aberrations: Coma and Astigmatism and their reduction 1.8 Types of chromatic aberrations: Longitudinal and Lateral 1.9 Applications of lenses in daily life Numerical Problems	

Module – 02	Interference and Diffraction	10 H
	Interference 2.1 Introduction to Interference 2.2 Phase change on reflection. (Stokes treatment) 2.3 Optical Path 2.4 Interference due to wedge shaped thin film 2.5 Applications of Interference : Newton's ring **Diffraction** 2.6 Introduction to Fresnel's and Fraunhoffer's diffraction 2.7 Fraunhoffer's diffraction at single slit, 2.8 Rayleigh criterion for resolution 2.9 Applications of Diffraction: Security holograms, medical imaging, etc. Numerical Problems	
Module – 03	**Polarization and Optical Instruments**	**08 H**
	1.1 Introduction to polarization 1.2 Brewster's law 1.3 Law of Malus 1.4 Polarization by double refraction 1.5 Nicol Prism 1.6 Microscope : Simple and Compound Microscope 1.7 Eye piece : Ramsden's and Huygens's eye piece Numerical Problems	

Activities: Conduct **any one** classroom activity during class lecture for each module.

Module 1: Geometrical Optics :

Activity 1: Perform an activity to understand the concept of Geometrical optics:

Activity 2: Perform an activity to explain the concept of image formation:

Module 2: Interference and Diffraction :

Activity 1: Perform an activity to explain the concept of diffraction:

Activity 2: Perform an activity to explain the concept of interference:

Module 3: Polarization and Optical Instruments :

Activity 1: Observe image under Simple/ Compound microscope.

Activity 2: Perform an activity to explain the concept of polarization:

Reference Books:

1. Optics by A. R. Ganesan, 4th edition, Pearson Education, E. Hetch.
2. A Textbook of Optics by N. Subhramanyam, Brijlal, M. N. Avadhanulu, S. Chand Publication
3. Physical Optics by A. K. Ghatak, McMillan, New Delhi
4. Fundamental of Optics by F. A. Jenkins, H. E. White Mc Graw-Hilll International edition
5. Principles of Optics, by D. S. Mathur, Gopal Press, Kanpur.

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S.Y.B.Sc. (Physics) (Sem-IV)

PHY-253-MJP : General Physics Lab-IV

Lectures: 60 hrs **(Credits-02)**

10) **Course Objectives:** This course aims to introduce Physics practical course is

1. To study the basic concepts regarding waves and Oscillation principles
2. To impart knowledge about optics
3. To understand physics principles in devices and its applications in the various instruments.
4. To impart knowledge about the measurements of physical quantities and its analysis.

B) Learning Course Outcomes (CO) : Upon completion of the course, the student will be able to,

1) Use and handle various instruments and equipment.
2) Design experiments to test a hypothesis and/or determine the value of an unknown quantities.
3) Investigate the theoretical principles of an experiment.
4) Setup experimental equipment to implement an experimental approach.
5) Analyze the data, plot appropriate graphs and reach conclusions from data analysis.
6) Work in a group to plan, implement and report on a project/experiment.

C) Instructional design:

1) Practical method, **2)** Tutorial method, **3)** Demo, 4) Use of Multimedia
5) Creation of online resources

D) Evaluation Strategies :

1) Practical examinations, **2)** Assignments, **3)** Orals, and Viva

E) Course Contents: - Practical: 60 hrs

Section I: Oscillation, Waves and Sound (Any-6)

Sr. No.	Title of the Experiments
1	Logarithmic decrement (in air and water)
2	Study of Lissajous figure and determination unknown frequency using CRO
3	Study of coupled oscillators comprising two simple pendulum (Mechanical) and determination of coupling coefficient
4	Determine 'g' by Keter's pendulum.
5	Determine 'k' of a compound pendulum.
6	Measurement of coefficient of absorption of sound waves for different materials (cork, thermocol, mica, paper etc.).
7	Determination of speed of sound by Quincke's method interferometer.
8	Directional characteristics of Microphone.
9	Velocity of sound by Phase shift method.
10	To Determine the velocity of sound in air at room temperature with Kundt's Tube.

11	Verify Laws of a stretched string (Three Laws).

Section II: Optics (Any-6)

Sr. No.	Title of the experiments
1	Thickness of a thin film using wedge shaped method
2	Measure of thin wire/ thin glass plate using wedge method
3	Determination of Radius of curvature of a given convex lens by forming Newton's rings.
4	To determine the dispersive power of the material of a prism using mercury source.
5	Determination of wavelength of monochromatic light by diffraction at the edge of a razor blade.
6	Optical activity of sugar solution using Polarimeter.
7	Determination of wavelength of light using Biprism.
8	Resolving power of grating
9	To determine wavelength of Na source and spectral lines of Hg source using plane diffraction grating.
10	Resolving power of a telescope.
11	Determination of refractive index of liquid using Pulfrich refractometer.
12	Determination of wavelength of source by forming Newton's rings.
13	Double Refracting prism

Section III: Additional Activities to be conducted during the semester (Any one)

1. Mini Projects with report (Minimum 10 pages with completion certificate)
2. Study tour / Industrial visit / Field visit with report.
3. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student in the semester).
4. Any two computer aided demonstrations (Using computer simulations or animations on YouTube).
5. Demonstrations – Any one demonstrations of other experiments.

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 2-experiments.

Note: Students have to perform total **12-**experiments (6-experiments from Section-I and 6 experiments from Section-II)

OR

Participated in Additional any **one** activity equivalent to **2-experiments** with 10-experiments (5-experiments from Section-I and 5-experiments from Section-II) mentioned above. Total laboratory work with additional **one** activity should be **12**-experiments.

References:

1) B.Sc. Practical Physics, C.L. Arora, 2010, S Chand and Company Limited.
2) Michael Nelson and Jon M. Ogborn, "Advanced level Physics Practical", 4th Edition, Heinemann Educational Publishers, reprinted (1985)
3) Prakash and Ramakrishna, "A Text Book of Practical Physics", 11th Edition, Kitab Mahal, (2011)
4) D. P. Khandelwal, "A Laboratory Manual of Physics for undergraduate classes", Vani Publication, (1985)
5) A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011, Kitab Mahal
6) Principles of Optics, Max Born & Emil Wolf, 7th Edn., 1999, Pergamon Press.
7) Waves and Oscillations - Stephenson.
8) The Physics of Waves and Oscillations - N. K. Bajaj, Tata McGraw- Hill, publication.
9) Fundamentals of Vibrations and Waves - S. P. Puri, Tata McGraw-Hill publication.

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20) Syllabus of Minor (MN) Courses (Minor)

Minor Courses (Semester III) (4 Credits) (2T+2P)

Note: Every subject has 2 credits

Semester-III

S.Y.B.Sc. (Physics) (Sem-III)

PHY-241-MN : Applied Physics-I

Lectures: 30 hrs **(Credits-02)**

A) Course Objectives: - This course aims

- **a)** To provide foundational knowledge about nanomaterials, their unique properties, and fabrication techniques.
- **b)** To discuss the physical principles governing the behaviour of materials at the nanoscale, including quantum effects.
- **c)** To introduce the fundamental principles of laser operation, including stimulated emission, population inversion, and optical resonators.
- **d)** To highlight the practical applications of lasers in industry, medicine, defence, communication, and research.
- **e)** To understand the physical principles underlying biological processes and systems.
- **f)** To explore the structure and function of biomolecules such as proteins, DNA, RNA

B) Learning Outcomes (CO): - Upon completion of this course student will able to

- **a)** Understanding the Nanoscale
- **b)** Nanomaterial Fabrication
- **c)** Applications of Nanotechnology
- **d)** Characterization Techniques
- **e)** Fundamental Principles of Lasers
- **f)** Types and Characteristics of Lasers
- **g)** Applications of Lasers
- **h)** Physical Principles in Biophysics
- **i)** Functioning of Bioinstrumentations
- **j)** Basic Understanding of Astrophysics and Space Mission

C) Instructional Design: -

1) Lecture method

2) Tutorial method

3) Seminars

4) Use of Multimedia

5) Creation of online resources

D) Evaluation Strategies

1) Descriptive written exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents: - **Lectures: 30 hrs**

Module - 01	**Nanotechnology and its Applications**	**08 H**
	• Introduction to Nanotechnology and nanoscience • Nanomaterials and its properties • Introduction to synthesis of materials using various methods • Applications of nanomaterials	
Module - 02	**LASERS and its Applications**	**07 H**
	• **Introduction to LASER** (Historical Development, Spontaneous and Stimulated Emission, Einstein's Coefficient, Population Inversion) • **Principles of LASER action** • **Characteristic of LASER Light** • **Types of LASER** (Solid State, Gas and Semiconductor Lasers) • **Applications of LASER** (Industrial, Medical and Communication)	
Module - 03	**Physics basis of Life**	**07 H**
	• **Introduction to Biophysics** (Definition and Scope, Importance of physics principles in understanding biological systems, Applications of biophysics in medicine, biology, and technology) • **Molecular Basis of Life** (Structure and function of proteins, DNA and RNA, Water as a biological solvent: Properties and significance, Concept of molecular interactions: Hydrogen bonding, Van der Waals forces, and hydrophobic interactions)	
Module - 04	**Astrophysics and Space Mission**	**08 H**
	• **Astrophysics:** Planets, Asteroids, Meteors, Comets. Origin and age of solar System, distances, physical size, mass, density, temperature, rotation period determination, Celestial hemisphere, Galaxies, Dark Matter and Dark Energy, the universe, Light and telescopes, Cosmology, • **Space Mission:** Natural and Artifical Sattelite, Geosyncronysed and Geostationary Sattelite, Different organization working in Space Mission, Purpose, Indian Organization-ISRO, Different Mission of ISRO and their purpose. Targets achived by ISRO. Applications of Space Missions to human beings.	

Activities: Conduct **any three** classroom activity during class lecture for each module.

- Demonstrate how surface area-to-volume ratio increases as materials are reduced to the nanoscale.
- Investigate how nanomaterials exhibit enhanced mechanical properties.
- Introduce the basic properties of laser light, such as coherence, monochromaticity, and directionality.
- Measure and understand the power and intensity of laser light.
- Understand the process of diffusion, a key principle in cellular biology.
- Measuring the Effect of Temperature on Protein

Reference Books:

1) "Nanotechnology: Principles and Practices" by Sulabha K. Kulkarni
2) "Introduction to Nanotechnology" by T. Pradeep
3) "Lasers: Principles, Types and Applications" by K.R. Nambiar
4) "Fundamentals of Lasers" by Jai Singh
5) "Laser Systems and Applications" by N. Venkatramani
6) "Biophysics" by M. Daniel
7) "Biophysics: Principles and Techniques" by M.A. Subramanian
8) "Essentials of Biophysics" by P. Narayanan
9) "Biomolecular Physics and Dynamics" by P.K. Gupta
10) "A text book of Optics", by N. Subrahmaniam and BrijLal, M N Avadhanulu, S Chand and Company, 23rd Edition, (2006)
11) "Optics", AjoyGhatak, 6th Edition,TataMc Grow Hill, (2017)
12) "Astronomy structure of the Universe", A.E. Roy and D. Clarke, Adam Hilger Pub
13) "Source Book of Space Sciences", Samuel Galsstone; D.Van Nostrand Co. Inc
14) "Astrophysics - Stars and Galaxies", K.D. Abhyankar, Tata McGraw Hill Pub.
15) "Textbook of Astronomy and Astrophysics with elements of cosmology", V.B. Bhatia, Narosa Pub.
16) "Structure of the Universe", J.V. Narlikar
17) "Astrophysics", Baidyanath Basu.
18) "Astrophysical Techniques", third Edition, C. R. Kitchin
19) "Fundamentals of Astronomy", Michael Seed
20) "Telescopes and techniques", C. R. Kitchin (Springer)

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S.Y.B.Sc. (Physics) (Sem-III)

PHY-242-MNP : Applied Physics Lab-I

Lectures: 60 hrs **(Credits-02)**

Practicals: 60 hrs

A) Course Objectives: - This course aims to introduce Applied Physics

1) To study the basic concepts regarding concepts of LASER and its applications.
2) To impart knowledge about computations and plotting of graphs using computer

B) Learning Outcomes (CO): - Upon completion of the course, the student will be able to,

- Understand importance use of bioistruments and nanomaterials enhance basic concepts in Physics.
- Identify and enhance analytical capabilities.
- Knowledge of Laser and its applications.
- Learn about characterization of materials.
- Knowledge of space science and astrophysics, etc.

C) Instructional Design: -

Practical method

D) Evaluation Strategies

1) Practical exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents : Student can use Computer and some physics instruments as per convenience of the Department Practical.

Section I: (Any-12)

Sr. No.	Title of the Experiments
1	Synthesis of TiO_2 / ZnO metal oxide nanoparticles using any synthesis method.
2	Study the optical properties of nanoparticles.
3	Analysis of the surface morphology of nanoparticles using Microscopy.
4	Study of Change in magnetic properties of Nanomaterials.
5	Measurement of the wavelength of a LASER using diffraction grating.
6	Measurement of the divergence of a LASER beam.
7	Measurement of the focal length of a given convex lens using a laser beam of light.
8	To determine the diameter of circular aperture using LASER diode source.
9	Determination of Planks constant using LED.
10	To study Isolation and Purification of Starch from Potato.
11	To study measurement of blood Pressure Using analog or digital Sphygmomanometer.
12	Measurement of Pulse Rate and Blood Oxygen Saturation (SpO_2) Using a Pulse Oximeter.
13	Study of Different Types of Fractures Using X-ray Films.
14	To study use of refractrometer and determination of refractive index of biofluids and biomolecular solutions.
15	Study the absorption and transmission spectra of proteins or nucleic acids.

16	Investigate the fluorescence properties of biological molecules such as proteins or DNA.
17	Measurement of temperature of the Sun using Stefan's law.
18	Study of Sun spot analysis by using any computer software.
19	Measurement of Solar Constant
20	To study and identify major constellations and bright stars using a star chart.

Section II: Additional Activities to be conducted during the semester (Any 3)

Sr. No.	Activities
A1	Mini Projects with report (one project equivalent to 3 activities)
A2	Study tour / Industrial visit / Field visit with report (one visit report equivalent to 3 activities)
A3	Understanding of nano dimension, its existence and its recent applications using literature
A4	Comparison of crystalline size of bulk and nanomaterials.
A5	Understanding of the different properties of LASER
A6	Understanding of ECG of Human being
A7	Calculate the approximate lifetime of stars based on their mass
A8	Study of different missions of ISRO and their purpose (any 3).
A9	To predict and simulate the radiation dose absorbed by astronauts during space missions.
A10	Theoretical study of sun spot analysis by using any computer software.
A11	Study of Solar Eclipse and Lunar Eclipse.

Study tour: Student have to participate in study tour organized by department to study about Physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 3-experiments.

Note: Students have to perform total **12-**experiments from Section-I and 3-activities from Section-II.

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Semester-IV

S.Y.B.Sc. (Physics) (Sem-IV)

PHY-291-MN : Applied Physics-II

Lectures: 30 hrs **(Credits-02)**

A) Course Objectives: - This course aims to introduce Artificial intelligence, Data Analysis and Instrumentation to students.

1) To study the basics of Artificial Intelligence.
2) To impart knowledge about Data Analysis in Physics.
3) To study different instruments used in scientific and industrial laboratory.

B) Learning Outcomes (CO): - Upon completion of the course, the student will be able to,

1) Utilize AI tools for various aspects in Physics
2) Understand errors in different experiments and data analysis
3) Learn measurement techniques and data analysis methods.
4) Understand the fundamental principles of instrumentation in physics.
5) Familiarize with various types of instruments and their applications.
6) Develop theoretical understanding of instruments and enhance experimental skills in instrument operation, calibration, and troubleshooting etc.

C) Instructional Design: -

1) Lecture method 2) Tutorial method 3) Seminars 4) Use of Multimedia

D) Evaluation Strategies

1) Descriptive written exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents: - **Lectures: 30 hrs**

Module - 01	**Artificial Intelligence in Physics**	**08 H**
	1. Introduction to AI, Machine learning, deep learning, and neural networks 2. Current research and applications of AI in Physics such as Materials Physics, Astrophysics etc., 3. Ethics and limitations of AI in Physics research and applications	
Module - 02	**Data Analysis in Physics**	**08 H**
	1. Overview of data analysis 2. Types of data (experimental, simulated, observational) 3. Statistical analysis (mean, median, variance, standard deviation) and Error analysis. 4. Data filtering, cleaning and normalization,	

	5. Data visualization and exploration using e.g. Origin, Microsoft Excel etc.	
Module - 03	**Instrumentation**	**14 H**
	1. Introduction and Overview of instrumentation in physics 2. Types of instruments (analog, digital, hybrid) 3. Measurement principles (accuracy, precision, resolution) 4. Introduction to electrical and electronic instruments : A) Multimeters B) Oscilloscopes C) signal generators etc. B) Introduction to Optical and Spectroscopic Instruments : A) Spectrometers (visible, UV, IR) B) Microscopes (optical, electron) C) Interferometers etc.	

Reference Books:

1) Artificial intelligence in Physics Education: a comprehensive literature review, Mahligawati 2023, IOP Publishing, Journal of Physics: Conference Series, https://dx.doi.org/10.1088/1742-6596/2596/1/012080
2) Artificial Intelligence by Rajiv Chopra (2012) S Chand Publication
3) An Introduction to Artificial Intelligence and Machine Learning (2023) by Manikandan Panerselvam, S Chand Publishing
4) Electronic Instrumentation (2017) by H. S. Kalsi McGraw Hill Education
5) Instrumentation: Theory and Application (2021 Edition) by A. K. Sawhney Dhanapat Rai and Co.
6) Electronic Measurements and Instrumentation (2013 Edition) by R S Sedha, S Chand Publication
7) Physics Laboratory Experiments by D. G. Christian
8) Nanotechnology: Principles and Practices (2015) by Sulabha K. Kulkarni, Springer Publisher.
9) Online and Web resources

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S.Y.B.Sc. (Physics) (Sem-IV)

PHY-292-MNP : Applied Physics Lab-II

Lectures: 60 hrs **(Credits-02)**

Practicals: 60 hrs

A) Course Objectives: - This course aims to introduce Applied Physics

3) To study the basic concepts regarding use of computer to analyse concepts in Physics
4) To impart knowledge about computations and plotting of graphs using computer

B) Learning Outcomes (CO): - Upon completion of the course, the student will be able to,

- Understand importance use of computer programming and plotting of graphs enhance basic concepts in Physics.
- Identify and enhance analytical capabilities.
- Computational capabilities and its significance
- Learn to use excel for drawing of graph
- Apply the knowledge of computer programming and use of Excel, etc.

C) Instructional Design: -

Practical method

D) Evaluation Strategies

1) Practical exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents : Student can use Computer and some physics instruments as per convenience of the Department Practical.

Section I: (Any-12)

Sr. No.	Title of the Experiments
1	Study any problem related to quantum system/ fluid flow/ climate physics using machine learning.
2	Solve any physical science problem using neural networks.
3	Identify the pattern using neural network and make prediction.
4	Plotting of sin, cos, tan, log and exponential functions.
5	Calculate mean, median, variance and standard deviation of a given data/function.
6	Analysis, filtering and normalization of given data.
7	Plotting of Lissajous figure using different values of a, b, c and respective equations.
8	Plotting of column, pie chart and graphs using excel.
9	Plotting of graphs using origin.
10	To study the analog meters for the measurement of electrical current and voltage.
11	Measurement of resistance using color code and millimeter.
12	To study the digital meters for the measurement of electrical current and voltage.
13	To study the Thermistor and understand its type.
14	To study the thermocouple and measure the temperature using it.
15	Study of LVDT circuit.
16	Study of transducers and measurement of sound intensity.
17	Measurement of Light intensity with change in source and distance.

18	Study of spectrometer to understand the optical phenomenon.
19	To study the visible and ultra violet spectroscopy.
20	To study the signal generator and record velocity of sound using Kund's tube.

Section II: (Any-3)

Sr. No.	Activities
A1	Mini Projects with report (one project equivalent to 2 activities)
A2	Study tour / Industrial visit / Field visit with report (one visit report equivalent to 3 activities)
A3	Plotting of graphs with proper scale and units.
A4	Applications of AI related to Physics in daily life.
A5	Applications of AI in Physics.
A6	Understanding of Excel to plot graphs.
A7	Understanding of Orgin to plot graphs.
A8	Understand the relation between resistance and temperature.
A9	Benefits and Limitations of AI in Physics Practicals.
A10	Study the use of thermocouple, light sensors in different machines.

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 3-experiments.

Note: Students have to perform total **12-**experiments from Section-I and 3-Activities from Section-II.

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21) Syllabus of Vocational Skill Courses (VSC)

VSC Courses (Semester III) (2 Credits) (2P)

Semester-III

S.Y.B.Sc. (Physics) (Sem-III)

PHY-221-VSC-P : Introduction to Computational Physics-I

Lectures: 60 hrs **(Credits-02)**

Course Contents: - **Practicals: 60 hrs**

A) Course Objectives: - This course aims to introduce Computational capabilities in Physics

5) To study the basic concepts regarding use of computer programming to analyse concepts in Physics
6) To impart knowledge about computations and plotting of graphs using computer

B) Learning Outcomes (CO): - Upon completion of the course, the student will be able to,

- Understand importance use of computer programming and plotting of graphs enhance basic concepts in Physics.
- Identify and enhance analytical capabilities.
- Computational capabilities and its significance
- Learn to use C++ Language for programming
- Apply the knowledge of computer programming and use of Excel, etc.

C) Instructional Design: -

1) Practical method for program writing

D) Evaluation Strategies

1) Practical exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents : Use C^{++} language.

Section I: (Any-12)

Sr. No.	Title of the Experiments
1	Write an algorithm (along with Flowchart) to learn basic programming concept for Addition, subtraction, multiplication & division of two numbers. (integer, float and complex numbers)
2	Write an algorithm (along with Flowchart) to learn conditional and loop instruction with program to check number for even/odd, prime no and factorial of given no
3	Write an algorithm (along with Flowchart) and program to find RMS velocity (Vrms= √3RT/M) of gas when R is initialized as constant, Temperature and Molecular wt. 'M' is provided through keyboard.
4	Write an algorithm (along with Flowchart) and program to find total Energy = Kinetic Energy + Potential Energy where K.E. = 1/2 mv^2 and P. E. = mgh of a particle. Students can provide through input as 'm' mass of particle and particle is dropped from height and time 't' (provided from keyboard) under the gravity g = 9.8 m/S^2 (Use the equations $v = u + a\,t$ or similar to get values)

<table>
<tr><td>5</td><td>Write an algorithm (along with Flowchart) and program to calculate moment of inertia of rotating bodies such as sphere, hollow sphere, disc etc use following formulae.
Solid Sphere - I= 2/5 MR^2
Hollow Sphere- I = 2/3 MR^2
Disc = ½ MR^2
Ring = MR^2 Provide M and R through Keyboard and choice for shape</td></tr>
<tr><td>6</td><td>Write an algorithm (along with Flowchart) and program to calculate force between mass of two an objects $F = G (M_1M_2)/r^2$</td></tr>
<tr><td>7</td><td>Write an algorithm (along with Flowchart) and program to calculate frequency of an oscillator by using $F = 1/2\pi(RC)^{1/2}$</td></tr>
<tr><td>8</td><td>Write an algorithm (along with Flowchart) and program to find output of Logical Operators AND, OR and NOT gates.</td></tr>
<tr><td>9</td><td>Write an algorithm (along with Flowchart) and program to calculate output voltage of Adder circuit using Inverting Operational amplifier.</td></tr>
<tr><td>10</td><td>Write an algorithm (along with Flowchart) and program to calculate equivalent focal length of two convex lens separated by finite distance using formula for different values of f1,f2 and x where 1/f = 1/f1 +1/f2 – x / f(1*f2)</td></tr>
<tr><td>11</td><td>Use excel sheets to produce table to analyze and plot graph of the relationship between displacement and the energies (kinetic, potential, and total) in simple harmonic motion with the equation
$x(t)=A\cos(\omega t)$, KE = ½ $m\omega^2(A^2-x^2)$ and PE = PE= ½ $m\omega^2x^2$ Take suitable value of A and ω and choose values of x = -10 to +10 with suitable increment.</td></tr>
<tr><td>12</td><td>Use excel sheets to produce table to analyze and plot graph of the relationship between coltage and current for ohms law and plot the graph
V = I R choose value of R = 1000 or 2000 ohms and vary values of V in the range 1 to 10 V with increment of 1V each time OR
Create table for Voltage and Charge Q in care of charging and discharging of Condenser Use the formula Vc = V exp (1- t / RC) choose suitable value of R = 1000 ohms and V = 10 V to calculate Values of Vc and t when t varies from 1 to 25 seconds</td></tr>
<tr><td>13</td><td>Plotting graphs with given table
You are given with table containing values of Voltage applied to diode and its forward current in the table Plot IV curve and find forward resistance = 1/ slope of the curve
<table>
<tr><td>V</td><td>0</td><td>0.1</td><td>0.2</td><td>0.3</td><td>0.4</td><td>0.5</td><td>0.6</td><td>0.7</td><td>0,8</td><td>0.9</td><td>1.0</td><td>1.1</td><td>1.2</td></tr>
<tr><td>I</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0.01</td><td>0.03</td><td>0.055</td><td>0.09</td><td>0.12</td><td>0.15</td><td>0.18</td></tr>
</table></td></tr>
<tr><td>14</td><td>Plotting graphs with given table
You are given with table containing values of distance covered in time t and velocity acquired at that instant t Plot graph distance against time and velocity against time</td></tr>
</table>

<table>
<tr><td></td><td>Use the kinematical equation s = ut + ½ a t2 and V = u + at use a = 9.8 m/s2 and choose u = 10 m/s and find S and V for the table
<table>
<tr><td>t</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>$S = ut + 1/2\ a\ t^2$</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>V = u + at</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>15</td><td>Use excel sheets to produce table to analyze and plot graph of the relationship between force between two masses m1 and m2 with respective the distance between the with the formula $F = G\ m1m2/\ r^2$ For simplicity Let us consider Gm1m2 as constant 1000 and vary distance r from 0.5 to 12m with increment as shown
<table>
<tr><td>r</td><td>0.5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>$F = 1000/(r^2)$</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
</table>

Section II: Additional Activities to be conducted during the semester (Any one)

1. Mini Projects with report.
2. Study tour / Industrial visit / Field visit with report.
3. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student in the semester).
4. Any two computer aided demonstrations (Using computer simulations or animations on YouTube).
5. Demonstrations – Any one demonstrations of other experiments.

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 2-experiments.

Note: Students have to perform total **12-**experiments

OR

Participated in Additional any **one** activity equivalent to **2-experiments** with 10-experiments from Section-I mentioned above. Total laboratory work with additional **one** activity should be **12**-experiments.

Reference:

1) The C programming language – Brian Kernighan

2) Let C - Kanitkar

3) Let us Python - Aditya Kanitkar

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Semester-IV

S.Y.B.Sc. (Physics) (Sem-IV)

PHY-271-VSC-P : Introduction to Computational Physics-II

Lectures: 60 hrs **(Credits-02)**

Course Contents: - **Practicals: 60 hrs**

A) Course Objectives: - This course aims to introduce Computational capabilities in Physics

- To study the basic concepts regarding use of computer programming to analyse concepts in Physics
- To impart knowledge about computations and plotting of graphs using computer

B) Learning Outcomes (CO): - Upon completion of the course, the student will be able to,

- Understand importance use of computer programming and plotting of graphs enhance basic concepts in Physics.
- Identify and enhance analytical capabilities.
- Computational capabilities and its significance
- Learn to use Python and C++ Language for programming
- Apply the knowledge of computer programming and use of Excel, etc.

C) Instructional Design: -

1) Practical method for program writing

D) Evaluation Strategies

1) Practical exam 2) Assignments 3) Seminars, Oral, Viva.

E) Course Contents : Use Python Language

Section I: (Any-12)

Sr. No.	Title of the Experiments
1	Write an algorithm (along with Flowchart) to Finding pressure using Van-der-Waals' equation of state. Where *Van der Waal's Equation for Real Gas:* $(P + a * n2 / V2) * (V - n * b) = n R T$ *where, average attraction between particles (a) = 1.360, volume excluded by a mole of particles (b) = 0.03186, Universal Gas constant (R) = 8.314.* Use: P = ((n * R * T) / (V — n * b)) — (a* n * n) / (V * V). You can extend this program to create arrays of various values of Pressure, Volute and Temperature to plot various graphs
2	Write an algorithm (along with Flowchart) to draw (line, circle, arc, ellipse) using Graphics. (Use equation of line, circle, arc & Ellipse). Line $y = mx + c$ Circle: collections of all points satisfying equation (x,y) = (r cos θ , r sin θ) for θ from 0 to 2π

3	Write an algorithm (along with Flowchart) using Trapezoidal rule: Evaluate a given function f(x) using Trapezoidal rule correct up to given accuracy by successively halving the step size. (Trapezoidal / rule:- limits from a to b , $\int f(x)\,dx$ = Area Under the Curve $= (h/2)\,[(y0 + yn) + 2\,(y1 + y2 + y3 + \ldots.. + yn-1)]$ Where $h = (b - a)/n$.
4	Write an algorithm (along with Flowchart) and write a program and display the Miller planes in the cubic lattice. Display the FCC, BCC, and simple cubic lattice on the computer screen.
5	Write an algorithm (along with Flowchart) and program to find Roots of polynomial using Newton Raphson Method. Using the formula $x_{n+1} = x_n - f(x_n)/f'(x_n)$ Where, 1. x_n is the estimated (n)th root of the function 2. $f(x_n)$ is the value of the equation at (n)th estimated root 3. $f'(x_n)$ is the value of the first order derivative of the equation or function at x_n.
6	Write an algorithm (along with Flowchart) and program to design Transistor Biasing components for Fixed base bias and Voltage divider bias with given formulae
7	Write an algorithm (along with Flowchart) and program to use programming and graphical tools to analyze and visualize the Maximum Power Transfer Theorem, which states that maximum power is transferred to a load when the load resistance equals the source resistance. The power delivered to a load RLR_LRL in a circuit is given by: $P = (V^2 / (R_L + R_i)^2) * RL$ Choose Values of V, Ri as fixed, for various values of R_L Get values of Power P in arrays and Plot Graph of Power against R_L
8	Write an algorithm (along with Flowchart) and program to analyze undamped simple harmonic motion (SHM) using computational methods, solving its governing differential equation, and visualizing the motion for different damping scenarios. Using basic equations to evaluate displacement at various time instances and plotting graph of displacement against time Use following equations to calculate displacement x $V = dx/dt$, Acc $a = -k\,x/m$ where a is acceleration at that instant, V is velocity, b is damping factor, k is spring constant and m is mass of bob. Calculate various points to plot with the equation $V_{i+1} = V_i + a_i * dt$ $X_{i+1} = x_i + V_i * dt$ Use Array method to get points and plot points on the computer

	OR use excel sheet to produce table of time t and values of velocity v, acceleration a and displacement x as shown below and plot graph of x against t <table><tr><td>Obs</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>...</td></tr><tr><td>t</td><td>0</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>a</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>v</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr><tr><td>x</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr></table> any other method to get points and plot
9	Write an algorithm (along with Flowchart) and program to calculate equivalent focal length of two convex lens separated by finite distance using formula $$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{d}{f_1 f_2}$$ Extension Power of combination of lenses separated by distance d is Power $P = P_1+P_2-d*P_1*P_2$ where $P_1 = 1/f_1$ & $P_2 = 1/f_2$
10	Write an algorithm (along with Flowchart) and program to Write an algorithm (along with Flowchart) and program to calculate focal length lens by using lens maker formula $$\frac{1}{F}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$
11	Write an algorithm (along with Flowchart) and program to calculate force between two charges by using coulombs law $F=\frac{1}{4\pi\varepsilon_0}\left(\frac{q_1 q_2}{r^2}\right)$ OR Use Excel sheet to create columns for distance r and force F and Plot graph of force against distance of separation
12	Write an algorithm (along with Flowchart) and program to calculate period of simple pendulum by using $T=2\pi\sqrt{\frac{l}{g}}$ OR Create Excel sheet for columns for Period T of simple pendulum for different values of length l and plot graph of T Vs length l
13	Write an algorithm (along with Flowchart) and program to calculate frequency observed by listener using equation for Doppler effect for all conditions for listener and source of sound ;use the equation f_o frequency observed, f_s frequency of source, v_o velocity of observer, v_s velocity of source, v velocity of sound $$f_o = f_s\frac{v \pm v_o}{v \pm v_s}$$
14	Write an algorithm (along with Flowchart) and program to initialize 2D array representing matrices, and produce product of two matrices

	OR Use excel sheet for Matrix definitions and use various functions to do matrix operations for addition, subtraction, determinant and multiplication of matrices
15	Use excel sheet to solve equations having five variables using matrix operations

Section II: Additional Activities to be conducted during the semester (Any one)

1. Mini Projects with report.
2. Study tour / Industrial visit / Field visit with report.
3. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student in the semester).
4. Any two computer aided demonstrations (Using computer simulations or animations on YouTube).
5. Demonstrations – Any one demonstrations of other experiments.

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 2-experiments.

Note: Students have to perform total **12-**experiments

OR

Participated in Additional any **one** activity equivalent to **2-experiments** with 10-experiments from Section-I mentioned above. Total laboratory work with additional **one** activity should be **12**-experiments.

Reference:

1) The C programming language – Brian Kernighan

2) Let C - Kanitkar

3) Let us Python - Aditya Kanitkar

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22) Syllabus of Indian Knowledge System (IKS) Courses :

Semester-III

S.Y.B.Sc. (Physics) (Sem-III)

IKS-201-PHY : India's Contribution to Physics

Lectures: 30 hrs **(Credits-02)**

A) Course Objectives: This course aims to align with the coursework structure and emphasize both historical and contemporary aspects of Indian contributions to physics.

- Understand the Historical Foundations of Physics in India.
- Recognize Contributions of Pioneering Indian Physicists.
- Analyse the Development of Scientific Institutions in India.
- Explore Contemporary Indian Contributions to Global Physics.
- Inspire Further Research and Innovation.

B) Learning Course Outcomes (CO): Upon completion of the course, the student will be able to, gain both theoretical knowledge and practical understanding, along with ethical and cultural insights, preparing them for further research or application in physics.

- Understand the Knowledge of Historical Foundations
- Identify the role of Indian research institutions in advancing physics research.
- Appreciation of Pioneering Contributions and the significant achievements of Indian physicists.
- Enhanced Analytical and Research Skills and Apply knowledge from historical and modern Indian contributions to develop innovative solutions to contemporary scientific problems.
- Develop curiosity and motivation to pursue advanced studies or careers in physics and related disciplines.

C) Instructional design:

1) Lecture method
2) Tutorial method
3) Seminars
4) Use of Multimedia
5) Study visits
6) Creation of online resources

D) Evaluation Strategies:

1) Written assignments on historical contributions.
2) Research projects on a chosen Indian physicist.
3) Presentations on modern applications of Indian discoveries.
4) Participation in discussions on the philosophical impact of Indian physics.
5) Descriptive written examinations
6) Seminars, Orals, and Viva

E) Course Content : Lecture : 30 hrs

Module: - 01	Ancient Indian Contributions to Physics	08 H
	• **Philosophical Foundations:** ○ Nyaya and Vaisheshika schools: Concepts of atoms (anu), time. ○ Classification of Predicable (Padartha), States of matter, Theory of gravitation and laws of motion in Vaisheshik Philosophy ○ Vedic concepts about Electricity, Sound and accoustics • **Astronomy and Physics in Vedic Texts:** ○ Astronomical references in the Vedas ○ Astronomical model and algorithms of the Vedāṅga-jyotiṣa ○ The Pañca-siddhāntikā of Varāhamihir-Meteorology and planetary science ○ Āryabhaṭīya of Āryabhaṭa ○ Calendrical computations	
Module: - 02	**Modern Indian Physicists and Their Contributions**	**08 H**
	• **19th and Early 20th Century:** ○ **J.C. Bose:** ▪ Contributions to electromagnetism and the demonstration of wireless communication. ▪ Studies on the properties of metals and plant physiology from a physical perspective. ○ **C.V. Raman:** ▪ Raman Effect: Scattering of light and its implications in spectroscopy. ▪ Nobel Prize-winning work and its applications. ○ **Meghnad Saha:** ▪ Saha Ionization Equation: Its importance in astrophysics and stellar atmospheres. ○ **Satyendra Nath Bose:**	

	▪ Bose-Einstein statistics and its role in quantum mechanics. ▪ Collaboration with Albert Einstein. • **Post-Independence Era:** ○ **Homi Bhabha:** ▪ Development of nuclear physics in India. ▪ Contributions to cosmic ray research. ○ **Vikram Sarabhai:** ▪ Contributions to space physics and the establishment of ISRO. ○ **Harish-Chandra:** ○ Work in mathematical physics and representation theory.	
Module: - 03	**India in Global Physics Research**	**08 H**
	• **Development of Research Institutions:** ○ Indian Association for the Cultivation of Science (IACS). ○ Tata Institute of Fundamental Research (TIFR). ○ Saha Institute of Nuclear Physics. ○ Physical Research Laboratory (PRL). • **Major Experiments and Discoveries:** ○ Raman Spectroscopy and its modern applications. ○ Advances in particle physics and neutrino studies at INO (India-based Neutrino Observatory). ○ Contributions to LIGO and gravitational wave detection.	
Module-4	**Contemporary Indian Contributions**	**06 H**
	• **Space and Astrophysics:** ○ Contributions of ISRO in space exploration and physics. ○ Astrosat and its role in multi-wavelength astronomy. • **Quantum Physics and Material Science:** ○ Research in Bose-Einstein condensates and quantum computing.	

	○ Advances in nanotechnology and material physics by Indian scientists. • **High-Energy Physics:** ○ Participation in CERN and the Large Hadron Collider. ○ Indian contributions to the study of Higgs boson	

Module 1: Ancient Indian Contributions to Physics

1. **Books:**
   - R. Balasubramanian, *Indian Philosophy and Physics: From Quantum Mechanics to Consciousness*.
   - S. Radhakrishnan, *Indian Philosophy*.
   - Debiprasad Chattopadhyaya, *History of Science and Technology in Ancient India*.
   - Āryabhaṭīya of Āryabhaṭa, K. S. Shukla and K. V. Sarma, Indian National Science Academy, 1976
   - Studies in Indian Mathematics and Astronomy: Selected Articles of Kripa Shankar Shukla, Kolachana et. al. (eds.), Culture and History of Mathematics 12, HBA, 2019
2. **Research Articles:**
   - Kak, Subhash. "The Speed of Light and Puranic Cosmology." *Indian Journal of History of Science*.
   - P. K. Basu, "Atomic Concepts in Vaisheshika Philosophy," *Indian Journal of History of Science*.
3. **Online Resources:**
   - Indian Academy of Sciences: Articles on Aryabhata and Brahmagupta.
   - Ancient Indian Science portal: Resources on Vedic astronomy and physics.

Module 2: Modern Indian Physicists and Their Contributions

1. **Books:**
   - Rajinder Singh, *J.C. Bose: The First Modern Scientist in India*.
   - G. Venkataraman, *Bhabha and His Magnificent Obsessions*.
   - R. Parthasarathy, *The Bose-Einstein Phenomena*.
2. **Biographies and Articles:**
   - "C.V. Raman and the Raman Effect" – *Resonance Journal of Science Education*.
   - S.N. Bose's collaboration with Einstein – Published letters in *Current Science*.
   - Meghnad Saha's works on astrophysics in *Astrophysical Journal*.
3. **Online Resources:**
   - Nobel Prize website for C.V. Raman's Nobel Lecture.
   - Tata Institute of Fundamental Research (TIFR): History and contributions.

Module 3: Institutions and Experiments

1. **Books:**
   - S. Irfan Habib, *J.C. Bose and the Indian Response to Western Science*.
   - Ashok Jain, *Indian Science and Technology in the 21st Century*.
2. **Research Papers:**

- Raman Spectroscopy: Applications and developments – *Journal of Raman Spectroscopy*.
- Advances in particle physics at INO – *Physical Review D*.

3. **Websites:**
   - Official websites of IACS, TIFR, and PRL for historical records and achievements.
   - LIGO India official page for gravitational wave research contributions.

Module 4: Contemporary Indian Contributions

1. **Books:**
   - G. Madhavan Nair, *Riding the Waves: A Journey into Space Science and Technology*.
   - K. Kasturirangan, *The Indian Space Odyssey*.
2. **Research Articles:**
   - ISRO's contributions to astrophysics – *Space Science Reviews*.
   - Indian contributions to quantum computing – *Nature Physics*.
3. **Websites:**
   - ISRO's official site for details on Astrosat and other space missions.
   - CERN's website for Indian contributions to the Large Hadron Collider.

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23) Syllabus of Generic Elective (GE)/Open Elective (OE) Courses :

Semester-III

S.Y.B.Sc. (Physics) (Sem-III)

OE-221-PHY -T: Eco-friendly Energy for Modern Living

Lectures: 30 hrs **(Credits-02)**

A) Course Objectives: This course aims to

1) Understanding the different types of renewable energy sources,
2) Identifying ways to incorporate them into daily routines,
3) Evaluating the environmental benefits of switching to renewables,
4) Analysing the economic impact of using renewable energy,
5) Exploring practical steps individuals can take to reduce their carbon footprint through energy choices at home and in their communities;
6) Encompassing topics like solar power, wind energy, geothermal, hydroelectricity, and biomass energy usage in everyday life scenarios.

B) Learning Course Outcomes (CO): Upon completion of the course, the student will be able to,

1) Describe sources and uses of energy.
2) Define renewable and non-renewable energy.
3) Provide examples of common types of renewable and non-renewable resources.
4) Understand and explain general ways to save energy at a personal, community and global level.

C) Instructional design:

1) Lecture method **2)** Tutorial method **3)** Seminars 4) Use of Multimedia
5) Study visits 6) Creation of online resources

D) Evaluation Strategies:

1) Written assignments.
2) Research projects.
3) Presentations on.
4) Participation in.
5) Descriptive written examinations
6) Seminars, Orals, and Viva

E) Course Content : **Lecture : 30 hrs**

Module: - 01	**Introduction to Renewable Energy**	**05 H**
	1.1 Conventional and Non-conventional energy sources 1.2 Renewable energy 1.3 Needs and importance of renewable energy sources	
Module: - 02	**Renewable energy sources**	**15 H**

	2.1 Solar energy & importance of solar energy, Advantages, Disadvantage and Applications (solar photovoltaic system, solar water heater, solar distillation, solar cooker) (Only the different applications listing) 2.2 Wind Energy, advantages and limitations of wind energy, Advantages, Disadvantage and Applications (only listing the different applications) 2.3 Tidal Energy, advantages of tidal energy, applications and limitations of tidal energy, Advantages, Disadvantage and Applications (only listing the different applications) 2.4 Hydropower energy Advantages, Disadvantage and Applications (only listing the different applications) 2.5 Environmental impact of conventional energy sources.	
Module: - 03	**Application in daily life**	**10 H**
	3.1 Construction and working of Wind mill 3.2 Construction and working of solar cooker 3.3 Use of wind energy in Agriculture and Food Production 3.4 Case study of Residential Solar Power Systems or Hospital Solar Power Systems 3.5 Study the website of the Tidal energy producing company 3.6 Study of hydro power plant	

References:

1. Solar energy - M P Agarwal - S Chand and Co. Ltd.
2. Renewable Energy Sources and Emerging Technologies by Kothari (Author)
3. Solar Photovoltaics: Fundamentals, Technologies And Applications
   CHETAN SINGH SOLANKI
4. Sukhatme, S. P., Nayak, J.K., Solar Energy-Principles of Thermal Collection and Storage, TMH, 2010, 3rd Edition.
5. Duffie, J. A., Beckman, W. A., Solar Energy Thermal Processes, John Wiley, 2013, 4th Edition.
6. Tester J. W., Drake E. M., Driscoll M. J., Golay, M. W, Peters, W. A., Sustainable Energy Choosing

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Semester-IV

OE-271-PHY -P: Li-Battery - Repairing and Maintenance

Lectures: 60 hrs **(Credits-02)**

A) Course objectives:

1. Develop a strong foundation in principles, Chemistry, Structural, working mechanism and efficient charging processes of Li-ion battery operation.
2. Gain familiarity with specialized tools used in Li-ion battery repair, such as multimeters, battery testers, ESR meters, and cell balancers.
3. Tailor knowledge to industry-relevant applications, such as repairing batteries for electric vehicles (EVs), power tools, and in renewable energy storage etc.
4. Encourage critical thinking and decision-making through Diagnosing complex battery faults, Designing efficient repair and maintenance strategies and troubleshooting issues with limited resources.
5. Use the knowledge of basics of Physics and battery to carryout work
6. Perform Battery repair and assembly as per the recommended quality standards
7. Implement the soft skills that are required to carry out work efficiently

B) Course Outcomes : By the end of the course, participants will:

1. Understand basics of Battery and storage.
2. Apply the knowledge for the repair of batteries.
3. Have a solid understanding of Li-ion battery technology and its common faults.
4. Be able to safely disassemble, repair, reassemble, and test battery packs.
5. Develop the skills to diagnose and resolve voltage imbalances, capacity loss, and BMS-related issues.
6. Be prepared to implement preventive maintenance strategies to prolong battery life.
7. Have the ability to manage safety risks and environmental concerns associated with Li-ion battery servicing.

C) Instructional Design :

1. Practical Method 2. Use of Multimedia, 3. Creation of Online resources 4. Seminars

D) Evaluation Strategies :

1. Objective 2. Assignments 3. Seminars 4. Practical

E) Course Content: (Any 12 experiments + 3 Activities) **Practicals: 60 hrs**

Section I: Theoretical Practical (Any-6)

Sr. No.	Title of the Experiments
1	To study the different chemistries and applications of Li-ion batteries
2	To understand the fundamental structure and operation of a Li-ion battery
3	To identify typical failure modes in Li-ion batteries
4	To understand best practices for prolonging battery life.
5	To study essential safety measures for working with Li-ion batteries.
6	To understand safe and effective charging techniques for Li-ion batteries.

7	To study the role of the BMS in battery safety and performance
8	To learn the criteria for replacing faulty cells in a battery pack
9	Service batteries by removing acid, remove plates from container, inspect parts, clean, replace the defective parts & reassemble.

Section II: Laboratory Practical (Any-6)

Sr. No.	Title of the experiments
1	To understand Battery Basics (different parts of storage batteries, cells i.e. Plates, Electrolyte, container)
2	To study capacity test using a battery tester (Measure voltage, current, resistance power & energy in DC & AC)
3	To identify and remove the faulty cell from battery pack
4	To reassemble and test the battery pack for Battery Management System
5	To test the charging and discharging performance of the battery.
6	To use diagnostic software for battery monitoring
7	To understand the working of a fast charger for battery
8	To identify visible signs of damage or wear
9	To assess the health and performance of individual battery cells
10	Test the battery for specific gravity, terminal voltage by High-rate discharge tester, capacity etc.
11	Top up the battery with distilled water, clean the terminals & vent plug
12	Measure the internal resistance & capacity of cell.

Section III: Additional Activities to be conducted during the semester (Any one)

1. Mini Projects with report.
2. Industry visit/educational visit at energy storage place/workshop/company
3. Demonstrations – Any one demonstrations of other experiments.

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Workshop / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 2-experiments.

Note: Students have to perform total **12-**experiments (6-experiments from Section-I and 6 experiments from Section-II)

OR

Participated in Additional any **one** activity equivalent to **2-experiments** with 10-experiments (5-experiments from Section-I and 5-experiments from Section-II) mentioned above. Total laboratory work with additional **one** activity should be **12**-experiments.

References :

1. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.
2. P. Elumalai & T. Maiyalagan, Reachable lithium-ion batteries: Trends and Trends and Progress in Electric Vehicle Technology, CRC Press, ISBN 9781138484092.
3. Edition: 2EV/Hybrid Batteries & Battery Material Suppliers: An Automotive Market Review
4. David Linden, Hand Book of Batteries, McGraw-Hill, Inc, New York.
5. Linden D and Thomas B. Reddy, Hand book on batteries and fuel cell", McGraw Hill Book Co., New York, 3rd Edition, 2002
6. Electric Vehicle Battery Systems Sandeep Dhameja, October 2001, Pub Newnes ISBN 0750699167.

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24) Syllabus of Skill Enhancement Courses (SECs) :

Semester-IV

S.Y.B.Sc. (Physics) (Sem-IV)

SEC-251-PHY-P: Basic Instrumentation Skills

Lectures: 60 hrs **(Credits-02)**

A) Course Objectives: This course aims to provide fundamental knowledge and skills on the basic instruments.

1) To study the basic concepts regarding various aspects of instruments.
2) To impart knowledge about the usage of instruments and its analysis.

B) Learning Course Outcomes (CO) : Upon completion of the course, the student will be able to,

1) Understand the working principles of various instruments.
2) Identify the errors in the instruments for further accurate measurement.
3) Acquire the scientific information of various electrical instruments.

C) Instructional design:

1) Practical method.
2) Seminars.
3) Use of multimedia.

D) Evaluation Strategies :

1) Descriptive written examinations.
2) Assignments.
3) Seminars, Orals, and Viva.

E) Course Contents: - **Practicals: 60 hrs**

Section I: (Any-12)

Sr. No.	Title of the Experiments
1	Study of load cell
2	Study of linear variable differential transformer [LVDT]
3	Study of torque measurement cell [TMC]
4	Study of Cathode ray oscilloscope [CRO]
5	Study of J-type and K-type thermocouples
6	To determine psychometric properties of air using sling psychomotor.
7	Study of Sound level meter.
8	Study of pressure gauge.
9	Study of orifice meter.

10	Study of LVDT as displacement transducer.
11	Strain measurement with data acquisition system.
12	LADDER Programming on PLC Automation of Car parking garage and product packaging.
13	Study Logic Gates using PLC
14	To measure pressure using elastic diaphragm(in variable Capacitor/ Bourden Tube)
15	To measure magnetic field using Hall probe for a system of ring magnets

Section II: Additional Activities to be conducted during the semester (Any one)

1. Mini Projects with report.
2. Study tour / Industrial visit / Field visit with report.
3. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student in the semester).
4. Any two computer aided demonstrations (Using computer simulations or animations on YouTube).
5. Demonstrations – Any one demonstrations of other experiments.

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 2-experiments.

Note: Students have to perform total **12**-experiments from Section-I.
OR
Participated in Additional any **one** activity equivalent to **2-experiments** with 10-experiments (10-experiments from Section-I and 1-Aditional activity from Section-II) mentioned above. Total laboratory work with additional **one** activity should be **12**-experiments.

References:

1) Instrumentation Device and System by Rangan, Mani Sharma, Tata Mc Graw Hill

2) Instrumentation Measurement and Analysis by Nakra, Choudhari, Tata Mc Graw Hill

3) https://old.mesce.ac.in/pdf/Instrumentation%20Lab.pdf

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S.Y.B.Sc. (Physics) (Sem-IV)

SEC-252-PHY-P: Sensors and Detection Technology

Lectures: 60 hrs **(Credits-02)**

A) Course Objectives:

The objective of a Skill Enhancement Practical Course in Sensors and Detection Technology is typically designed to provide students with hands-on experience in the operation, application, and integration of various sensors and detection systems. The course typically aims to bridge the gap between theoretical knowledge and practical application, preparing students to work with cutting-edge sensor technologies in various sectors.

B) Learning Course Outcomes (CO)

The Learning Course Outcomes of a Skill Enhancement Practical Course in Sensors and Detection Technology are the specific knowledge, skills, and competencies that students are expected to achieve by the end of the course. These outcomes generally focus on both theoretical understanding and hands-on practical skills.

By the end of the course, students will:

1. Understand the principles of various sensor technologies (e.g., temperature, pressure, proximity, motion).
2. Select appropriate sensors for specific applications.
3. Integrate sensors with microcontrollers (e.g., Arduino, Raspberry Pi).
4. Analyze and interpret sensor data.
5. Develop a working project using sensors and detection technology.

By achieving these outcomes, students will be better prepared to work with modern sensor technologies in a range of applications, and possess both practical skills and theoretical knowledge to contribute effectively in sensor-based fields.

C) Instructional design:

1) Lab sessions for hands-on work with sensors.

2) Group discussions and troubleshooting sessions.

3) Lectures on theory and concepts.

D) Evaluation Strategies:

1) Journal presentation

2) Orals, and Viva

3) Practical Exams

E) Course Contents: - **Practicals: 60 hrs**

Section I: (Any-12)

Sr. No.	Title of the Experiments
1	Analysis of Temperature Variations Using Thermal Sensors
2	Investigation of Heat Distribution on a Surface Using Temperature Mapping Techniques
3	Study of Variation of Light Intensity with Distance Measured by Sensor
4	Exploring Object Detection and Distance Measurement with Ultrasonic Sensors
5	Determining the Speed of a Moving Object Using Ultrasonic Sensors
6	To measure weight using a force-sensitive resistor (FSR)
7	Measurement of sound intensity using sound level meter
8	Measurement of strength of magnetic field using Hall effect sensor
9	Measuring and analyzing changes in the position or distance of an object using capacitive displacement sensor
10	Temperature measurement using fiber optic sensor
11	Determine the Refractive Index Using an Optical Sensor Array
12	Determining the Magnetic Properties of Materials Using a Gaussmeter
13	Detection & measurement of nuclear radiation using G.M. detector
14	Study of a Pyroelectric Sensor for Temperature Detection

Section II: Additional Activities to be conducted during the semester (Any one)

1. Monitoring Water Quality Using Optical Turbidity Sensors
2. Tracking Magnetic Field Variations in a Coil Using a Magnetic Field Sensor
3. Heat Transfer and Thermal Resistance Experiment Using Thermocouples
4. Measurement of Ambient Noise Levels in Different Environments
5. Detection of Liquid Levels Using Fiber Optic Sensors
6. Measurement of Humidity Using Resistive Humidity Sensors
7. Mini Projects with report.
8. Study tour / Industrial visit / Field visit with report.

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 2-experiments.

Note: Students have to perform total **12**-experiments from Section-I.
OR

Participated in Additional any **one** activity equivalent to **2-experiments** with 10-experiments (10-experiments from Section-I and 1-aditional activity from Section-II) mentioned above. Total laboratory work with additional **one** activity should be **12**-experiments.

REFERENCES:

1) Sensors and Transducers: D. Patranabis, PHI Learning Private Limited (2003).

2) Sensors and Signal Conditioning: Ramón Pallás-Areny & John G. Webster, Wiley (2012).

3) Introduction to sensors: John Vetelino & Aravind Reghu, CRC press (2017).

4) Measurement, Instrumentation and Sensors Handbook-Spatial, Mechanical, Thermal and Radiation Measurement: John G. Webster & Halit Eren, Taylor & Francis (2014).

5) Sensors and Transducers: Ian Sinclair, Newnes (2000).

6) Measurement systems: Application & design: E.O.Doebelin, Mc Graw Hill (2004).

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S.Y.B.Sc. (Physics) (Sem-IV)

SEC-253-PHY-P: Introduction to Physics of Devices

Lectures: 60 hrs **(Credits-02)**

A) Course Objective- The course aims to introduce

- To understand physics principles in devices and its applications in the various instruments.
- To impart knowledge about the measurements of physical quantity and its analysis

B) Course Outcomes- Upon completion of the course, the students will able to

- Understand the physics principles in various devices.
- Acquire the scientific information of various physical and electrical devices used in physics practicals.
- Identify the errors in instrument and study their analysis.
- Recognize different electronic components, devices and their applications.

C) Instructional Design-

1. Lecture Method 2. Use of Multimedia, 3. Creation of Online resources 4. Seminars

D) Evaluation Strategies-

1. Descriptive 2. Assignments 3. Seminars, Oral and Viva.

E) Course Contents: - **Practicals: 60 hrs**

Section I: (Any-12)

Sr. No.	Title of the Experiments
1	Verification of JOULE'S law (As $\Delta\theta \propto I^2$)
2	To measure the resistivity of the material of a wire
3	To investigate the variation of the resistance of a metallic conductor with temperature
4	To investigate the variation of the resistance of a thermistor with temperature
5	To investigate the variation of current (I) with p.d. (V) for a metallic conductor
6	To investigate the variation of current (I) with p.d. (V) for a filament bulb
7	To investigate the variation of current (I) with p.d. (V) for copper sulfate solution with copper electrodes
8	Photoconductivity (photocurrent as a function of irradiance at constant voltage)
9	To determine the wavelength of laser source using diffraction of single slit.
10	To determine the wavelength of laser source using diffraction of double slits
11	To study the construction and working of solid state laser and gas laser.
12	To determine the ionisation potential of mercury
13	To study Coefficient of viscosity by Capillary Flow method
14	To determine Boltzmann constant using V-I characteristics of PN junction diode.

15	Study of Unipolar Junction Transistor (UJT) Characteristics.
16	Design and study of solar cell characteristics
17	Comparison of E.M.F.'s of Two Cells with the Help of Potentiometer
18	To measure magnetic field by hall probe method.
19	To study I-V characteristics of Tunnel diode.
20	To study construction of DC power supply.

Section II: Additional Activities to be conducted during the semester (Any one)

1. Mini Projects with report.
2. Study tour / Industrial visit / Field visit with report.
3. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student in the semester).
4. Any two computer aided demonstrations (Using computer simulations or animations on YouTube).
5. Demonstrations – Any one demonstrations of other experiments.

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 2-experiments.

Note: Students have to perform total **12-**experiments (6-experiments from Section-I and 6 experiments from Section-II)

OR

Participated in Additional any **one** activity equivalent to **2-experiments** with 10-experiments (12-experiments from Section-I and 1-aditional activity from Section-II) mentioned above. Total laboratory work with additional **one** activity should be **12-**experiments.

REFERENCES :

1. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011,Kitab Mahal
2. Electronic Devices & circuit Theory, R.L.Boylestad& L.D.Nashelsky, 2009, Pearson
3. A text book in Electrical Technology – B. L. Theraja- S. Chand and Co. (Volume III) Publishers, New Delhi
4. BSc Practical Physics,-Harnam Singh, S Chand Publishers, New Delhi
5. B.Sc. Practical Physics, Aora C.L., S Chand & Company, New Delhi

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S.Y.B.Sc. (Physics) (Sem-IV)

SEC-254-PHY-P: Technical Design and Drawing of Electronic Circuit

Lectures: 60 hrs **(Credits-02)**

A) Course Objectives: The course aims to introduce

- To understand physics principles in devices and its applications in the various instruments.
- To impart knowledge about the measurements of physical quantity and its analysis

B) Learning Course Outcomes (CO) : Upon completion of the course, the students will able to

- Understand the physics principles in various devices.
- Acquire the scientific information of various physical and electrical devices used in physics practicals.
- Identify the errors in instrument and study their analysis.
- Recognize different electronic components, devices and their applications.

C) Instructional design:

1) Practical method, **2)** Tutorial method**, 3**) Use of Multimedia, 4) Creation of online resources

D) Evaluation Strategies :

1) Practical examinations, **2)** Assignments **3)** Orals, and Viva

E) Course Contents: - **Practicals: 60 hrs**

Section I: (Any-6)

Sr. No.	Title of the Experiments
1	To study different types of electronic passive and active devices and their symbols.
2	To study the circuit layout, part packages/numbers of electronic components using technical data sheet.
3	To study the different types of Analog and Digital Integrated Circuits (ICs) and their package layout.
4	To study the different types of circuit boards and the soldering and desoldering techniques by mounting different electronic components and ICs on various circuit boards.
5	To study PCB manufacturing Process with PCB design rules and layout.
6	To study the different types of electronic measuring devices and their use in testing of various electronic components.
7	To study the various applications of CRO.
8	To study the various functions of function generator
9	To study the characteristics of rectifier diode and Zener diode.

	To study and design the electronically regulated power supply (ERPS) using three pin regulators
	To study the different types of temperature sensors and their characteristics
	To study the different types of light sensors and their characteristics.
	To study and design the transistor as switch to operate relay using temperature or light sensor.
	To study and design for the implementation of given Boolean equation using logic gate ICs.
	To study and design for the implementation of full adder circuit using K-map.
	To study and design the adder, integrator and differentiator circuit using OPAMP IC-741.
	To study circuit design and simulation software for Analog and Digital circuits (e.g. PROTEUS).
	To study the PCB designing software like EasyEDA, PCAD, Orcad, etc.

Section II: Activities (Any-1)

Sr. No.	Title of the experiments
1	Industrial Visit/Study tour/ Industrial exhibition / seminars.
2	Project with Circuit Design, PCB, Analysis and Result (e.g. Temperature Controller Circuit).
3	How to design a circuit for a PCB board (workshop Visit)
4	Hands on Training - Actual PCB Board designing (workshop Visit)

Study tour: Student have to participate in study tour organized by department to study about physics in Industry / Company / Organization / Research Institute / Research organization / Small scale industry / University Department and compulsory submitted study tour report equivalent to 2-experiments.

Note: Students have to perform total **12**-experiments from Section-I.

OR

Participated in Additional any **one** activity equivalent to **2-experiments** with 10-experiments (10-experiments from Section-I and 1-Activity from Section-II) mentioned above. Total laboratory work with additional **one** activity should be **12**-experiments.

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25) Field Project (FP) :

Semester-III

S.Y.B.Sc. (Physics) (Sem-III)

Guidelines for Field Project (FP)

Lectures: 60 hrs **(Credits-02)**

Field project work will provide students opportunity to visit and observe situation in rural and urban contexts, students are expected to observe and study actual field situations in socio-economic contexts while doing their field work. It will improve opportunities to understand interconnect between theoretical knowledge and practical applications. Field project is expected to enhance their sensitivity to socio-economic issues and improve their ability of problem solving as well as designing innovative solutions to the existing and emerging problems. Field project component will broaden the possibilities of deeper learning and enhancing research acumen of students. Field project broadens opportunities of social responsibility, environmental sustainability, nation building and peace.

Objectives:

- Align classroom learnings with awareness about socio-economic conditions.
- Provide students with exposure to socio economic conditions and align their experiences with contemporary problems.
- Integrating theoretical and practical modes blended learning under the guidance of their faculty.
- Enhance research skills including knowledge discovery, analytical tools, methodologies, and ethical conduct.
- Facilitate problem-solving, decision-making, teamwork, and collaboration.
- Foster ability to work in team, develop social awareness and nurture human values among students.
- Encourage collaboration between Higher Education Institutes (HEIs), social organization, Government and non-government institutes for better implementation of Field project.

Outcomes:

- Apply concepts learned in classrooms to real-world socioeconomic conditions enhancing their understanding and skills.
- Show insights into the challenges, opportunities and culture of socioeconomic diversity, preparing them for future role as responsible citizens.
- Demonstrate evidence of research aptitude and skills of critical thinking, analytical skills, and ethical research conduct in field work.
- Display problem-solving abilities in making informed decisions in complex scenarios through practical situations.

- Work in teams and collaborate to achieve common goals in the work field environments through collaborative efforts.
- Show integrity in their dealings with their work and the people that they interact with by upholding professional; principles and ethical standards.

Project Report:

All projects should be typed on A4 sheets, Font Size 12, Times New Roman, one and a half spacing on executive bond paper. The project report shall have appropriate chapter scheme and be presented in minimum of 20 pages.

Report arrangement :

1) Title Page
   - Title of the Report
   - Name of the Student
   - Seat number
   - Program Title
   - Name of the Guide
   - Month and year of Submission
2) Certificate by the Institute
3) Certificate by Guide
4) Student's Declaration
5) Acknowledgement
6) Abstract : (200-300 words)
7) Table of contents :
8) List of Figures and Tables :

Chapter-1: Introduction

Chapter2: Literature Review

Chapter 3: Methodology

Chapter 4: Field Work Descriptions, Observations and Analysis

Chapter 5: Conclusion and Recommendations

9) References
10) Appendices

Evaluation Pattern :

Evaluation during the FP program involves two key components:

a) Internal Evaluation (30%) : by Guide (Marks 15)

Field visit completion, Attendance and interaction = 05 marks

Overall Report quality = 10 marks

Total = 15 marks

b) External Evaluation (70%) : by External Examiner (Marks 35)

Objectives, Literature Review, Methodology, Data Analysis, Conclusion	= 20 marks
Overall Project Report Structure	= 05 marks
Presentation Skills	= 10 marks

Total	= 35 marks

Certificate:

Certificate

I hereby certify that Mr./Ms. _____ Student of _____ Institute studying in _____ has completed a project titled _____ in the area of _____specialization for the academic year 2025-2026. To the best of my knowledge the work of the student is original and the information included in the project is correct.

Guide Head of the Department

Declaration :

Declaration

I, Mr./Ms. _____ Student of _____ Institute studying in _____ hereby declare that I have completed the field project entitled _____during the academic year 2025-2026. The report work is original and the information/data included in the report is true emerging from the primary and/ secondary data gathered and analyzed as part of this project. Due credit is extended on the work of Literature/Secondary Survey by endorsing it in the Bibliography as per prescribed format.

Signature of the Student with Date
Name of Student

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26) Community Engagement and Service or Programme (CEP) :

Semester-IV

S.Y.B.Sc. (Physics) (Sem-III)

Guidelines for Community Engagement Programme (CEP)

Lectures: 60 hrs **(Credits-02)**

Objectives :

a. To develop an understanding of community needs and challenges.
b. To equip students with skills to identify problem areas within the community.
c. To guide students in creating effective project proposals.
d. To apply classroom knowledge of courses to field realities and thereby improve the quality of learning.

Field Work :

a. To provide practical experience in implementing community projects.
b. To assess students' ability to apply theoretical knowledge in real-world situations.
c. To develop skills in project management, teamwork, and communication.

Field Report:

All report should be typed on A4 sheets, Font Size 12, Times New Roman, one and a half spacing on executive bond paper. The report shall have appropriate chapter scheme and be presented in minimum of 20 pages.

Report arrangement :

1) Title Page
   - Title of the Report
   - Name of the Student
   - Seat number
   - Programme Title
   - Name of the Guide
   - Month and year of Submission
2) Certificate by the Institute
3) Certificate by Guide
4) Student's Declaration
5) Acknowledgement
6) Abstract : (200-300 words)

Chapter-1:

Chapter2:

Chapter 3: y

Chapter 4: Field Work

Chapter 5: Conclusion and Recommendations

7) References
8) Appendices

Evaluation Pattern :

Evaluation during the CEP programme involves two key components:

a) Internal Evaluation (30%) : by Guide (Marks 15)

Field visit completion, Attendance and interaction = 05 marks
Overall Report quality = 10 marks

Total = 15 marks

b) External Evaluation (70%) : by External Examiner (Marks 35)

Field visits, Field work Reflection and Analysis, Conclusion = 15 marks
Overall Project Report Structure = 05 marks
Presentation Skills and Community Impact Assessment = 15 marks

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Total = 35 marks

Certificate:

Certificate

I hereby certify that Mr./Ms. _____ Student of _____ Institute studying in _____ has completed a report titled _____ in the area of _____specialization for the academic year 2025-2026. To the best of my knowledge the work of the student is original and the information included in the report is correct.

Guide Head of the Department

Declaration :

Declaration

I, Mr./Ms. _____ Student of _____ Institute studying in _____ hereby declare that I have completed the field report entitled _____during the academic year 2025-2026. The report work is original and the information/data included in the report is true emerging from the primary and/ secondary data gathered and analyzed as part of this project. Due credit is extended on the work of Literature/Secondary Survey by endorsing it in the Bibliography as per prescribed format.

Signature of the Student with Date
Name of Student

X***** rΩb *****X