The Poona Gujarati Kelavani Mandal's
HARIBHAI V. DESAI COLLEGE
of Arts, Science & Commerce (Autonomous)
Affiliated to Savitribai Phule Pune University
(Linguistic Minority Institution) AICTE NO. : 1-44457797714
ID No.: PU / PN / ASC / 057/ (1984)
NAAC Grade B++ (2.86 CGPA) ■ AISHE CODE : C-41829
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BOS in PHYSICS

Restructured Syllabus (CBCS Pattern as per NEP 2020)
To be implemented from Academic Year: 2024-25

Faculty	**Science**
Program	**B.Sc (Physics)**
Class	**F.Y.B.Sc**

Semester	Course Code	Type of Course	Course Title	Theory/ Practical	Credits	No. of clock hours per week
I	**PHY-101-TH**		**Fundamentals of Physics-I**	**Theory**	**02**	**03**
	PHY-102-PR		General Physics Lab-I	Practical	02	04 per batch
	SEC-101-PHY-PR		**Experimental Skills in Physics**	**Practical**	**02**	**04 per batch**
	SEC-102-PHY-PR		Physics of Water Filtration Systems	Practical	02	
	SEC-103-PHY-PR		Renewable Energy and Energy Harvesting	Practical	02	
	SEC-104-PHY-PR		Programming for Physical Applications (C++ / Python)	Practical	02	
	OE-101-PHY-TH		Physics of Daily Life	Theory	02	03
	OE-102-PHY-TH		Biological Physics	Theory	02	03
	OE-101-PHY-TH		**Physics in Competitive Examination**	**Theory**	**02**	**03**
Semester	**Course Code**	**Type of Course**	**Course Title**	**Theory/ Practical**	**Credits**	**No. of clock hours per week**

II	**PHY-151-TH**		**Fundamentals of Physics-II**	**Theory**	**02**	03
	PHY-152-PR		General Physics Lab-II	Practical	02	04
	SEC-151-PHY-PR		Numerical Techniques in Physics	Practical	02	04
	SEC-152-PHY-PR		Introduction to Laser and Fibre Optics	Practical	02	04
	SEC-153-PHY-PR		Radiation Safety	Practical	02	04
	SEC-154-PHY-PR		Basic Lab Electric devices and Circuits	Practical	02	04
	SEC-151-PHY-PR		**Basic Electronic Components**	**Practical**	**02**	04
	OE-151-PHY-PR		**LED Light Repairing and Maintenance.** Maintenance and Repairing of Physics Lab equipment.	**Practical**	**02**	04
	OE-152-PHY-PR			Practical	02	04

PHY-101-TH (Fundamentals of Physics-I)

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

Unit	Title and Contents	No. of lectures in Clock Hours
1	**Motion** Introduction to motion, Types of motion, Inertia, Newton's laws of motion with explanation. Various types of forces in nature, frames of references (Inertial and non-inertial) **Numerical Problem**	**06hrs**
2	**Fluid Mechanics** Concept of Viscous forces and Viscosity, Coefficient of Viscosity, Steadyand turbulent flow, Reynold's number, Equation of Continuity, Bernoulli's Principle, Applications of Bernoulli's principle (Venturimeter. Pitot Tube), Applications of viscous fluids. **Numerical Problems**	**08hrs**
3	**Physics of Atoms** Introduction to Atom, Atomic Models: Thomson's Atomic Model Rutherford's Atomic Model, Bohr's Atomic Model, Atomic Spectra: Emission line Spectrum, Absorption line spectrum, Uses of Atomic Spectra, Classical planetary model of Hydrogen Atom, The Bohr Theory of the Hydrogen Atom, The Hydrogen Spectrum, Frank-Hertz experiment. **Numerical Problem**	**08 hrs**
4	**LASERS and Its Applications** Introduction to LASERS, Basic Principle of Lasers: Three Processes, Characteristics of Lasers: brief explanation, Boltzmann Distribution Law, Population Inversion and Pumping, Types of Lasers: He-Ne Laser, Ruby Laser, Applications of Lasers **Numerical Problem**	**08hrs**

PHY-102-PR (General Physics Lab-I)

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

(Any 12 experiments + 3 Experimental Activities)

Unit	Title and Contents	No. of lectures in Clock Hours
Section I	**Mechanics and its application (Any-6)** **1.** To study basic differentiation and integration using standard examples. **2.** To study mean deviation, standard deviation, and error analysis. **3.** Conversions of units of various measurements. **4.** To study and use of various measuring instrument's 1. Vernier caliper 2. Micrometer Screw Gauge 3. Travelling Microscope 4.Spectrometer. **5.** To determine an acceleration due to gravity "g" by using Bar Pendulum. **6.** To determine an acceleration due to gravity "g" by using Keter's Pendulum. **7.** To determine the Coefficient of Viscosity by using Poiseuille's method **8.** To study and verify Bernoulli's Theorem **9.** To determine the moment of inertia of Disc by Torsional Oscillations **10.** To determine the moment of inertia of a Flywheel **11.** To determine the surface tension using Capillary Rise method **12.** To determine the Surface Tension of Water by using Jaeger's method **13.** To determine the Surface Tension of Mercury by using Quincke's Method **14.** To determine the Surface Tension of Mercury by using Method of Ripples.	
Section II:	**Physics Principles and Applications (Any-6)** **1.** To study of Spectrometer Calibration (Determination of Angle of the Prism and Refractive Indices of different colors) **2.** To determine the Dispersive Power of the Material of a Prism **3.** To determine the Cauchy's Constants A and B of the Material of a Prism **4.** To determine the Planck's Constant	

	5. To study the I-V characteristics, and calculate FF, Efficiency of p-n junction Solar Cell **6.** To determine the first excitation potential of gas by Frank Hertz Experiment **7.** To study of Divergence of LASER beam **8.** To determine the Diameter of Thin Wire by using LASER light **9.** To determine the wavelength of LASER light by using Plane Diffraction Grating. **10.** To study of Total Internal Reflection using LASER light. **11.** To determine the particle size of any sample material powder by using LASER light **12.** To determine wavelength of LASER using Metric Ruler (Scale) **13.** To demonstrate how the gamma-ray energy varies following Compton scattering	

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

1. Mini Projects with report (Minimum 10 pages with completion certificate daily signed by project guide and HOD of Department).
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.

Note: Students have to perform 12-experiments (6-experiments from Section-I and 6 experiments form Section-II) And Participated in additional any three activities equivalent to 3-experiments with 12-experiments. Total laboratory work with additional activities should be 15-experiments.

SEC-101-PHY-PR (Experimental Skills in Physics)

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

(Any 12 experiments + 3 Experimental Activities)

Sr.No.	Title and Contents	No. of lectures in Clock Hours
1.	Conversions of units of various measurements.	
2.	To plot the graph of distance verses time, velocity verses time by given data and write the conclusion	
3.	To determine the least count of instruments like Vernier Calliper, Micrometer Screw Gauge, Travelling Microscope, Spectrometer, etc.	
4.	To determine the inner and outer radius of given pipe by using Vernier Calliper and determine the diameter of pin by using micrometer screw gauge.	
5.	To determine the radius of curvature of the lenses by using spherometer.	
6.	To measurement of relative humidity using hygrometer	
7.	To find unknown incident power using solar insolation calibration curve	
8.	To determine the coefficient of viscosity of water by Viscometer.	
9.	To determine the angle of prism by using spectrometer.	
10.	To study how to plot the graph of any single observation on graph paper and how to observe the readings from graphs (e.g. I-V, V-T, I-T, etc.)	
11.	To study how to plot the graph of two or more observations on a single graph. (e.g. Charging and discharging of capacitor, Line and Load regulation, etc.)	
12.	To study the measurement of sound frequency of audio speaker.	
13.	Calibration of Spectrometer to determine RI of prism	
14.	To measure the viscosity of a liquid using viscometer.	
15.	Study and use of Analogue Multimeter	
16.	Study and use of Digital Multimeter	
17.	Study and use of CRO	

Additional Activities to be conducted related to subject (Any-3)

1. Mini Projects with report.
2. Industrial /Research organization /Working organization /Field visit with report.
3. Any one computer aided demonstrations (Using computer simulations or animations).
4. Demonstrations – Any one demonstrations.

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments with 12-experiments. Total laboratory work with additional activities should be 15-experiments.

OE-101-PHY-TH (Physics in Competitive Examination)

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

Unit	Title and Contents	No. of lectures in Clock Hours
1.	**Introduction of Basic Physics** Introduction of subject, Physics in Everyday Life: Facts, & Importance How is physics used in today's world? How is physics important to man? Understanding of, Laws and applications of motion, forces, and gravity. Processes of work and energy Laws of thermodynamics. How light and sound waves function in our environment. Principles of electricity and magnetism and their applications Principles of Electromagnetic Spectrum.	**10**
2.	**Measurements in Physics** Basic fundamentals of Physics There are seven (7) main factors we can measure, i.e. mass, length, time, current, temperature, the amount of a substance, and luminosity. There were four basic measurements such as mass (weight), distance or length, area and volume. System of Units and its measurement Derived Units, Conversion of Units SI and CGS systems Problems	**10**
3.	**Applications of Physics** The importance of Physics in education, research, and practical applications in various fields such as engineering, technology, biology, medicine, and industry. General study of Microwave ovens, LCD, Lasers, Electric motors, Hybrid car, Projector, X-ray, CT Scan, RADAR, DRONE, Musical Instruments, iPhone, laptop, electric vehicles, solar panels etc.	**10**

PHY-151-TH (Fundamentals of Physics-II)

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

Unit	Title and Contents	No. of lectures in Clock Hours
1	**Fundamentals of Thermodynamics** Concept of thermodynamic state, Equation of state, Van der Waal's equation of state, Thermal equilibrium, Zeroth law of thermodynamics, Thermodynamic processes: Adiabatic, Isothermal, Isobaric and Isochoric changes, Indicator diagram, Work done during isothermal change, Adiabatic relations, Work done during adiabatic change, Internal energy, Internal energy as state function, First law of thermodynamics, Reversible and Irreversible changes, Problems.	**08**
2	**Applied Thermodynamics** Conversion of heat into work and it's converse, Second law of thermodynamics, Concept of entropy, Temperature - entropy diagram, T-dS equations, Clausius - Clapeyron latent heat equations, Problems.	**06**
3	**Heat Transfer Mechanisms** Carnot's cycle and Carnot's heat engine and its efficiency, Heat Engines: Otto cycle & its efficiency, Diesel cycle & its efficiency, Refrigerators: General principle and coefficient of performance of refrigerator, Simple structure of Vapour compression refrigerator, Air Conditioning: Principle and it's applications, Problems.	**08**
4	**Thermometry** Concept of heat & temperature, Principle of thermometry, Temperature scales & interconversions, Principle, Construction and Working: (Liquid thermometers, Liquid filled thermometers, Gas filled thermometers, Bimetallic thermometers, Platinum resistance thermometer, Thermocouple), Problems.	**08**

PHY-152-PR (General Physics Lab-I)

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

(Any 12 experiments + 3 Experimental Activities)

Unit	Title and Contents	No. of lectures in Clock Hours
Section I	**Thermal Physics (any 6)** 1. To determine the Coefficient of Thermal Conductivity by Lee's method 2. To determine the Specific Heat of Graphite. 3. To study the Carnot's cycle by drawing graphs of Isothermal and Adiabatic curves. 4. To investigate the first law and Second law of thermodynamic using heat Engine 5. To study the 2 / 4-Stroke Petrol Engine 6. To study the 4-Stroke Diesel Engine. 7. To determine the Temperature Coefficient of Thermistor. 8. To study the Thermocouple as a Thermometer 9. To determine the Calorific Values of Different Fuels. 10. To determine the Temperature Coefficient of Resistivity of PTC / NTC type Material. 11. To determine the Coefficient of Liner Expansion of Metals. 12. To determine the specific heat capacity of water by electrical method. **13.** To determine the specific heat capacity of a given solid by the method of mixture.	
Section II:	**Electricity and Magnetism (any 6)** **1.** Study of Digital Multimeter for measuring (i) Resistances, (ii) AC and DC Voltages, (iii) DC Current, and (iv) checking electrical fuses. **2.** Study of AC and DC Voltage Sensitivity by using CRO. **3.** Study of I-V Characteristics of p-n Diode and Zener Diode **4.** Study of Charging and Discharging of a Capacitor **5.** Study of L-R Circuit. **6.** Study of Impedance of series LCR series circuit.	

	7. Study of Series and Parallel circuit using Capacitor (Voltage-Current Division Rule) **8.** Determination of Frequency of AC by using Sonometer **9.** Study of Kirchhoff's Voltage and Current Law **10.** Comparison of Capacitor using De Sauty's Method **11.** Measurement of Dielectric Constant using Schering Bridge Experiment **12.** To verify Ampere's Law experimentally by graphing the magnetic field strength.	

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

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 experimentsperformed by the student).
4. Any two computer aided demonstrations (Using computer simulations or animations).
5. Demonstrations – Any one demonstrations.

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.

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

And Participated in additional any three activities equivalent to 3-experiments with 12- experiments. Total laboratory work with additional activities should be 15-experiments.

SEC-151-PHY-PR (Basic electronics components)

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

(Any 12 experiments + 3 Experimental Activities)

Unit	Title and Contents	No. of lectures in Clock Hours
1.	To determine the value of a resistor using its color code.	
2.	To study and measure value of resistance for different types of resistors using digital multimeter.	
3.	To study and measure value of capacitance for different types of capacitors using digital multimeter.	
4.	Measurement of AC and DC voltage and current using DMM.	
5.	To verify the voltage divider rule.	
6.	To verify the equivalent resistance in series and parallel combinations.	
7.	To verify Ohm's Law using a resistor.	
8.	Study of transformer.	
9.	Study of electromagnetic induction.	
10.	To study variation of resistance with light intensity (LDR).	
11.	To study forward and reverse bias of ordinary (p-n junction) and zener diode	
12.	To study I-V characteristics of LED.	
13.	To measure ac, and dc voltage by using CRO.	
14.	To measurement of rise, fall and delay times using a CRO.	
15.	To measure frequency of different signals by using CRO.	

Additional Activities to be conducted related to subject (Any-3)

1. Mini Projects with report.
2. Industrial /Research organization /Working organization /Field visit with report.
3. Any one computer aided demonstrations (Using computer simulations or animations).
4. Demonstrations – Any one demonstrations.

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments with 12-experiments. Total laboratory work with additional activities should be 15-experiments.

OE-PHY-PR (LED Light Repairing and Maintenance in Daily Life)

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

(Any 12 experiments + 3 Experimental Activities)

Unit	Title and Contents	No. of lectures in Clock Hours
1	To identify the different LEDs in the circuit and measure its activities (ON/OFF).	
2	.To measure the Power and Energy of different LEDs.	
3	To study how soldering and de-soldering of LED in done. (Hands on Training)	
4	To check the voltage and current output at different sections of units of LED.	
5	To check LEDs in series and parallel circuit. (Hands on Training)	
6	To check the burnt out and damage LEDs in bulbs.	
7	To perform repair and replacement of LEDs and other components.	
8	To study an assembly of LED bulbs / Strips dismantle with different wattage.	
9	To identify the operation of LED in the fiber optics.	
10	To check and replace the burnt and damage LED strips	
11	To demonstrate the process of soldering if loose, de-soldered wires and connections are found.	
12	To demonstrate basic knowledge of assembly of products such as spot light, LED bulb and LED tube light.	
13	To study the characteristics of three indicator LEDs that emit in the infrared, red and blue parts of the spectrum.	
14	To investigate the relationship between the Threshold Voltage of an LED and the wavelength of light emitted from the LED.	
15	To study and measure the P-I characteristics of Light Emitting Diode (LED) used in optical fiber communication as a light source.	
16	To determine and plot the characteristics of the light emitting diode in the forward-bias region, and to compare between different colored diodes.	
17	To measure I-V characteristics of Infrared (IR), Red and Blue light emitting diodes (LEDs).	

18	To measurement of Led Light output using a Photodiode.	
19	To study the wavelength characteristics of LED for different 3 colors and measure it.	
20	To study the properties of LED and how they can combined in the 7-segment display.	
21	**Additional Activities to be conducted related to subject (Any-3)** Mini Projects with report. Industrial /Research organization /Working organization /Field visit with report. Any one computer aided demonstrations (Using computer simulations or animations). Demonstrations – Any one demonstrations.	

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Date: 07/04/2025

BOS in PHYSICS

Restructured Syllabus (CBCS Pattern as per NEP 2020)

To be implemented from Academic Year: 2025-26

Faculty	**Science**
Program	**B.Sc (Physics)**
Class	**S.Y.B.Sc**

Credit framework for second year B.Sc:

Semester	Course Code	Type of Course	Course Title	Theory/ Practical	Credits	No. of clock hours per week
III	PHY-201-MJ-TH	**Compulsory Course**	Mathematical Methods in Physics-I	Theory	02	02
	PHY-202-MJ-TH		Electronics-I	Theory	02	02
	PHY-203-MJ-PR		General Physics Lab-III	Practical	02	04 per batch
	PHY-221-VSC-PR	Vocational Skill Course	Data Analysis and Statistical Methods	Practical	02	04 per batch
	PHY-FP-231-PR	FP/OJT/CEP	Field Project-I	Practical	02	04 per batch
	PHY-241-MN-TH	Minor	Basic Mathematical Physics	Theory	02	02
	PHY-242-MN-PR	Minor	Basic Physics Laboratory-I	Practical	02	04 per batch
	OE-201-PHY-TH	GE/OE	Renewable Energy for Daily Life-I	Theory	02	02
	NA	SEC	NA			
	PHY-201-IKS-TH	IKS	India's Contribution to Physics	Theory	02	02
	AEC-231-Hindi/Marathi	AEC	Hindi/Marathi	Theory	02	02
	-	CC	-	-	02	-
Total					**22**	

Semester	Course Code	Type of Course	Course Title	Theory/ Practical	Credits	No. of clock hours per week
IV	PHY-251-MJ-TH	**Compulsory Course**	Oscillations, Waves and Sound	Theory	02	02
	PHY-252-MJ-TH		Optics	Theory	02	02
	PHY-253-MJ-PR		General Physics Lab-IV	Practical	02	04 per batch
	PHY-271-VSC-PR	Vocational Skill Course	Introduction to Arduino	Practical	02	04 per batch
	PHY-FP-281-PR	FP/OJT/CEP	Field Project-II	Practical	02	04 per batch
	PHY-291-MN-TH	Minor	Concepts of Modern Physics	Theory	02	02
	PHY-292-MN-PR	Minor	Basic Physics Laboratory-II	Practical	02	04 per batch
	OE-251-PHY-TH	GE/OE	Renewable Energy for Daily Life-II	Theory	02	02
	SEC-251-PHY-PR	SEC	Optometry	Practical	02	04 per batch
	AEC-281-Hindi/Marathi	AEC	Hindi/Marathi	Theory	02	02
	-	CC	-	-	02	-
Total					**22**	

Dr. Sagar S. Jagtap

Chairman, BOS in Physics

Second Year B.Sc. Program in Physics

(Faculty of Science & Technology)

S.Y.B.Sc. (Physics)

To be implemented from Academic Year 2025-2026

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: 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:

Physics program outcomes aim to produce physics graduates with a strong foundation in physical principles, scientific inquiry, critical thinking, and problem-solving, as well as effective communication, laboratory, and research skills. 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) Physical Principles:

Understand and apply fundamental physical principles to analyze and solve problems in various contexts.

c) 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, data analysis, and research ethics. Physics research skill useful to design, conduct, and present original research projects, demonstrating skills in literature review, methodology, and data analysis.

d) Scientific Inquiry:

Design, conduct, and present experiments/investigations to answer scientific questions and test hypotheses.

e) Hands-on/ Laboratory Skills:

Comprehensive hands-on/ laboratory exercises/ demonstrate proficiency 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.

f) Problem-Solving:

Apply physical principles and mathematical tools to solve complex problems in physics and related fields.

g) 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.

h) Interdisciplinary Approach:

Apply physical principles to understand and address challenges in other disciplines, such as engineering, biology, and environmental science.

i) 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. Students can effectively communicate physical concepts, results, and ideas through written, oral, and visual means.

j) 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. Critically evaluate physical phenomena, arguments, and data to form informed conclusions.

k) Ethical Practice:

Demonstrate awareness of ethical considerations in scientific research, data management, and professional conduct.

l) **Lifelong Learning:**

Stay up-to-date with advancements in physics and related fields, fostering a culture of continuous learning and professional development.

5) Programme Structure :

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

Table: Credit framework of undergraduate degree programme in Physics.

UG Credit Framework (Faculty of Science & Technology)

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 ***Honors 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 ***Honors Degree*** in Major and Minor with **176** credits.

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.

6) 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 Examinations:

The summative end-semester 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.

7) Scheme of Examination :

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

- Theory Paper of 02 Credits:
  - o Internal Exam (15 M) + Theory Exam (35 M) = Total 50 M
  - o Duration: For Internal exam = 30 Min. and for theory Exam = 02 hours.
- Practical Paper of 2 Credits:
  - o Internal Exam (15 M) + Practical Exam (35 M) = Total 50 M
  - o Duration: For Internal exam = 40 Min. and for Practical Exam = More than 04 hours.

Internal exam will be conducted by the college/institutes during the semester.

External exam will be conducted by the college/institutes 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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S.Y.B.Sc. (Physics) (Sem-III)

PHY-201-MJ-TH: Mathematical Methods in Physics-I

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

Learning Outcomes:

After the completion of this course students will be able to

- Understand the complex algebra useful in physics courses.
- Understand the concept of derivative and partial differentiation.
- Understand the role of partial differential equations in physics.
- Understand vector algebra useful in mathematics and physics.
- Understand the concept of Integration.

Unit	Title and Contents	No. of lectures in Clock Hours
1	**Complex Numbers:** Introduction to complex numbers Polar, exponential forms of complex numbers (Euler's formula), and related Physics examples Argand diagram, Algebra of complex numbers (Addition, Subtraction, Multiplication, and Division) De-Moivre's Theorem (without proof) Power, and root of complex numbers Trigonometric, and exponential functions Applications of complex numbers in Physics Applications of complex numbers to determine velocity and acceleration in curved motion. Problems.	**06 hrs**
2	**Partial Differentiation:** Introduction to derivatives Fundamental formulae and Rules of derivative Types of differentiation: ordinary and partial differentiation (using limit) with various physics examples Successive differentiation, Total differentiation, Exact differential Chain rule Theorems of differentiation Change of variables from Cartesian to polar co-ordinates Conditions for maxima and minima (without proof) Differential Equation: Degree, order, linearity and homogeneity of ordinary differential equation	**08 hrs**

	Problems.	
3	**Vector Algebra and Analysis:** Introduction to scalars and vectors with various examples of physics Dot product and cross product of two vectors and their physical significance Scalar triple product and its geometrical interpretation Vector triple product and its geometrical interpretation Scalar and vector fields with various examples of physics Differentiation of vectors with respect to scalar Vector differential operator and Laplacian operator Gradient of scalar field and its physical significance with examples Divergence of scalar field and its physical significance with examples Curl of vector field and its physical significance with examples. Problems	**09 hrs**
4	**Integration:** Introduction to integration Indefinite integration Fundamental Formulae of indefinite integration Definite integration Double and triple integration Physical interpretation and various examples in Physics Examples of Integration in Physics Problems	**07**

Reference Books:

1. Methods of Mathematical Physics - Laud, Takwale and Gambhir.
2. Mathematical Physics - B.D.Gupta.
3. Mathematical Physics - Rajput and Gupta.
4. Mathematical Methods in Physical Science - Mary and Boas.
5. Vector analysis - Spiegel and Murrey.
6. Mathematical Methods for Physicists - Arfkenand Weber (5th Edition)
7. Fundamentals of Mathematical Physics - A.B.Gupta.
8. Vector Analysis - Seymour Lipschutz and Dennis Spellman.

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

PHY-202-MJ-TH: Electronics-I

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

Learning outcomes: On successful completion of this course the students will be able to

- Apply different theorems and laws to electrical circuits.
- Understand the relations in electricity.
- Understand the parameters, characteristics and working of transistors.
- Understand the functions of operational amplifiers.
- Design circuits using transistors and applications of operational amplifiers.
- Understand the Boolean algebra and logic circuits.

Unit	Title and Contents	No. of lectures in Clock Hours
1	**Network Theorem** Krichhoff's Law**,** Voltage and current Divider Circuit, Thevenin's Theorem**,** Norton's Theorem**,** Superposition Theorem, Maximum Power transfer theorem (Without proof). **Problems**	**08 hrs**
2	**Study of Transistors** **2.1** Bi-junction Transistor Revision of bipolar Junction Transistor, Types, Symbol and basic action, Configuration (Common Base, Common Emitter and Common Collector), Current Gain Factors (a and ß) and their relat ions, Input, Output and transfer Characteristic of CE Configuration, Biasing method and Voltage Divider, DC Load line (CE), Operating Point (Q- point), Transistor as a switch. **Problems** **2.2** Uni-Junction Transistor	**10 hrs**

	Symbol, Types, Construction, Working Principle, I-V characteristics, Specifications and Parameters of Uni-Junction Transistor (UJT), UJT as a relaxation Oscillator. **Problems**	
3	**Operational Amplifiers and Application** Introduction**,** Ideal and practical Characteristics, Operational Amplifier: IC741- Block Diagram and Pin diagram Concept of Virtual Ground, Inverting and Non-inverting operational amplifiers with concept of gain, Operational amplifier as an adder and subtractor. **Problems**	**06 hrs**
4	**Number Systems and Logic Gates** Number System: Binary, Binary coded Decimal (BCD), Octal, Hexadecimal, Basic Logic gates (OR, AND, NOT), Derived gates: NOR, NAND, EXOR, EXNOR, with symbols and truth table, Boolean Algebra, De Morgan's theorem and its verification **Problems**	**06 hrs**

Reference Books:

1. Electronic Principles-Malvino, 7th Edition, Tata Mc-Graw Hills publication.
2. Principles of Electronics-V.K. Mehta, S. Chand publication.
3. Op-amp and Linear Integrated Circuit-Ramakant Gaikwad, Prentice Hall of India publication.
4. Integrated Circuit-Botkar, Khanna Publication, New Delhi.
5. Digital Principles and Application-Malvino and Leech, Tata Mc-Graw Hills publication.

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

PHY-203-PR: General Physics Lab-III

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

Learning Outcome: After completing this practical course students will be able to

- Develop hands-on skills in designing and testing electronic circuits.
- Gain proficiency in using software tools for mathematical computation and data visualization.
- Cultivate problem-solving and analytical skills, with a focus on practical applications of theoretical concepts.
- Enhance the ability to work with laboratory instruments such as the CRO, power supplies, and multimeters.
- Improve teamwork and communication skills through collaborative activities such as projects, demonstrations, and report writing.
- Work in a group to plan, implement and report on a project/experiment.
- Keep a well-maintained and instructive laboratory logbook.

Section-I: Electronics-I (Any Eight)

1. Circuit Theorems (Thevenin's, Norton's and Maximum Power Transfer Theorems)
2. Transistor Characteristics (Input and Output characteristics of CE Configuration)
3. Single Stage Transistor Amplifier
4. Study of Rectifiers (Half, Full Wave and Bridge) with different filters
5. I-V Characteristics of UJT
6. Zener as a Regulator (Line and Load Regulation)
7. Transistor as a switch
8. Op-amp as inverting and non-inverting amplifier
9. Op-amp as an adder and subtractor
10. Study of logic gates and verification of de Morgan's theorems.
11. 4-bit binary adder/subtractor
12. Use of CRO(AC/DC Voltage measurement, Frequency measurement)

13 UJT as Relaxation Oscillator

Section-II: Mathematical Methods in Physics/Use of Computer (Any Four)

1. Plotting of various trigonometric functions using spread sheet/any graphic software viz. Microsoft Excel, Origin: sinx, cosx, tanx, e^{x}, e^{-x}, logx, lnx, x^{n}
2. Plotting of conic sections using spreadsheet /any graphic software viz. Microsoft Excel, Origin: circle, ellipse, parabola, hyperbola
3. Inverse, determinant of matrix, solution of linear equations using Microsoft Excel or Origin software
4. Differentiation of different functions (logarithmic, trigonometric, exponential etc.), product of functions, quotient etc.
5. Integration using simple formaulaes such as integration of rational functions, by parts, trigonometric functions, exponential, logarithemic etc.

Additional Activities (Any three)

1. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student)
2. Any two computer aided demonstrations (Using computer simulations or animations)
3. Demonstrations-Any two demonstrations
4. Study tour with report
5. Mini project

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments. Total laboratory work with additional activities should be 15-experiments.

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

PHY-221-VSC-PR: Data Analysis and Statistical Methods

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

(Any 12 experiments + 3 Experimental Activities)

Learning Outcome: After completing this practical course students will be able to

- Understand basic and advanced statistical concepts relevant to physics experiments.
- Apply MS Excel and Origin to analyze experimental data and perform curve fitting.
- Perform regression, error analysis, and uncertainty calculations.
- Generate good quality graphs and interpret data trends.
- Use data analysis to verify physical laws and constants through experimental results.

Section-I: Use of MS-Excel

1. Data Visualization: Create graphs and charts to visualize data, including line plots, scatter plots, and histograms.
2. Error Analysis: Use formulas to calculate the errors in measurements, including absolute and relative errors.
3. Mean, Median, Mode: Calculate mean, median, and mode of a dataset, and understand their significance.
4. Standard Deviation: Calculate standard deviation of a dataset, and understand its significance.
5. Linear Regression: Perform linear regression analysis in MS-Excel, including calculating slope and intercept.
6. Curve Fitting: Fit curves to experimental data in MS-Excel, including polynomial and exponential fits.
7. Peak Analysis: Analyze peaks in spectra or other data, including calculating peak positions and intensities.
8. Hypothesis Testing: Perform hypothesis testing on experimental data, including t-tests and ANOVA.
9. Correlation Analysis: Analyze correlations between variables, including calculating correlation coefficients.
10. Regression Analysis: Perform regression analysis on experimental data, including linear and non-linear regression.

11. Use of various statistical functions/parameters for analysis of experimental data.
12. Study of statistical distributions (Gaussian/Poisson/Binomial/Normal distributions) of Physics experiments.

Section-II: Use of Origin/Any other software

1. Introduction to Origin: Learn basic operations in Origin software, including data entry and graphing.
2. 2D Graphing: Create 2D graphs in Origin software, including line plots, scatter plots, Pie chart, bar graph and Histograms of a dataset.
3. 3D Graphing: Create 3D graphs in Origin software, including surface plots and scatter plots of a dataset.
4. Curve Fitting: Fit curves to experimental data in Origin software, including polynomial and exponential fits of a dataset.
5. Peak Analysis: Analyze peaks in spectra or other data in Origin software, including calculating peak positions and intensities.
6. Calculate the slope and intercept of a linear graph in Origin software.
7. Uncertantities: To calculate the uncertainties in measurements OR to show the uncertainties of the given database using Origin software.
8. Plotting of various trigonometric functions in Origin software.
9. Plotting of various standard functions (Parabola, Hyperbola, Ellipse & Circle) in Origin software.

Additional Activities (Any Three)

1. Plotting of any two graphs using MS-Excel/Origin Software/Any other Software (of data obtained from various experiments performed by the student).
2. Study tour with report.
3. Mini project.
4. Data analysis competitions.
5. Group discussions.

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments. Total laboratory work with additional activities should be 15-experiments.

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

PHY-241-MN-TH: Basic Mathematical Physics

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

Learning Outcomes:

After the completion of this course students will be able to

- Understand the coordinate systems in physics courses.
- Understand the concept of various mathematical functions of real and complex variables in Physics.
- Understand the concept of derivative and partial differentiation.
- Understand the role of ordinary and partial differential in physics.
- Understand vector algebra useful in mathematics and physics.

Unit	Title and Contents	Total Clock Hours
1.	**Co-ordinate Systems** Cartesian Coordinate system (2D and 3D): Position vector and its length, unit vector, scalars and vectors with various examples of physics using Cartesian coordinate system Length, surface and volume element 2D polar coordinate system: Polar coordinates, Examples in Physics Transformation equation from Cartesian to polar coordinate system (2D) Vector projection and examples Problems	**06 hrs**
2.	**Fundamental Mathematical functions in Physics** Real numbers, Introduction to standard functions of real numbers (Line, curve, exponential, logarithmic, and periodic functions) with graphical representation and their physical interpretation with examples. Trigonometric functions and relations Complex Numbers and function with graphical representation and examples	**07 hrs**
3.	**Differentiation:** Introduction to derivatives Physical interpretation with examples Derivative of some of the elementary functions Differentiation of products, Chain rule, Differentiation of quotients, Implicit Types of differentiation: ordinary and partial differentiation with various physics examples	**09 hrs**

	Successive differentiation Condition of Maxima and minima function using graph (without proof) Ordinary and Partial differential equations with examples of Physics	
4.	**Vector Algebra and Analysis:** Dot product and cross product of two vectors and their physical significance Scalar and vector fields with various examples of physics Vector differential operator and Laplacian operator Gradient of scalar field, Divergence and Curl of vector field and their physical significance with examples Gradient of scalar field and its physical significance with examples Divergence of scalar field and its physical significance with examples Curl of vector field and its physical significance with examples. Problems	**08 hrs**

Reference Books:

1. Methods of Mathematical Physics - Laud, Takwale and Gambhir.
2. Mathematical Physics - B.D.Gupta.
3. Mathematical Physics - Rajput and Gupta.
4. Mathematical Methods in Physical Science - Mary and Boas.
5. Vector analysis - Spiegel and Murrey.
6. Mathematical Methods for Physicists - Arfkenand Weber (5th Edition)
7. Fundamentals of Mathematical Physics - A.B.Gupta.
8. Vector Analysis - Seymour Lipschutz and Dennis Spellman.

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

PHY-242-MN-PR: Basic Physics Lab-I

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

Learning Outcomes: On completion of this course, the learner will be able to

- **Understand and apply basic mathematical tools** such as vectors, matrices, differential equations, and coordinate transformations to solve simple physical problems.
- **Develop numerical reasoning skills** to approximate solutions of equations, integrals, and differential equations using analytical techniques.
- **Apply Basic Mathematical Physics** to model physical systems and interpret their behavior.
- **Visualize mathematical and physical functions** through plotting and data analysis using manual methods.

List of Practicals:

1. **Plot y = mx + c** for different values of m and c (on graph paper or digitally).
2. **Vector Addition and Subtraction** using graphical methods.
3. **Dot Product and Cross Product**: Manual computation for given vectors.
4. **Conversion between Coordinate Systems**: Cartesian ↔ Polar (and back).
5. **Basic Matrix Operations**: Addition, multiplication, transpose, and inverse (manually and using calculator/Python).
6. **Simple Differential Equations**: Analytical solution of dy/dx = ky type equations.
7. **Verification of Trigonometric Identities** numerically using calculator
8. **Graphical Solution of Equations**: Plotting y = f(x) and locating roots visually.

8. **Least Squares Linear Fit (Manual)**: Simple line fitting to small data sets by hand.
9. **Generate and Plot a Table of y = sin(x), cos(x)** for x in degrees or radians.
10. **Plotting a Function (like y = x² or e^x)** using any language or Excel.
11. **Random Number Generator in C**: Demonstrate uniform distribution.
12. **Simple Harmonic Oscillator Simulation using Euler Method** (basic numerical physics).

Additional Activities (Any Three)

1. Plotting of any two graphs using MS-Excel/Origin Software/Any other Software (of data obtained from various experiments performed by the student).

2. Study tour with report.
3. Mini project.
4. Data analysis competitions.
5. Group discussions.

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments. Total laboratory work with additional activities should be 15-experiments.

Reference Books:

1. Mathematical Physics by H.K. Dass and Dr. Rama Verma
2. Mathematical Physics by B.D. Gupta
3. Mathematical Methods for Physicists and Engineers by K.M. Varma
4. Programming in C- (Schaum's series), Gottfreid, TMH
5. Let us C- Yashwant Kanetkar, BPB publications
6. Introductory methods of numerical analysis-S. Sastry, Prentice Hall
7. Computer oriented numerical methods – V. Rajaraman.

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

PHY-201-IKS-TH: India's Contribution o Pysics

Lectures: 30 **(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

1) Understand the Historical Foundations of Physics in India.
2) Recognize Contributions of Pioneering Indian Physicists.
3) Analyze the Development of Scientific Institutions in India.
4) Explore Contemporary Indian Contributions to Global Physics.
5) 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.

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

E) Course Contents: Theory

Module-1	**Ancient Indian Contributions to Physics**	**07 hrs**
	Philosophical Foundations: o Samkhya and Vaisheshika schools: Concepts of atoms (anu), time, and motion. o Nyaya philosophy: Logical reasoning and inference in natural phenomena. **Astronomy and Physics in Vedic Texts:** o Aryabhata: The concept of rotation of Earth and celestial mechanics. o Brahmagupta: Gravity and planetary motion. o Varahamihira: Meteorology and planetary science.	
Module-2	**Modern Indian Physicists and Their Contributions**	**08 hrs**
	19th and Early 20th Century: o **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-3	**India in Global Physics Research**	**08 hrs**
	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**	**07 hrs**
	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.	

F) REFERENCES:

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.*
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.

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

PHY-251-MJ-TH: Oscillations, Waves and Sound

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

Learning Outcomes:

On completion of this course, the learner will be able to

- Study underlying principles of oscillations and its scope in development.
- Understand and solve the equations / graphical representations of motion for simple harmonic, damped, forced oscillators and waves.
- Explain oscillations in terms of energy exchange with various practical applications.
- Solve numerical problems related to undamped, damped, forced oscillations and superposition of oscillations.
- Study characteristics of sound, decibel scales and applications.

Unit	Title and Contents	No. of lectures in Clock Hours
1	**Undamped Free Oscillations:** Different types of equilibria (static, dynamic, stable, unstable, and metastable equilibrium) – definitions only with examples. Definitions of linear Simple Harmonic Motion (S.H.M) and angular S.H.M. Differential equation for linear S.H.M. and its solution. Composition of two perpendicular linear S.H.Ms. for frequency ratio 1:1 and 2:1 (analytical method). Lissajous figures, their demonstration (optical and electrical method) and applications. Problems.	**06 hrs**
2	**Damped Oscillations:** Introduction Differential equation for damped harmonic oscillator and its solution, discussion of different cases. Logarithmic decrement. Average energy of damped harmonic oscillator. Quality factor. Application: LCR series circuit. Problems.	**08 hrs**
3	**Forced Oscillations:** Introduction. Differential equation for forced oscillations and its solution. Resonance: mechanical, acoustic and electrical. Velocity and Amplitude resonance. Sharpness of resonance and half width. Average energy of forced oscillator.	**09 hrs**

	Quality factor of forced oscillator. Relation between quality factor and bandwidth. Application of forced oscillations- LCR series circuit. Problems.	
4	**Wave Motion:** Introduction Equation for longitudinal waves (one dimension only). Equation for transverse waves (one dimension only). Energy density and intensity of a wave. Seismic waves and gravitational waves. Sound waves: sound Intensity, Loudness, Pitch, Quality and timbre Reverberation time and reverberation of hall. Sabine's formula Problems.	**07 hrs**

Reference Books:

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

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

PHY-252-MJ-TH: Optics

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

Learning Outcomes: On successful completion of this course the students will be able to

- Acquire the basic concept of wave optics.

- Describe how light can constructively and destructively interfere.
- Explain why a light beam spread out after passing through an aperture
- Summarize the polarization characteristics of electromagnetic wave
- Understand the operation of many modern optical devices that utilize wave optics
- Understand optical phenomenon such polarization, diffraction and interference in terms of the wave model
- Analyze simple example of interference and diffraction.

Unit	Title and Contents	No. of lectures in Clock Hours
1	**Geometrical optics** Introduction to lenses and sign conventions, Thin lenses: lens equation for convex lens, Lens maker equation, Concept of magnification, deviation and power of thin lens, Equivalent focal length of two thin lenses, Concept of cardinal points, Lens aberrations: Types of aberrations, Achromatism. **Problems.**	**09 hrs**
2	**Optical Instruments** Introduction, Simple Microscope, Compound Microscope, Ramsden's eye piece. **Problems.**	**06 hrs**
3	**Interference and Diffraction** Introduction, Phase change on reflection. (Stokes treatment), Interference due to wedge shaped thin film, Newton's ring, Diffraction types: Fresnel's diffract ion and Fraunhoffer's diffract ion, Fraunhoffer's diffraction at single slit, Plane diffraction grating, Rayleigh criterion for resolution. **Problems**	**10 hrs**

4	**Polarization** Introduction, Brewster's law, Law of Malus, Polarization by double refraction, Nicol Prism. **Problems.**	**05 hrs**

Reference Books:

1. Optics - A.R. Ganesan, 4th edition, Pearson Education.

2. A Textbook of Optics - N. Subhramanyam, Brijlal, M.N. Avadhanulu, S. Chand Publication. 3. Physical Optics - A.K. Ghatak, McMillan, New Delhi

4. Fundamental of Optics - F.A. Jenkins, H.E.White, Mc Graw-Hilll International edition

5. Principles of Optics - D.S. Mathur, Gopal Press, Kanpur.

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

PHY-253-MJ-PR: General Physics Lab-IV

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

Learning Outcome: After completing this practical course students will be able to

- Develop hands-on skills in experimental physics, focusing on wave and optical phenomena.
- Gain proficiency in using laboratory equipment such as interferometers, polarimeters, and goniometers.
- Understand the practical applications of theoretical concepts in oscillations and optics through direct experimentation.
- Improve skills in data analysis, interpretation, and presentation using software tools like spreadsheets.
- Enhance the ability to work collaboratively, communicate findings effectively, and write comprehensive reports on experimental results.
- Work in a group to plan, implement and report on a project/experiment.
- Keep a well-maintained and instructive laboratory logbook.

Section I: Oscillations and Waves

1. Logarithmic decrement (in air and water).
2. Study of coupled oscillators comprising two simple pendulum (Mechanical) and determination of coupling coefficient.
3. 'g' by bar pendulum.
4. Study of musical scales using a signal generator and musical instruments.
5. Measurement of coefficient of absorption of sound for different materials (cork, thermocol, mica, paper etc.).
6. Study of Lissajous's figures and determination of unknown frequency.
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 frequency of an electrically maintained tuning fork by stroboscopic method.
11. To determine the velocity of sound in air at room temperature with Kundt's Tube.
12. Electric oscillator using LCR circuit

Section II: Optics

1. Newton's Ring: Determination of wavelength of monochromatic light source (λ).
2. Dispersive power of glass prism.
3. Total internal reflection using LASER beam and glass prism.
4. Diffraction at the edge of a razor blade.
5. Optical activity of sugar solution using Polarimeter.
6. Goniometer to determine cardinal points and focal length.
7. To determine temperature of sodium flame.

8. Double refracting prism.
9. Determination of Cauchy's constant

Additional Activities (Any two)

1. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student).
2. Any two computer aided demonstrations (Using computer simulations or animations).
3. Demonstrations –Any two demonstrations.
4. Study tour with report.
5. Mini project.

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments. Total laboratory work with additional activities should be 15-experiments.

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

PHY-271-VSC-PR: Introduction to Arduino

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

(06 Theory lectures + Any 08 Practical's OR 01 Project)

Introduction:

Arduino is an open-source electronics platform based on simple hardware and software. It consists of programmable microcontroller boards with digital and analog I/O pins that interface with sensors and actuators. Programs are uploaded via USB using C/Python-based languages. This course emphasizes hands-on learning and creative project development using Arduino boards.

Objectives:

• Create awareness and interest in Arduino technology
• Introduce Arduino boards, sensors, and actuators
• Develop basic interfacing and programming skills
• Familiarize students with Arduino IDE and smart system applications
• Enable design and implementation of smart systems

Course Outcomes:

After completing the course, students will be able to:

• Understand and use Arduino boards and I/O devices
• Apply basic programming concepts for Arduino
• Design Arduino-based applications across domains
• Analyze the performance of Arduino-based systems
• Adapt to new IDEs, compilers, and Arduino-compatible platforms

Instructions: This course consists of two parts

• Part I: Theory and Part II: Practical / Project.
• Part II has two sub parts:
• Part II(A) : Practical / Demonstration & Part II(B) : Project. The A or B parts are optional, students can opt any one for 1 credit

Part I: Theory

Unit	Topics	Lectures
I : Introduction to Microcontrollers	Introduction to Embedded Systems, Block Diagram, Single Board Computers (SBC) and System on Chip (SoC), Single Board Microcontroller (SBM), microprocessor vs microcontrollers, Basic system with microcontroller such as Arduino (SBM), Raspberry Pi (SoC) etc.	03
II : Introduction to Arduino and Arduino Programming	• Arduino Basics: What is Arduino, Advantages of Arduino, Arduino Types, Arduino Components, Arduino Uno Architecture • Arduino Hardware: Types of Arduino boards, Various components on Arduino Board, Various	03

	sensors and actuators: Overview of Sensors working, Analog and Digital Sensors	

Part II (A): Arduino Programming (Practicals) : Any 8 [24 L]

Simple Practicals using Arduino Uno Board (Software + Hardware): Choose any-4 Practicals from group-1 and any-4 practicals from group-2. (Total = 10 practicals)

Group 1 : Any-4

1 Demonstration of Arduino Uno Board, Its Various Components, Pins

2 Installation Arduino Software (IDE) on computer, Introduction to Sketch, Loading of Program from computer, Simple programs: Hello Word, Blinking of LED on Arduino board etc.

3 Interfacing external LED (ON & OFF); Fading of LED

4 Analog Read Serial: 1. Read a potentiometer, print its state out to the Arduino Serial Monitor. 2. Read an analog input and prints the voltage to the Serial Monitor.

5 Digital Read Serial: Interfacing a switch, Read a switch, print the state out to the Arduino Serial Monitor.

6 Digital: Interfacing push Button: Use a push button to control an LED or Buzzer

7 Digital : State Change Detection: Count the number of button pushes.

8 Analog In Out Serial: Read an analog input pin, map the result, and then use that data to dim or brighten an LED.

Group 2 : Any 4

9 Knock: Detect knocks with a piezo element.

10 Interfacing of Ultrasonic Sensor, Detect objects with an ultrasonic range finder.

11 Interfacing of Proximity Sensor

12 Interfacing of Temperature & Humidity Sensor : To interface DHT11 sensor for recording temperature and humidity readings with Arduino.

14 Interfacing LCD display with Arduino

Interfacing of Relay Switch and Servo Motor with Arduino

15 Interfacing Bluetooth Module to Arduino

16 Interfacing of Motion (PIR Sensor) or Light Sensor using (LDR & LED) or Gas Sensor (MQ-2) with Arduino **OR**

Part II (B): Arduino Programming (Practical / Demonstration)

Project : any-1 Simple Projects Using Arduino Uno Board [24 L]

1 Line Following Robot with Arduino

2 Obstacle Avoiding Robot with Arduino

3 Weather Station using Arduino

4 Home Automation using Arduino

5 Android Based Air quality Monitor

6 Intelligent automatic irrigation system

References:

1. www.arduino.cc
2. https://www.arduino.cc/en/Tutorial/BuiltInExamples
3. https://create.arduino.cc/projecthub.

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

PHY-291-MN-TH: Concepts of Modern Physics

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

Learning Outcomes: On successful completion of this course the students will be able to

- **Understand** the limitations of classical physics and the need for modern physics.
- **Explain** the concepts of special relativity and its implications on time and space.
- **Apply** quantum theory to phenomena like the photoelectric effect and de Broglie waves.
- **Describe** atomic models and interpret atomic spectra.
- **Analyze** nuclear reactions and understand the principles of radioactivity.
- **Identify** fundamental particles and comprehend their interactions.
- **Relate** modern physics concepts to real-world applications in technology and medicine.

Unit	Title and Contents	No. of lectures in Clock Hours
1	**Introduction to Modern Physics & Special Relativity** Limitations of classical physics, Einstein's postulates of special relativity, Time dilation and length contraction, Relativistic addition of velocities, Mass-energy equivalence ($E = mc^2$). **Problems.**	**08 hrs**
2	**Quantum Theory** Blackbody radiation and Planck's hypothesis, Photoelectric effect and Einstein's explanation, de Broglie hypothesis and matter waves, Heisenberg's uncertainty principle, Wave-particle duality, Schrödinger's wave equation (time-independent), Particle in a box model	**10 hrs**

	Problems.	
3	**Atomic Models and Spectra** Rutherford's and Bohr's atomic models, Hydrogen spectrum, Quantum numbers and atomic orbitals (qualitative), Stern-Gerlach experiment. **Problems**	**06 hrs**
4	**Nuclear Physics** Nuclear structure and properties, Binding energy and mass defect, Radioactive decay laws (α, β, γ decay), Half-life and mean life, Applications of radioactivity. **Problems.**	**06 hrs**

Reference Books:

1. “Concepts of Modern Physics" by Arthur Beiser.
2. "Fundamentals of Physics" by Halliday, Resnick, and Walker.
3. "Modern Physics" by R. Murugesan.
4. "Modern Physics for Scientists and Engineers" by Thornton and Rex.
5. "University Physics" by Young and Freedman.

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

PHY-292-MN-PR: Basic Physics Laboratory-II

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

Learning Outcome: After completing this practical course students will be able to

- Demonstrate proficiency in conducting modern physics experiments.
- Analyze experimental data and draw meaningful conclusions.
- Understand the practical applications of theoretical concepts.
- Develop skills in using various laboratory instruments and equipment.
- Communicate experimental findings effectively through reports and presentations.

Section I: Optics, Wave Phenomena, Quantum and Atomic Physics

1. Determination of wavelength using a diffraction grating.
2. Study of Lissajous figures using a cathode ray oscilloscope (CRO).
3. Measurement of the refractive index of a prism using a spectrometer.
4. Determination of Planck's constant using the photoelectric effect.
5. Determination of the energy gap of a semiconductor.
6. Study of the characteristics of a solar cell.
7. Study of Newton's Rings and determination of the radius of curvature.
8. Measurement of diameter of thin wire using laser diffraction.

Section II: Nuclear Physics, Modern Physics

1. Verification of inverse square law of radiation.
2. Measurement of the absorption coefficient of gamma rays.
3. Study of the gamma spectrum using a scintillation counter.
4. Determination of the energy of beta particles.
5. Measurement of the divergence of a laser beam.
6. Measurement of resistivity of material by Four probe method.
7. Study of the Franck-Hertz experiment.
8. e/m ratio using Thomson method.
9. Verification of Stefan’s law of radiation.

Additional Activities (Any two)

1. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student).
2. Any two computer aided demonstrations (Using computer simulations or animations).
3. Demonstrations –Any two demonstrations.
4. Study tour with report.
5. Mini project.

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments. Total laboratory work with additional activities should be 15-experiments.

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

SEC-251-PHY-PR: Optometry

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

(Any 12 experiments + 3 Experimental Activities)

Learning Outcomes:

1. Understand and apply the laws of reflection.
2. Investigate the characteristics of images formed in plane, concave and convex mirrors.
3. Explore image formation with concave and convex lenses.
4. Investigate the combined effects of multiple lenses.
5. Understand the working principle of simple and compound microscopes and telescopes.
6. Study of spectrometer
7. Use of prism to study reflection, refraction, and dispersion.

Unit	Title and Contents
1.	Study of law of reflection using plane mirror
2.	Focal length of convex mirror
3.	Focal length of concave mirror
4.	R.I. of of liquid using concave mirror/concave lens
5.	Study law of refraction using glass slab and
6.	Radius of curvature of a lens
7.	Focal length and power of convex lens
8.	Focal length and power of concave lens
9.	Focal length and power of equivalent lens of combination of two lenses
10.	Magnifying power of simple microscope
11.	Magnifying power of compound microscope
12.	Magnifying power of telescope
13.	Angle of glass prism using spectrometer
14.	R.I of glass prism using spectrometer
15.	Dispersive power of prism
16.	Study of total internal reflection

Additional Activities to be conducted related to subject (Any-3)

1. Mini Projects with report.
2. Industrial /Research organization /Working organization /Field visit with report.
3. Any one computer aided demonstrations (Using computer simulations or animations).
4. Demonstrations – Any one demonstrations.

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments. Total laboratory work with additional activities should be 15-experiments.

References Books:

1. Text Book of Optics by Subrahmanyam, Brij Lal & Avadhanulu
2. Optics/7th Edition by Ajoy Ghatak.
3. Concepts of Physics" by H.C.Verma.

The Poona Gujarati Kelavani Mandal's
HARIBHAI V. DESAI COLLEGE
of Arts, Science & Commerce (Autonomous)
Affiliated to Savitribai Phule Pune University
(Linguistic Minority Institution) AICTE NO. : 1-44457797714
ID No.: PU / PN / ASC / 057/ (1984)
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BOS in PHYSICS

Restructured Syllabus (CBCS Pattern as per NEP 2020)

To be implemented from Academic Year: 2026-27

Faculty	**Science**
Program	**B.Sc (Physics)**
Class	**T.Y.B.Sc**

Semester wise syllabus

Semester	Course Code	Type of Course	Course Title	Theory/ Practical	Credits	No. of clock hours per week
V	PHY-301-MJ-TH	Compulsory Course	Mathematical Methods in Physics-II	Theory	02	02
	PHY-302-MJ-TH		Electrodynamics	Theory	02	02
	PHY-303-MJ-TH		Classical Mechanics	Theory	02	02
	PHY-304-MJ-TH		Atomic and Molecular Physics	Theory	02	02
	PHY-305-MJ-PR		General Physics Lab-V	Practical	02	04 per batch
	PHY-306-MJ-PR		General Physics Lab-VI	Practical	02	04 per batch
	PHY-311-MJ-TH	Major Elective	Renewable Energy Sources-I	Theory	02	02
	PHY-312-MJ-PR		Renewable Energy Sources-I	Practical	02	04 per batch
	PHY-321-VSC-PR	Vocational Skill Course	Computational Physics using C Programming	Practical	02	04 per batch
	PHY-331-FP-PR	FP/CEP	Field Project-II	Practical	02	04 per batch
		Minor		Theory	02	02

Total					22	
Semester	**Course Code**	**Type of Course**	**Course Title**	**Theory/ Practical**	**Credits**	**No. of clock hours per week**
VI	PHY-351-MJ-TH	**Compulsory Course**	Solid State Physics	Theory	02	02
	PHY-352-MJ-TH		Quantum Mechanics	Theory	02	02
	PHY-353-MJ-TH		Thermodynamics and Statistical Physics	Theory	02	02
	PHY-354-MJ-TH		Nuclear Physics	Theory	02	02
	PHY-355-MJ-PR		General Physics Lab-VII	Practical	02	04 per batch
	PHY-356-MJ-PR		General Physics Lab-VIII	Practical	02	04 per batch
	PHY-361-MJ-TH	**Major Elective**	Renewable Energy Sources-II	Theory	02	02
	PHY-362-MJ-PR		Renewable Energy Sources-II	Practical	02	04 per batch
	PHY-371-VSC-PR	**Vocational Skill Course**	Python Programming	Practical	02	04 per batch
	PHY-381-OJT-PR	**OJT**	On Job Training	Practical	04	04 per batch
Total					**22**	

Dr. Sagar S. Jagtap

Head, Department of Physics

Third Year B.Sc. Program in Physics

(Faculty of Science & Technology)

T.Y.B.Sc. (Physics)

To be implemented from Academic Year 2026-2027

Salient Features of Revised Syllabi in Physics As far as possible to promote:

1) **Physics Education through Master Texts:** It helps in understanding the theoretical and mathematical development of the subject and to create interest in the subject.

2) **Physics Education through Experimentation:** It helps in general to improve scientific attitude. So emphasis is given on the development of experimental skills, data analysis, calculations, and also on the limitations of the experimental method and data and, results obtained.

3) **Physics Education through Problem Solving**: It helps in understanding the concepts of physics. It underline the strength of equations, formulae, graphs, mathematical tools to tackle the problems. So accordingly, we have introduced compulsory problem part in the question paper.

4) **Physics Education through History and Philosophy**: It helps in understanding the conceptual development of the subject and thereby increase the interest in the subject. A topic on this is introduced in the Physics Course.

5) **Physics Education through Awareness of Misconceptions**: It improves the scientific awareness among the students. A discussion on different subjects are encouraged.

6) **Physics Education through Proto-research**: It creates interest in the subject and improves technological aspect. Accordingly, mini projects, hands-on activities, projects, models and demonstrations etc. is included in the syllabi.

7) **Physics Education through Qualitative Overview**: It creates interest in the subject to continue to work in the field of science in general and physics in particular. Accordingly future directions and frontiers of the subject are included in the syllabi.

8) **Structure of Question paper:** Existing structure shall continue.

9) **ATKT Rules**: Existing rules shall apply.

Semester-V

T.Y.B.Sc. (Physics) (Sem-V)

PHY-301-MJ-TH: Mathematical Methods in Physics-II

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

Learning Outcomes:

After the completion of this course students will be able to

1. Learn the different coordinate systems and the differential operators.
2. Solve ordinary and partial differential equations
3. Understand the concept of relativity and importance of transformation equations
4. Solve various properties of special functions
5. Learn various easy methods to solve complicated differential equations
6. Know the significance of mathematical methods in Physics

Unit	Title and Contents	No. of lectures
1	**1: Curvilinear Co-ordinates (8L)** Cartesian, spherical and cylindrical co-ordinate systems with examples in Physics, transformation equation, General Curvilinear co-ordinate system: Co-ordinate surface, co-ordinate lines, length, surfaces and volume elements in curvilinear co-ordinate system. Orthogonal curvilinear co-ordinate system, expressions for gradient, divergence, Laplacian, and curl, special case for gradient, divergence and curl in Cartesian, spherical polar and cylindrical co-ordinate system, Problems.	**08 hrs**
2	**2: The Special Theory of Relativity (6L)** Introduction and applications, Newtonian relativity, Galilean transformation equation, Michelson Morley experiment, Postulates of special theory of relativity, Lorentz transformations, Kinematic effects of Lorentz transformation, Length contraction, Proper time, Problems.	**06 hrs**
3	**3: Partial Differential Equations (10L)** Ordinary differential equations (ODE) and Partial differential equations (PDE) with examples of Physics, General methods for solving second order PDE, Method of separation of variables in Cartesian, Spherical polar and cylindrical co-ordinate system (two dimensional Laplace's equation, one dimensional Wave equation), Singular points (x = x0), Solution of ordinary differential equation-Statement of Fuch's theorem, Frobenius method of series solution, Singularity of Legendre, Hermite, Bessle, and Laguerre dufferential equations	**10 hrs**
4	**4: Special Functions (06L)** Introduction, generating function for Legendre Polynomials: Pn(x), Properties of Legendre Polynomials, Generating function for Hermite Polynomials: Hn(x), Properties of Hermite Polynomials, Bessel function	**06 hrs**

	of first kind: Jn (x), Properties of Bessel function of first kind, Applications of Special Functions in Physics, Problems.	

Reference books:

1. Mathematical methods for physicists, Arfken and Weber, Acadmic press Newyork, 7th Edition.

2. Mathematical physics, Rajput, Pragati prakashan-1997.

3. Mathematical methods in the physical sciences – Marry L. Boas, John Willy & Sons publication, 3rd Edition-2005.

4. Introduction to special relativity, Robert Resnick, John Wiley & Sons, Inc.-1968.

5. Mathematical physics, B. D. Gupta, Vikas publishing house Pvt. Ltd., 4th edition-2010.

6. Mathematical physics, H. K. Dass, Dr. Rama Varma, S. Chand & Company Pvt. Ltd.,7th Edition 2014 7. The Special Theory of Relativity: A Mathematical Approach-Farook Rahaman, Springer Publication -2014.

T.Y.B.Sc. (Physics) (Sem-V)

PHY-302-MJ-TH: Electrodynamics

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

Learning Outcomes:

After the completion of this course students will be able to

1. Solve the problem of electric field intensity and electric potential due to free and bound charges.
2. Derive the relation between different parameters of electrostatics in dielectric material
3. Learn the boundary conditions in electrostatics and magnetostatics
4. Apply different laws of magnetostatics to obtain magnetic field due to current carrying materials.
5. Get the introduction to Electromagnetic induction, Maxwell's equations, and Poynting vector

Unit	Title and Contents	No. of lectures
1	**1: Electrostatics (08 L)** a. Coulomb's law, Superposition principle, Electric field intensity due to point charge and group of charges, Electrostatic Potential, Potential energy of system of charges b. Gauss's law of electrostatic with proof. c. Statement of Poisson's and Laplace's equation, Boundary Value problems in electrostatics- Solution of Laplace equation in Cartesian system, Boundary conditions, Problems.	**08 hrs**
2	**2. Electrostatic in Dielectric Material (06L)** a. Electric field intensity and electric potential at a point due to dipole b. Torque acting on an electric dipole c. Polar and non-polar dielectric materials d. Polarization P, Electric displacement D, Electric susceptibility and dielectric constant, bound volume and surface charge densities. e. Electric field at an exterior and interior point of dielectric f. Gauss's law in dielectrics, Problems.	**06 hrs**
3	**3: Magnetostatics (10 L)** a. Magnetic induction, magnetic flux and magnetic field. b. Magnetic induction due to straight current carrying conductor, magnetization of matter, relationship between B, H and M. c. Boundary conditions at the interface of two magnetic media (Normal and tangential components). d. Biot-Savart's law, Ampere's force law, Magnetic force between two current carrying loops, Ampere's circuital law. e. Gauss's law in magnetostatics f. Equation of continuity, Magnetic vector potential A, Magnetic susceptibility and permeability, Problems	**10 hrs**
4	**4: Electrodynamics (06 L)** a. Electromagnetic induction, Faradays law of induction, Lenz's law, displacement current, generalization of Amperes' law. b. Maxwell's equations (Differential and Integral form) and their physical significance.	**06 hrs**

	c. Polarization, reflection and refraction of electromagnetic waves through media. d. Wave equation and plane waves in free space. e. Poynting theorem and Poynting vector, Problems	

Reference Books:

1. Introduction to Electrodynamics; D. J. Griffith; Cambridge India; Fourth edition (2020)

2. Classical Electrodynamics; J. D. Jackson; Wiley; Third edition (2007)

3. Introduction to Electrodynamics; A. Z. Capri, Panat P. V.; Alpha science international ltd; Illustrated edition(2002)

4. Foundations of electromagnetic theory; Reitz, Milford and Christy; Pearson education India; Fourth edition (2010)

5. Electrodynamics; Gupta, Kumar, Singh; Pragati Prakashan; Ninteenth edition (2011)

6. Electromagnetic field and waves; Paul-Lorrain, D. R. Corson; W.H. Freeman & co. Ltd; Second edition (1970)

7. Electricity and magnetism; Murugeshan; S. Chand; (2020)

8. Electromagnetic theory and electrodynamics; Satya Prakash; Kedar Nath Ram Nath; (2020)

T.Y.B.Sc. (Physics) (Sem-V)

PHY-303-MJ-TH: Classical Mechanics

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

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. Analyze the motion of particles under electric, magnetic, and central force fields using principles of classical mechanics and to apply conservation laws (linear momentum, angular momentum) to systems of particles and dynamical problems.
2. Explain and derive Kepler's laws of planetary motion and describe the dynamics of artificial satellites.
3. Distinguish between elastic and inelastic scattering and evaluate scattering parameters such as cross-sections and impact parameter.
4. Formulate and solve mechanical problems using Lagrangian and Hamiltonian approaches, including constrained systems and generalized coordinates.
5. Solve advanced numerical problems in particle dynamics, central force motion, scattering theory, and analytical mechanics.
6. Students will be able to demonstrate introductory awareness of AI and machine learning concepts and their basic applications in classical mechanical systems.

Unit	Title and Contents	No. of lectures
1	**1: Mechanics of system of particles** Applications of Newton's laws of motion - a. Projectile motion b. Charged Particles: Lorentz force, Motion of a charged particle in constant electric and magnetic field c. System of particles: Concept of Centre of mass, Conservation of linear momentum, angular momentum (statements only) d. Introductory AI in Classical Mechanics e. Machine Learning for Trajectory Prediction (Regression models for projectile motion and orbit estimation). f. Problems	**08 hrs**
2	**2: Central force Field** a. Central force Field: Definition and Properties of central force field. Reduction of two body problem to an equivalent one body problem b. Motion in central force field, c. Kepler's laws of planetary motion and their proof d. Artificial satellite and its orbit e. Problems.	**08 hrs**

3	**3: Scattering of particles** a. Elastic and inelastic scattering: Definition and properties, b. Elastic scattering - Laboratory and center of mass system. c. Scattering: Scattering angles in laboratory and center of mass system. d. Differential cross-section, impact Parameter, total cross-section in brief. e. AI-based Classification in Scattering Experiments (Basic classification algorithms for elastic and inelastic events). f. Problems	**06 hrs**
4	**4: Langrangian and Hamiltonian formulation** a. Limitations of Newton's Law of Motion, b. Constraints and Their Classification, Example of Constrains, degrees of freedom, generalized coordinate, configuration space, c. Principle of Virtual work done, d. D'Almeberts Principle of virtual work, e. Langrangian equation from D' Alembert's principle, cyclic coordinates, f. Phase space, Hamiltonian's equations g. Problems	**08 hrs**

Reference books:

1. Classical Mechanics, J.C. Upadhyaya, Himalaya publishing Houses, 2nd Edition of 2005.
2. Introduction to Classical Mechanics, R. G. Takawale, P. S. Puranik, Tata McGraw Hill publishing Company Ltd., New Delhi.
3. Classical Mechanics, NC Rana and PS Joag, Tata McGraw Hill Education Private Limited, New Delhi, 1991.
4. Classical Mechanics by P.V.Panat.
5. Classical Mechanics, Herbert Goldstein, Narosa Publishing House.
6. Classical Mechanics – H. Goldstein
7. Classical Mechanics – J. R. Taylor
8. Machine Learning – Tom M. Mitchell
9. Introduction to Machine Learning with Python – Andreas C. Müller & Sarah Guido

T.Y.B.Sc. (Physics) (Sem-V)

PHY-304-MJ-TH: Atomic and Molecular Physics

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

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. Understand atomic structure, vector atom model, space quantization, electron spin, Pauli Exclusion Principle, and electronic configurations.
2. Explain spin–orbit interaction, spectral terms, selection rules, and spectra of one and two valence electron systems (Na and He atoms).
3. Describe LS and JJ coupling schemes, singlet–triplet separation, and Lande's interval rule.
4. Understand normal and anomalous Zeeman effect, Stark effect (qualitative), and their experimental arrangements and applications.
5. Explain molecular spectra including rotational, vibrational, and electronic spectra of diatomic molecules and applications of UV-Visible spectroscopy.
6. Describe the classical and quantum theory of Raman effect and applications of Raman spectroscopy.
7. Solve numerical problems related to atomic spectra, coupling schemes, Zeeman effect, and molecular spectroscopy.

Unit	Title and Contents	No. of lectures
1	**Atomic structure** 1. Revision of various atomic models 2. Vector atom model (Concepts of space quantization and electron spin) 3. Pauli Exclusion Principle and electron configuration, Quantum states, Spectral notations of quantum states. 4. Problems, AI in atomic structure.	**04 hrs**
2	**One and Two Valence electron systems** 1. Spin-Orbit Interaction (Single valence electron atom), Energy levels of Na-atom, Selection rules, Spectra of sodium atom, Sodium doublet. 2. Spectral terms of two electron atoms, terms for equivalent electrons, LS and JJ-coupling schemes. 3. Singlet-Triplet separations for interaction energy of LS coupling, Lande's interval rule, Spectra of Helium atom. 4. Problems	**08 hrs**

3	**Zeeman Effect** 1. Zeeman Effect 2. Experimental arrangement 3. Normal and anomalous Zeeman Effect 4. Stark effect (Qualitative discussion) 5. Applications of Zeeman effects 6. Problems, AI in Zeeman Effect.	**04 hrs**
4	**Molecular spectroscopy** 1. Introduction of molecular spectra and its types 2. Rotational energy levels, Rotational spectra of rigid diatomic molecule 3. Vibrational energy levels 4. Rotational and Vibrational spectra 5. Electronic spectra of molecules 6. Applications of UV-Vis spectroscopy 7. Problems	**08 hrs**
5	**Raman spectroscopy** 1. History of Raman effect, Molecular polarizability 2. Classical theory and Quantum theory of Raman Effect 3. Characteristics Raman Lines and Applications of Raman spectroscopy 4. Problems, AI in Raman effect.	**06 hrs**

Reference books:

1) R. Murugeshan, Er. K. Sivaprasath, Modern Physics, S. Chand, 2014, Revised edition

2) Robert Eiseberg, Robert Resnik, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley, 2016, 2nd edition

3) G. Aruldhas, Molecular structure and Spectroscopy, PHI, 2015, 2nd edition

4) Colin Banwell, Elaine McCash, Fundamentals of Molecular Spectroscopy, TMH, 4th ed

5) Arthur Baiser, Concepts of Modern Physics , McGraw Hill International, 4th edition

6) White H. E, Introduction to Atomic spectra, McGraw Hill International.

T.Y.B.Sc. (Physics) (Sem-V)

PHY-305-MJ-PR: General Physics Lab-V

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

(General Physics & Electromagnetism) **(12 Experiments)**

	General Physics **(ANY SIX)**
1.	Kater's pendulum
2.	Young's modulus by Koeing method
3.	Young's modulus by Newton's rings
4.	Determination of Y and η by flat spiral spring
5.	Determination of Y by bending method.
6.	Moment of Inertia by Bifilar suspension
7.	Study of Poisson's ratio of rubber using rubber tube /rubber chord
8.	Surface tension liquid by Fergusson method
9.	Surface tension of mercury by Quincke's method
10.	Determination of coefficient of Viscosity by Poiseuille's
11.	Viscosity of Liquid by rotating cylinder method.
	Electromagnetism **(Any SIX)**
1.	To determine the dielectric constant of a given dielectric material
2.	Self-Inductance by Maxwell's bridge
3.	Self-Inductance by Anderson's bridge
4.	To study mutual inductance between two coils
5.	Core losses in transformers
6.	Electromagnetic pendulum
7.	To determine the inductance of a coil using an LCR bridge
8.	To measure magnetic susceptibility of given material by Gouy's method.
9.	Study of Hysteresis curve of ferromagnetic material
10.	To find horizontal component of Earth's magnetic field using magnetometer.

Additional Activities (Any THREE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments
- Study tour with report equivalent to 2 experiments
- Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations) (Any 2 demonstrations equivalent to 2 experiments)

Note: Students have to perform ten experiments or one additional activities in addition to 12 experiments mentioned above. Total laboratory work with additional activities should be equivalent to 15 experiments.

T.Y.B.Sc. (Physics) (Sem-V)

PHY-306-MJ-PR: General Physics Lab-VI

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

(Acoustic, Optics & Atomic Molecular Physics) **(12 Experiments)**

	Acoustic	**(Any Four)**
1.	Frequency response of loudspeaker (twitter, woofer, mid-range)	
2.	Study of interference by Quinck's method	
3.	Use of Ultrasonic interferometer to measure velocity of sound in liquids	
4.	Transmission loss using expansion chamber muffler.	
5.	Directional characteristics of Microphone.	
6.	Velocity of sound by Phase shift method.	
	Optics	**(Any Four)**
7.	Determination of Resolving Power of grating	
8.	Determination of wavelength by Constant deviation spectrometer	
9.	Llyod's mirror	
10.	'μ' By total internal reflection of light	
11.	Young modulus using Newton's ring method	
12.	To determine the speed of light	
	ATOMIC AND MOLECULAR PHYSICS	**(Any Four)**
13.	Determination of Rydberg's constant	
14.	Zeeman Effect	
15.	Energy band gap using UV-Visible spectroscopy	
16.	To study absorption spectra of Iodine molecule and to determine its dissociation energy using spectrometer	
17.	To study the Electron Spin Resonance and determine Lande's g-factor	
18.	Study of Frank Hertz experiment	
19.	Study of Raman spectroscopy	

Additional Activities (Any THREE)

- Demonstrations: Any 2 demonstrations equivalent to 2 experiments o
- Study tour with report equivalent to 2 experiments o Mini project equivalent to 2 experiments
- Computer aided demonstrations (simulations or animations) (Any 2 demonstrations equivalent to 2 experiments)

Note: Students have to perform ten experiments or one additional activities in addition to 12 experiments mentioned above. Total laboratory work with additional activities should be equivalent to 15 experiments.

T.Y.B.Sc. (Physics) (Sem-V)

PHY-311-MJ-TH: Renewable Energy Sources-I

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

Learning Outcomes: After successful completion of this course, students will be able to:

1. **Understand and classify different energy sources**, especially solar and renewable energy systems.
2. **Explain solar radiation concepts** and their role in energy availability on Earth.
3. **Describe the principles and working of solar thermal devices** and their practical uses.
4. **Understand photovoltaic technology**, including solar cells, modules, efficiency, and applications.
5. **Analyze factors influencing the performance** of solar energy systems.
6. **Recognize the need for and methods of energy storage**, including batteries, supercapacitors, and hydrogen systems.

Unit	Topics	Lectures
1	**An Introduction to Energy Sources:** 1. Energy: Definition, Classifications of energy sources 2. Conventional and non-conventional energy sources. 3. Sun: The source of energy (Structure, Characteristics and Composition) 4. Solar Constant 5. Electromagnetic Energy Spectrum. 6. Solar radiations outside earth atmosphere. 7. Solar radiation at the earth surface. 8. Problems 9. Artificial Intelligence (AI) applications in Energy sourses	**08**
2	**Photothermal Applications:** 1. Photothermal devices: Solar Insolation, Selective Coating, Glass Cover, Heat Conductor and Heat Insulation. 2. Solar water heating systems: Types, construction and working of Liquid Flat Plate Collector (FPC) and Evacuated Tube Collector (ETC) 3. Energy Balance Equation (without thermal Analysis). 4. Concentrating collectors: Flat plate collector with plane reflector, Cylindrical parabolic, Compound parabolic, Collector with fixed circular concentrators and moving receiver, paraboloid concentrator. 5. Comparative study between flat plate collector and solar concentrators. 6. Solar distillation, Solar dryer, Solar cooker (box type)	**08**

3	**Photovoltaic systems:** 1. Introduction to Photovoltaic effect and Photovoltaic Conversion. 2. Basic photovoltaic system for power generation 3. Basics of Solar Cell, PV modules, Arrays, 4. Solar Cell: I-V characteristics, Power output and conversion efficiency. 5. Factors affecting on photovoltaic efficiency. (Change in amount of input light, solar cell area, change in angle, Change in operating Temperature etc.) 6. Types of solar cells: p-n junction solar cell, p-i-n diode solar cell, cadmium sulphide solar cell, Gallium arsenide solar cell, Indium phosphide solar cell, nano-crystalline solar cell. 7. Application of solar photovoltaic systems. 8. How Artificial Intelligence (AI) is useful in solar photovoltaic applications.	**08**
4	**Energy Storage:** 1. Importance and Needs of Energy storage in Conventional and Nonconventional Energy Systems. 2. Various forms of Energy Storage 3. Electrical Energy: Super capacitors 4. Electrochemical Energy: Battery 5. Chemical Energy: Hydrogen Production and storage 6. Role of Artificial Intelligence (AI) in Energy Storage	**06**

Reference Books:

1. Non-conventional Energy sources, G. D. RAI (4th edition), Khanna Publishers, Delhi.
2. Solar Energy, S.P. Sukhatme (second edition), Tata Mc. Graw Hill Ltd, New Delhi.
3. Solar Energy Utilizations**,** G. D. RAI (5th edition), Khanna Publishers, Delhi.
4. Energy Storage: Fundamentals, Materials and Applications, by Huggins R. A., Springer
5. Chemical and Electrochemical Energy System by R. Narayan and B. Viswanathan, University Press.
6. Battery Systems Engineering by C. D. Rahn and C. Wang, Wiley Pub.
7. Electrochemical Energy Storage for Renewable sources and grid balancing by P. T. Moseley and J. Garche, Elsevier Science.
8. Solar Photovoltaic Technology and Systems by C S Solanki

T.Y.B.Sc. (Physics) (Sem-V)

PHY-312-MJ-PR: Renewable Energy Sources-I

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

Any 15 practical's are compulsory to perform out of the list given below. Out of 15 practical's, 03 practical's are equivalent to laboratory/industry visit. A educational visit activity is compulsory with report writing and submission.

Learning Outcomes: After successful completion of this course, students will be able to:

1. **Measure and analyze solar radiation parameters** and understand their effect on solar energy utilization.
2. **Operate and evaluate solar thermal devices** such as solar cookers, dryers, water heaters, and distillation units.
3. **Determine electrical characteristics of photovoltaic systems**, including I–V curves, power output, and efficiency of solar cells/panels.
4. **Investigate the influence of environmental and design factors** (tilt angle, light intensity, temperature, load conditions) on PV performance.
5. **Examine energy storage systems** by studying charging–discharging behavior of batteries and supercapacitors used in renewable setups.
6. **Apply renewable energy concepts in practical situations**, including small solar applications and basic energy audit or efficiency analysis.

List of Practical's:

A. Basics of Solar Radiation & Energy Sources

1. To measure the intensity of solar radiation using a lux meter / solar power meter at different times of the day.
2. To estimate the solar constant using available radiation data (calculation-based practical).
3. To study of variation of solar intensity with tilt angle of a solar panel.

B. Photothermal Applications

4. To study the construction and working of Flat Plate Collector (FPC) using a demonstration model or actual system.
5. To study the performance of solar water heater (temperature rise vs time).
6. To determine the efficiency of box type solar cookers.
7. To study the solar dryer system and measure the drying rate of a sample material.
8. To study the solar distillation system and estimate the distilled water output.
9. To calculate the thermal efficiency of liquid flat plate collector (ETC/FPC).
10. To study the box type solar cooker.

11. To determine the thermal efficiency of parabolic solar cooker.

C. Photovoltaic Systems

12. To study the I-V characteristics of a solar cell and determine maximum power point.
13. To determine the efficiency of a solar panel under given illumination.
14. To study the effect of light intensity on solar cell output (voltage/current vs intensity).
15. To series and parallel combination of solar cells/modules and study of output characteristics.
16. To study of basic standalone photovoltaic power system (panel–battery–load setup).
17. To calculate an efficiency and fill factor of PN junction solar cell.

D. Energy Storage

18. To study charging and discharging characteristics of a rechargeable battery.
19. To study supercapacitor charging/discharging curves and comparison with battery.
20. To estimate the energy storage capacity of a battery used with a solar panel.

E. Optional Skill Based Practical's (Recommended for Current Relevance)

21. Design and testing of a small solar-powered device (lamp/mobile charger).
22. To conduct the energy audit of a Classroom/Laboratory/Home to do the basic load calculation and saving suggestions.
23. To perform the comparative study of LED vs conventional lighting for energy efficiency.

Reference Books:

1. Non-conventional Energy sources, G. D. RAI (4th edition), Khanna Publishers, Delhi.
2. Solar Energy, S.P. Sukhatme (second edition), Tata Mc. Graw Hill Ltd, New Delhi.
3. Solar Energy Utilizations**,** G. D. RAI (5th edition), Khanna Publishers, Delhi.
4. Energy Storage: Fundamentals, Materials and Applications, by Huggins R. A., Springer
5. Chemical and Electrochemical Energy System by R. Narayan and B. Viswanathan, University Press.
6. Battery Systems Engineering by C. D. Rahn and C. Wang, Wiley Pub.
7. Electrochemical Energy Storage for Renewable sources and grid balancing by P. T. Moseley and J. Garche, Elsevier Science.
8. Solar Photovoltaic Technology and Systems by C S Solanki

T.Y.B.Sc. (Physics) (Sem-V)

PHY-321-VSC-PR: Computational Physics using C Programming

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

12 Theory lectures + Any 12 Practical's (48) = 60

Learning Outcomes: After successful completion of this course, students will be able to:

1. **Understand and apply programming fundamentals**
   Explain algorithm development, flowcharts, and the basic structure of C programs including data types, variables, and constants.
2. **Develop C programs using operators and control structures**
   Write programs using decision-making and looping statements to solve numerical and logical problems.
3. **Use arrays, pointers, and user-defined functions effectively**
   Implement arrays for data processing, apply pointers, and develop modular and recursive programs.
4. **Apply graphics concepts in C programming**
   Use basic graphic commands (Point, Line, Circle, Arc, Ellipse, Bar) to create simple graphical applications.
5. **Apply C programming to scientific and mathematical problem solving**
   Develop programs to solve problems related to physics and mathematics such as gas laws, projectile motion, thermodynamics, and sorting techniques.
6. **Demonstrate practical programming competence through experiments or project work**
   Design, implement, test, and execute C programs independently as part of practical or project components.

Instructions: This course consists of two parts • Part I: Theory • Part II: Practical.

Part I: Theory

Unit	Topics	Lectures
I : Introduction to C-programming	a) Definition and Properties of algorithms, Algorithm development, Flow charts- symbols and simple flowcharts. b) Introduction and Structure of C-program, 'C' Character set, key words, Constants and variables, Variable names, Data types, qualifiers and their declarations, Symbolic Constants. c) Input/output functions: scanf( ), printf( ), getchar(), putchar(), gets(), puts(). d) Operators and Expressions: Arithmetic Operators, Relational Operators, Logical Operators, Assignment Operators, Conditional Operator. e) Control statements: if, if else, while, do while, for loop, nested control structures (nested if, nested loops), break, continue, switch- case statement, goto statement.	06

II : Arrays, Pointers, user defined function and Graphics in C-Language	a) Arrays: 1-D, 2-D: Arranging numbers in descending and ascending order. b) Concept of pointers with suitable illustrative examples. c) Concepts of graphics in C, Some simple graphic commands- Point, Line, Circle, Arc, Ellipse, Bar with suitable illustrative examples.	06

Part II (A): C-Programming (Practicals) : Any 12 [48 L]

List of Practical's:

1. Program to find addition, subtraction, multiplication and division of two numbers.
2. Factorial of a number by successive multiplication method.
3. Program to find average of numbers.
4. Program to find out roots of a quadratic equation.
5. Position time data using kinematic equations
6. Write C program to find pressure using ideal gas equation of state.
7. Write C program to calculate the change in internal energy by using first law of thermodynamics.
8. Write C program to calculate pressure at one point using Bernoulli's equation.
9. Write a C program to find pressure using volume by Boyle's law.
10. Calculate efficiency of a heat engine using c programming.
11. Program to find rms velocity of a gas. Formula $c = \sqrt{\frac{3RT}{M}}$
12. To find vertical height and time of flight of projectile motion

    Formula: Vertical height $H = \frac{v^2 \sin\theta}{2g}$ Time of flight $\frac{2v \sin\theta}{g}$
13. Write a C program to calculate sum of odd numbers using array.
14. Write a C program to calculate minimum number using array.
15. Program to sort numbers in ascending order using array.
16. Write a C program to calculate factorial using recursion (user defined function)

Reference Books:

1. Programming in C- (Schaum's series), Gottfreid, TMH
2. Programming in C- Balgurusami, Prentice Hall publications
3. Let us C- Yashwant Kanetkar, BPB publications
4. Programming with C- K.R. Venugopal, S. R. Prasad, TMH.
5. Introductory methods of numerical analysis-S. Sastry, Prentice Hall
6. Computer oriented numerical methods – V. Rajaraman.

T.Y.B.Sc. (Physics) (Sem-V)

PHY-331-FP-PR: Field Project (FP)

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

Field project work will provide students with an 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 components will broaden the possibilities of deeper learning and enhancing research acumen of students. Field project broadens opportunities for 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 should 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:
9) References
10) Appendices

Chapter 1: Introduction

Chapter2: Literature Review

Chapter 3: Methodology

Chapter 4: Field Work Descriptions, Observations and Analysis

Chapter 5: Conclusion and Recommendations

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 = 10 marks

Overall Report quality = 10 marks

Total = 20 marks

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

Objectives, Literature Review, Methodology, Data Analysis, Conclusion	= 15 marks
Overall Project Report Structure	= 05 marks
Presentation Skills	= 10 marks
Total	= 30 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

Semester-VI

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-351-MJ-TH: Solid State Physics

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

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. **Understand crystal structure concepts** including lattice, unit cell, Bravais lattices, Miller indices, packing fraction, and reciprocal lattice.
2. **Explain X-ray diffraction techniques** and apply Bragg's law to analyze crystal structures.
3. **Describe free electron and band theory of solids**, including Fermi energy, density of states, and classification of metals, semiconductors, and insulators.
4. **Explain magnetic properties of materials** such as dia-, para-, ferro-, and antiferromagnetism, and basic concepts of superconductivity.
5. **Solve numerical problems** related to crystallography, diffraction, electronic properties, and magnetism.

Unit	Title and Contents	No. of lectures
1	**1: The Crystalline Structures** Lattice, Basis, Translational Vectors, Primitive Unit Cell, Symmetry Operations, Different types of lattices: 2D and 3D (Bravais lattices) Miller indices, Inter Planer Distances, SC, BCC and FCC structures, Packing Fraction, Crystal structures NaCl, diamond, CsCl, ZnS, HCP, Concept of Reciprocal Lattice and its properties, AI in Crystallography, Problems.	**08 hrs**
2	**2: X ray Diffraction and Experimental Methods** Bragg's Diffraction, Bragg's Law, Experimental X-ray diffraction Methods: The Laue Method, Bragg's Spectrometer, The Powder Crystal Method, Analysis of cubic structure by Powder Method, Ewald's Construction, Bragg's Diffraction condition in direct and reciprocal lattice, AI in X-ray diffraction, Problems	**08 hrs**
3	**3: Free Electron and Band Theory of Metals** Assumptions of Classical and Somerfield Free Electron model, Energy levels and Density of States (One and Three Dimensions), Nearly free electron model, Fermi energy, Fermi level, Hall Effect, Mobility, Hall Angle Band Theory of Solids: Origin of energy gap, Energy bands in Solids, Distinction between metal, semiconductor and insulator, Problems	**08 hrs**

4	**4: Magnetism** Diamagnetism, Langevin theory of Diamagnetism, Paramagnetism, Langevin theory of Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferromagnetic Domains, Hysteresis, Curie temperature, Neel temperature, AI in magnetism, Problems.	**06 hrs**

Reference books:

1. Solid State Physics S.O.Pillai, 6th Edition, New Age International (P) Ltd, Publisher, (2010).
2. Solid State Physics – Kakani S.L. and Hemrajani C, 4th Edition, S. Chand Publication (2005).
3. Fundamentals of Solid State Physics – B.S.Saxena, R.C.Gupta and P.N.Saxena, Pragati Prakashan, Meerut , Uttar Pradesh
4. Introduction to Solid State Physics- Charles Kittel, John Wiley and Sons, 7th Edition.
5. Solid State Physics- A.J.Dekker, Macmillan India Ltd, (1998).
6. Solid State Physics- R.K. Puri, V.K. Babbar, S. Chand Publication.
7. Elementary Solid State Physics Principles and Applications, M Ali Omar, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.(2006)
8. Problems and Solution in Solid State Physics-S.O. Pillai, New Age International (P) Ltd.
9. Solid State Physics, P.K. Palanisamy, Scitech Publications(India) Pvt Ltd, Chennei, 1st Edition (2004)
10. Solid State Physics: Essential Concepts, David W. Snoke, 2nd Edition, Cambridge University Press

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-352-MJ-TH: Quantum Mechanics

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

Course Learning Outcomes: After successful completion of this course, students will be able to:

1. Explain the origin of quantum mechanics through key experiments such as black body radiation, photoelectric effect, matter waves, and the uncertainty principle.
2. Interpret the physical meaning of the wave function and apply time-dependent and time-independent Schrödinger equations to quantum systems.
3. Apply quantum mechanical formalism to solve standard problems such as free particle, potential step and barrier, tunnelling, particle in a box, and rigid rotator.
4. Analyze quantum systems using operators, eigenvalues, eigenfunctions, and expectation values.
5. Apply the concepts of Hermitian operators, commutation relations, and parity in quantum mechanical formulations.
6. Develop problem-solving skills in quantum mechanics through mathematical modeling and interpretation of microscopic physical phenomena.
7. Students will be able to demonstrate introductory awareness of Artificial Intelligence concepts and their basic applications in quantum mechanics, including wave function modeling and fundamental ideas of quantum computing.

Unit	Title and Contents	No. of lectures
1	**1: Origin of Quantum Mechanics** 1. Historical Background: Black body radiation, photoelectric effects. 2. Matter waves - De Broglie hypothesis. Davisson and Germer experiment. 3. Wave particle duality, wave packet, phase velocity, group velocity and relation between them 4. Heisenberg's uncertainty principle with Electron diffraction experiment, different forms of uncertainty. 5. Different fields of applications of quantum mechanics 6. Problems	**08 hrs**
2	**2: The Schrodinger equation** 1. Physical interpretation of wave function 2. Schrodinger time dependent equation. 3. Schrodinger time independent equation (Steady state equation). 4. Requirements of wave function. 5. Probability current density, equation of continuity, and its physical significance. 6. Expectation value, Ehrenfest's theorem (Only statements) 8. Problems	**08 hrs**
3	**3: Applications of Schrodinger Steady state equation**	**08 hrs**

	1. Free particle. 2. Particle in infinitely deep potential well (one - dimension). 3. Step potential. 4. Potential barrier. (Qualitative discussion). Barrier penetration and tunnelling effect. 5. Rigid rotator (free axis). 6. Problems	
4	**4: Operators in Quantum Mechanics** An operator in Quantum mechanics, Eigen function and Eigen values. 1. Hermitian operator. 2. Position, Momentum operator, angular momentum operator, and total energy operator (Hamiltonian). 3. Commutator brackets- Simultaneous Eigen functions. 4. Commutator Algebra 5. Commutator bracket using position, momentum and angular momentum operator 6. Concept of parity according to quantum mechanics, parity operator and its Eigen values. 7. AI and Machine Learning for Quantum Systems • Regression for wave function/probability density fitting • Concept of function approximation 8. Introduction to Quantum Computing • Classical bit vs qubit • Superposition and measurement • Basic idea of quantum gates 9. Problems	**06 hrs**

Reference books:

1. Eisberg, Robert M., and Robert Resnick. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles. Wiley, 1985. ISBN: 9780471873730.
2. Liboff, Richard L. Introductory Quantum Mechanics. Addison Wesley, 2002. ISBN: 9780805387148.
3. Griffiths, David J. Introduction to Quantum Mechanics. Upper Saddle River, Pearson Prentice Hall, 2005. ISBN: 9780131118928
4. Feynman, Richard P., Robert B. Leighton, and Matthew L. Sands. The Feynman Lectures on Physics. Addison Wesley, 1989. ISBN: 9780201500646.
5. P M Mathews and K Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill publication, ISBN. : 9780070146174
6. N. Zettili, Quantum Mechanics- Concepts and applications, Wiley publication, ISBN: 978-0-470 02679-3
7. Ajoy Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer Publication, ISBN 978-1-4020-2130-5
8. G Aruldhas, Quantum Mechanics, Phi Learning Private Ltd., ISBN : 97881203363
9. Shankar, Ramamurti. Principles of Quantum Mechanics. Springer, 2008. ISBN: 9780306447907.
10. Gupta, Kumar & Sharma, Quantum Mechanics, Jai Prakash Nath Publications.
11. Quantum Computation and Quantum Information – Michael A. Nielsen & Isaac L. Chuang
12. Machine Learning – Tom M. Mitchell
13. Introduction to Machine Learning with Python – Andreas C. Müller & Sarah Guido

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-353-MJ-TH: Thermodynamics and Statistical Physics

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

Learning Outcomes:

After the completion of this course students will be able to

1. Understand the transport phenomenon in thermodynamics
2. Solve thermodynamic properties using Maxwell's equations
3. Use fundamental statistics for small and large scale distribution
4. Learn in detail the statistical ensemble and apply to the system of thermodynamics system and elementary particles
5. Distinguish between classical and quantum statistics.
6. Learn various distribution functions

Unit	Title and Contents	No. of lectures
1	**1: Transport phenomenon and Maxwell's relations:** Mean free path, Transport phenomenon, Viscosity, Thermal conductivity and diffusion. Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function, Gibb's function, Derivation of Maxwell Relations, Specific heat and latent heat equations, Joule Thomson effect (Throttling Process), Problems	**08 hrs**
2	**2: Elementary Concepts of Statistics:** Probability, distribution functions, Random Walk and Binomial distribution, Probability distribution for large-scale N, Gaussian probability distributions, Problems	**08 hrs**
3	**3: Statistical Distribution of System of Particles and Ensembles:** Specification of state of system, Statistical ensembles, Basic Postulates, Probability calculations, Behaviors of density of states, Thermal, Mechanical and general interactions Micro canonical Ensemble (Isolated System), Canonical ensembles, simple application of canonical ensemble, Molecules in Ideal gas, Calculation of mean values in canonical ensemble, Grand canonical ensemble Problems.	**08 hrs**
4	**4: Introduction to Quantum Statistics:** Quantum distribution function, Maxwell-Boltzmann's statistics, Bose-Einstein Statistics, Fermi-Dirac Statistics, Comparison of the distributions. Applications of Quantum Statistics, Impact of artificial intelligence (AI) in modern thermodynamics and thermodynamics AI, Problems.	**06 hrs**

Reference books:

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

2) F. Reif, Fundamentals of statistical and thermal physics

3) A. Beiser, Perspectives of modern physics

4) B.B. Laud, Fundamental of Statistical Mechanics

5) R.B. Singh, A primer of Statistical Mechanics

6) Gupta, Kumar, Statistical Mechanic

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-354-MJ-TH: Nuclear Physics

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

Course Learning Outcomes:

After successful completion of this course, students will be able to:

1. Understand the structure and properties of the nucleus, including nuclear forces, binding energy, stability of nuclei, and radioactive decay laws.
2. Explain different types of radioactivity, radioactive equilibrium, radiocarbon dating, and applications of radioisotopes in various fields.
3. Describe the working principles and classification of particle accelerators (LINAC, Cyclotron) and nuclear radiation detectors (G.M. counter, scintillation counter).
4. Explain nuclear forces, meson theory, elementary particles, quark model, and nuclear models such as shell model and liquid drop model.
5. Understand nuclear reactions, Q-value, nuclear cross-section, fission, fusion, chain reaction, and basic principles of nuclear reactors.
6. Solve numerical problems related to nuclear structure, radioactivity, nuclear reactions, and reactor theory.

Unit	Title and Contents	No. of lectures
1	**1: Nuclear Structure, Properties and Radioactivity:** Basic Concept of Nucleus: • Composition, charge, size, density of nucleus(Revision) • Nuclear Angular momentum, • Nuclear magnetic dipole moment • Electric quadrupole moment, Parity & symmetry, • Mass defect and Binding energy, packing fraction, • Classification of nuclei, • Stability of nuclei (N Vs Z Curve) and problems. Radioactivity: • Radioactivity disintegration (concept of natural and artificial radioactivity, Properties of α, β, γ-rays, Laws of radioactive decay, half-life, mean life, Specific activity and its units (Revision) • Successive disintegration and equilibriums and radioisotopes. • Radiocarbon dating • Application of radioactivity (Agricultural, Medical, Industrial, Archaeological). • Problems, AI in Radioactivity.	**08 hrs**
2	**2: Particle Accelerator and Radiation Detectors:** Particle Accelerators: • Introduction and Classification • Linear Accelerator (electron/proton LINAC) • Cyclic Accelerator (Cyclotron) • Particle Accelerators In India (Discussion only). Nuclear Detector: • Classification of Nuclear Detectors • Gas filled Detectors (G. M. counter) • Solid state detectors (scintillation counter) • Problems, AI in accelerator & nuclear detector.	**06 hrs**

3	**3: Nuclear forces and Nuclear Models:** Nuclear Forces: • Classification of Nuclear Forces • Meson theory of nuclear forces, • Properties Of nuclear forces, properties of deuteron system, Elementary particles, • Quarks model for elementary particles • Shell Model: Assumptions, Evidences, and Spin and Parity limitations. • Liquid drop model: Assumptions • Semi-empirical B.E. formula • Problems:	**08 hrs**
4	**4: Nuclear Reactions and Reactor Theory:** Introduction to Nuclear reactions: • Nuclear Reaction, Conservation laws (Revision) • The Q-value equation, Exothermic and Endothermic reaction • Compound nucleus • Threshold energy • Nuclear cross-section • Nuclear fission , nuclear fusion stellar energy, chain reaction and critical mass, • Nuclear reactor and its basic components, homogeneous and heterogeneous reactors, power reactor, fast breeders • Nuclear Reactors In India (Discussion only) • Problems, AI in nuclear reactor.	**08 hrs**

Reference books:

1. Dr. S. N. Ghoshal, Nuclear Physics, Revised Edition, S. Chand Publication, 2014

2. D. C. Tayal, Nuclear Physics, Revised Enlarged Edition, Himalaya Publishing House.

3. K.S. Krane, Introductory Nuclear Physics, Wiley, India, 1988

4. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill

5. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989

6. S.B. Patel, Nuclear Physics: An Introduction, New Age International, 1991

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-355-MJ-PR: General Physics Lab-VII

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

Learning Outcome: After completing this practical course students will be able to

- **Perform experiments confidently** related to solid state physics and thermal physics using proper laboratory methods.
- **Measure important physical quantities** such as band gap, Hall coefficient, thermal conductivity, specific heat, and related constants.
- **Understand the practical applications of theoretical concepts** like semiconductor behavior, heat transfer, gas laws, and statistical distributions.
- **Record observations correctly and analyze data** using graphs, calculations, and basic error estimation.
- **Use laboratory instruments properly** such as semiconductor devices, calorimeters, thermometers, and electrical measuring instruments.
- **Write clear and systematic practical reports** with proper results and conclusions.

Section-I: Solid State Physics (Any Six)

1. To determine the energy band gap of a semiconductor using PN junction diode characteristics.
2. To determine the Hall coefficient and charge carrier concentration of a semiconductor.
3. To determine the resistivity of a semiconductor using the four-probe method.
4. To study the current–voltage characteristics of a solar cell and determine its efficiency.
5. To determine the magnetic susceptibility of a paramagnetic material using Gouy's method.
6. To study the hysteresis loop of a ferromagnetic material using a CRO.
7. To determine the lattice constant of a crystal using X-ray diffraction data.
8. To determine Planck's constant using LED characteristics.
9. To determine the crystallite size using XRD data analysis.
10. To study the characteristics of a photodiode.
11. To determine the Seebeck coefficient of a thermocouple.
12. Study of Temperature Dependence of Semiconductor Resistance.

Section-II: Thermodynamics and Statistical Physics (Any Six)

1. To determine the thermal conductivity of a bad conductor using Lee's disc method.
2. To determine the thermal conductivity of a good conductor using Searle's apparatus.
3. To verify Newton's law of cooling.
4. To determine thermal conductivity of rubber/bad conductor.
5. Study of Statistical Error Analysis.
6. Determination of Standard Deviation in Data.
7. Study of Gaussian Distribution.
8. Determination of Poisson Distribution in Nuclear Counting.

9. Study of Platinum Resistance Thermometer (PRT).
10. Determination of Stefan's Constant.
11. Determination of pressure coefficient of air by constant volume thermometer.
12. Thermal conductivity by Forbes Method.
13. Thermal diffusivity of Brass.
14. Thermal and Electrical conductivity of Cu.
15. Viscosity of Liquid by rotating cylinder method.

Additional Activities (Any three)

1. Plotting of any two graphs using spreadsheets/Origin software (of data obtained from various experiments performed by the student)
2. Any two computer aided demonstrations (Using computer simulations or animations)
3. Demonstrations-Any two demonstrations
4. Study tour with report
5. Mini project

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments. Total laboratory work with additional activities should be 15-experiments.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-356-MJ-PR: General Physics Lab-VIII

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

Learning Outcome: After completing this practical course students will be able to

- Perform experiments to study **radioactive decay, nuclear radiation, and quantum phenomena**.
- Measure and analyze **physical constants** such as Planck's constant, work function, half-life, and decay constant.
- Operate **laboratory instruments safely**, including GM counters, scintillation detectors, and photodiodes.
- Understand and **verify fundamental principles** of nuclear and quantum physics experimentally.
- Collect, record, and **analyze experimental data** using graphs, calculations, and error estimation.
- Prepare **systematic lab reports** with observations, results, and scientific conclusions.

Section-I: Nuclear Physics (Any Six)

1. To study counting statistics using GM counter.
2. To determine dead time of GM counter.
3. To verify inverse square law for gamma radiation using GM counter.
4. To calculate linear attenuation coefficient using GM counter.
5. To calculate efficiency of detector using GM counter.
6. To measure the absorption coefficient of gamma rays using GM counter.
7. To measure the absorption coefficient of beta rays using GM counter.
8. To determine range & energy of beta particle using GM counter.
9. To calculate the half-life using graphical method using GM counter.
10. To measure background radiation using GM counter.
11. Determination of Activity of a Given Source using GM counter.
12. Determination of Operating Voltage & plateau length of GM Counter.
13. Energy Calibration of Cesium-137 source using NaI(Tl) detector.
14. Identification of Unknown Gamma Source using NaI(Tl) detector.
15. Determination of Energy Resolution of NaI(Tl) Detector
16. Determination of Relative Efficiency using NaI(Tl) detector.
17. Absolute Efficiency Determination using NaI(Tl) detector.
18. Determination of Linear Attenuation Coefficient using NaI(Tl) detector.
19. Determination of Mass Attenuation Coefficient using NaI(Tl) detector.
20. Determination of Activity of a Gamma Source using NaI(Tl) detector.
21. Efficiency Variation with Source-to-Detector Distance using NaI(Tl) detector.

Section-II: Quantum Mechanics & General Physics (Any Six)

1. To study photoelectric effect and determine work function.
2. To determine wavelength using diffraction grating.
3. Verification of Stefan's fourth power law by bulb filament.
4. To perform Frank–Hertz experiment.
5. Determine the divergence of a laser beam.

6. Study diffraction by a circular aperture or wire using laser.
7. Determine the wavelength of laser light using a Michelson interferometer.
8. Determination of Diameter of Laser Beam.
9. Determination of Refractive Index of Liquid using Laser.
10. Determination of Electron Charge-to-Mass Ratio (e/m).
11. Study of Millikan's Oil Drop Experiment.
12. Study of laser diffraction by metal ruler.

Additional Activities (Any three)

1. Plotting of any two graphs using spreadsheets/Origin software (of data obtained from various experiments performed by the student)
2. Any two computer aided demonstrations (Using computer simulations or animations)
3. Demonstrations-Any two demonstrations
4. Study tour with report
5. Mini project

Note: Students have to perform 12-experiments and participated in additional any three activities equivalent to 3-experiments. Total laboratory work with additional activities should be 15-experiments.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-361-MJ-TH: Renewable Energy Sources-II

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

Learning Outcomes: After successful completion of this course, students will be able to:

1. **Understand the principles of bioenergy and biofuels**, including biochemical, thermochemical, and transesterification routes for energy production from biomass.
2. **Describe the construction and working of biogas plants and biomass energy systems**, and evaluate factors affecting bio-digestion and gasification.
3. **Explain the fundamentals of wind energy conversion systems**, including types of wind machines, components, and analysis of wind data.
4. **Understand alternative energy sources** such as tidal and geothermal energy, their methods of utilization, and advantages and limitations.
5. **Explain the concepts and importance of energy management**, including strategies for energy conservation in industrial and commercial systems.
6. **Understand the role of energy audits**, energy managers, and basic measurement tools, and interpret simple energy audit case studies.

Unit	Topics	Lectures
1	**Bioenergy and Biofuels:** **Bioenergy:** 1. Introduction to Bioenergy 2. Basic Routs: Biochemical, Thermochemical, Transesterification 3. Biochemical- Biogas generation/methanation 4. Biogas plant: Floating gas holder and fixed dome type biogas plant, construction and working 5. Factors affecting on bio-digestion (list of factors). 6. Thermochemical: Pyrolysis, Gasification, Carbonization 7. Transesterification 8. Comparative study of floating gas holder and fixed dome type biogas plant. 9. Working of downdraft gasifier. 10. Various methods to obtain energy from biomass. **Biofuel:** 1. Introduction to Biofuels 2. Production of Biofuels (Jatropa and Sugar cane bagasse) * Advantages of Artificial Intelligence (AI) in Bioenergy.	08
2	**Wind Energy:** 1. Introduction to wind energy. 2. Principles and components of wind energy conversion system. 3. Classification of wind machines: Horizontal axial machine and vertical axial machine.	08

	4. Advantages and disadvantages of wind energy. 5. Wind data 6. Applications of Artificial Intelligence (AI) in Wind Energy technology.	
3	**Other Energy Sources:** 1. Introduction to tidal and geothermal energy. 2. Tidal energy: methods of utilization of tidal energy. 3. Advantages and disadvantages of tidal power generation. 4. Geothermal energy: Geothermal sources and energy conversion. 5. Advantages and disadvantages of geothermal energy. 6. Introduction to Thermocell	**08**
4	**Energy Management:** 1. Introduction to Energy Management (Definition, Principles etc) 2. Need of Energy Saving and Management 3. Different strategies of Energy Management 4. Role of Energy Managers and Auditors 5. Energy Audit Measurements and Instruments, and Preparation of Energy Audit Report (in brief). 6. Case studies of Energy Audit & Management (e.g. Industries & Green Buildings, Boilers, Furnaces, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery, Electric motors, Pumping systems, Fans and blowers, Cooling Towers, Industrial/Commercial Lighting system, BEE Star rated equipment) anyone. 7. Role of Artificial Intelligence (AI) in Energy Management.	**06**

Reference Books:

1. Non-conventional Energy Sources, G. D. RAI (4th edition), Khanna Publishers, Delhi.
2. Solar Energy, S.P. Sukhatme (second edition), Tata Mc Graw Hill Ltd, New Delhi.
3. Solar Energy Utilisation**,** G. D. RAI (5th edition), Khanna Publishers, Delhi.
4. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
5. Energy Management Principles: C.B.Smith (Pergamon Press).
6. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
7. Energy Economics -A.V.Desai (Wieley Eastern)
8. Industrial Energy Conservation: D.A. Reay (Pergammon Press)
9. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Inter science publication)
10. Industrial Energy Management and Utilisation –L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington)
11. Hand book of Energy Audit by Sonal Desai (Publisher Tata McGraw Hill.)
12. Energy Management and Conservation Handbook, Frank Kreith and Yogi Goswami, (CRC Press).

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-362-MJ-PR: Renewable Energy Sources-II

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

Any 15 practical's are compulsory to perform out of the list given below. Out of 15 practical's, 03 practical's are equivalent to laboratory/industry visit. A educational visit activity is compulsory with report writing and submission.

Learning Outcomes: After successful completion of this course, students will be able to:

1. **Explain the principles of bioenergy and biofuel production**, including biochemical, thermochemical, and transesterification processes.
2. **Describe the construction and operation of biogas plants, biomass gasifiers, and other biomass energy systems**, and analyze factors affecting their performance.
3. **Understand wind energy conversion systems**, classify wind turbines, and interpret basic wind data for power estimation.
4. **Explain the working principles and applications of tidal and geothermal energy systems**, including their advantages and limitations.
5. **Apply concepts of energy management and conservation** and identify strategies for efficient energy use in domestic and industrial sectors.
6. **Understand the role of energy audits, measurement tools, and reporting**, and interpret simple case studies related to energy efficiency.

List of Practical's:

A. Bioenergy and Biofuels

1. To study the biogas plant model (floating drum and fixed dome) with its construction and working.
2. Comparative study of floating drum vs fixed dome biogas plant using models/charts.
3. To demonstrate the anaerobic digestion in biogas plant using organic waste.
4. To study the different factors affecting biodigestion process. (pH/temperature/moisture concept experiment or data analysis).
5. To estimate the calorific value of biomass briquettes/pellets. (theoretical/experimental).
6. Demonstration/model study of downdraft gasifier and biomass gasification process.
7. To study the thermochemical conversion processes – pyrolysis, gasification, carbonization (model/simulation).

B. Wind Energy

8. To study the wind energy conversion system (WECS) using model or demonstration setup.
9. To measure the wind speed using anemometer at different locations and analysis of wind data.
10. To study power output vs wind speed using a small wind turbine kit/model.
11. To perform comparative study of horizontal-axis and vertical-axis wind turbines using models/charts.

C. Other Renewable Energy Sources

12. To study the tidal energy power plant models/working principle (barrage/stream concept).
13. To study the geothermal energy system using charts/models or virtual lab.
14. To determine the selectivity ratio of Selective and Non-selective coatings.

D. Energy Management and Audit

15. To perform the Energy audit of a classroom/laboratory with load calculation and energy-saving suggestions.
16. To measure the power consumption of household appliances using wattmeter/energy meter.
17. To study the comparison of lighting efficiency of LED, CFL, and incandescent lamps.
18. To measure power factors and energy consumption of electrical loads.
19. To prepare an energy audit report based on collected measurements.
20. To study the BEE star-rated appliances and estimation of annual energy savings.

E. Optional Skill Based Practical's (Recommended for Current Relevance)

21. To do energy audit of home/society/college/industry and prepare a detail energy audit report.
22. To study and analysis of home Electricity Bill with details.

Reference Books:

1. Non-conventional Energy Sources, G. D. RAI (4th edition), Khanna Publishers, Delhi.
2. Solar Energy, S.P. Sukhatme (second edition), Tata Mc Graw Hill Ltd, New Delhi.
3. Solar Energy Utilisation**,** G. D. RAI (5th edition), Khanna Publishers, Delhi.
4. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
5. Energy Management Principles: C.B.Smith (Pergamon Press).
6. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
7. Energy Economics -A.V.Desai (Wieley Eastern)
8. Industrial Energy Conservation: D.A. Reay (Pergammon Press)

9. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Inter science publication)
10. Industrial Energy Management and Utilisation –L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington)
11. Hand book of Energy Audit by Sonal Desai (Publisher Tata McGraw Hill.)
12. Energy Management and Conservation Handbook, Frank Kreith and Yogi Goswami, (CRC Press)

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-371-VSC-PR: Python Programming

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

12 Theory lectures + Any 12 Practical's (48) = 60

Learning Outcomes: After successful completion of this course, students will be able to:

1. Explain algorithm development, flowcharts, and the basic structure of C programs including data types, variables, and constants.
2. Write programs using decision-making and looping statements to solve numerical and logical problems.
3. Implement arrays for data processing, apply pointers, and develop modular and recursive programs.
4. Use basic graphic commands (Point, Line, Circle, Arc, Ellipse, Bar) to create simple graphical applications.
5. Develop programs to solve problems related to physics and mathematics such as gas laws, projectile motion, thermodynamics, and sorting techniques.
6. Design, implement, test, and execute C programs independently as part of practical or project components.

Instructions: This course consists of two parts • Part I: Theory • Part II: Practical.

Part I: Theory

Unit	Topics	Lectures
I: Introduction to Python Programming Language	**Introduction to Python Programming Language**: **1. Introduction to Python Language,** • Strengths and Weaknesses, • IDLE, Dynamic Types, • Naming Conventions, • String Values, • String Operators, **2.Data Collections and Language Component:** • Introduction, • Control Flow and Syntax, • Indenting, • The if Statement, • Application of IDLE and dynamic using AI,	06
II: Functions and Modules	**1.Functions and Modules:** • Introduction • Defining Your Own Functions Parameters • Function Keyword and Optional Parameters • Functions Passing Functions to a Function • Mapping Functions in a Dictionary **2.Modules** • Standard Modules – math	06

	• Standard Modules – time • AI in Functions and Modules • Learning python using AI	

Part II (A): C-Programming (practical's): Any 12 [48 L]

List of Practical's:

1. Using AI write a Python program to calculate velocity, acceleration, and force using user input values.
2. Write a Python program to format experimental observation data using string operations.
3. Write a program using conditional statements to classify materials as conductor, semiconductor, or insulator based on resistivity.
4. Develop a Python program to compute kinetic energy, potential energy, or momentum based on user selection.
5. Write functions to calculate displacement and velocity using standard equations of motion.
6. With the use of AI Create a function to calculate gravitational force with an optional default value of the gravitational constant.
7. Write a Python program demonstrating passing functions as arguments to compute different physics quantities.
8. Applying AI operation develops a menu-driven physics calculator using dictionary mapping for formulas such as force, work, pressure, and energy.
9. Write a program using the math module to calculate projectile motion parameters such as range, maximum height, and time of flight.
10. Write a Python program using the time module to simulate time measurement in physical processes (e.g., oscillations or decay timing).
11. Develop a program to compute mean value, absolute error, and percentage error from experimental readings.
12. Develop an integrated mini-project: a menu-driven Physics Calculator using functions, conditional statements, dictionary mapping, and standard modules.
13. Write a Python program to calculate wavelength, frequency, and energy of a photon using Planck's equation.
14. Develop a program to compute equivalent resistance for series and parallel combinations of resistors.
15. Write a Python program to calculate magnetic force on a charged particle moving in a magnetic field.
16. Develop a program to calculate capacitance and energy stored in a capacitor for given values of voltage and capacitance.

Reference Books:

1) Python Programming: Using Problem Solving Approach. By Reema Thareja.
2) Think Python By Allen Downey
3) Problem Solving and Python Programming By Bal Guruswami McGrow Hill
4) Let Us Python By Aditya Kanetkar
5) Learning with Python By Allen Downey
6) Data Analytics By Bharti Motwan.

T.Y.B.Sc. (Physics) (Sem-VI)

PHY-381-OJT-PR: On Job Training (Basic Instrumentation and Industrial Exposure)

Lectures: 60 **(Credits-04)**

After completion of this course, students will be able to:

1. Understand the **basic working principles of common physical and electrical instruments**.
2. Identify and explain the **functions of major components** used in appliances and instruments.
3. Apply classroom physics concepts to **real-life industrial situations**.
4. Follow **safety procedures and professional ethics** in a workplace.
5. Develop basic **technical and communication skills** required for employment.
6. Prepare a **systematic technical report** on industrial training.

Course Objective:

On Job Training is an effective method of providing **practical, industry-based learning** to undergraduate physics students. This course aims to familiarize students with the **working environment, basic instruments, tools, and safety practices** used in industries and service centers related to physical and electronic instruments.

Through observation and guided hands-on activities, students gain practical exposure and understand the **real-world applications of physics concepts** learned in the classroom.

General Description of OJT:

On Job Training is conducted at an authorized **industry, laboratory, service center, or repair workshop**. During the training, students:

- Become familiar with the **workplace environment**
- Learn about **basic tools, instruments, and components**
- Observe manufacturing or repairing processes
- Perform **simple supervised hands-on tasks**
- Understand professional ethics and safety rules

Training Activities (Any TWO must be completed):

Students shall perform any **two activities** from the following:

a) Visit to a company / workshop / repair center
b) Study of various parts and components used
c) Hands-on training under supervision
d) Attachment of training letter from authorized training center
e) Preparation of a detailed training report
f) Evaluation by training supervisor and college teacher

Suggested Areas for OJT (Choose Any One):

1. Refrigerator / Cooler Repairing Center
2. Air Conditioner Installation and Servicing

3. Solar Panel Installation and Maintenance
4. Battery Charging and Maintenance Unit
5. Basic Power Supply Building and Repair
6. Electrical Appliances Repair (Fan, Iron, Mixer, Heater)
7. Television / Radio Repair
8. Two-stroke or Four-stroke Engine Workshop
9. Digital Watch / Clock Repair
10. Physics Laboratory Instruments (Vernier, Micrometer, Galvanometer, Multimeter, etc.)
11. CRO / Function Generator / Multimeter (Basic servicing)
12. Home Appliances Manufacturing / Repair
13. Any small-scale industry related to Physical or Electrical Instruments

Structure of Student Report (Mandatory):

Each student must submit a report including:

1. **Introduction of the Training Center**
    - Name and address
    - Nature of work
2. **Objectives of Training**
3. **Description of Instruments and Parts Studied**
    - List of tools and components
    - Their functions
4. **Work Performed / Hands-on Training Details**
    - Activities carried out
    - Observations
5. **Safety Measures and Precautions**
6. **Learning Outcomes**
7. **Photographs / Attendance Record (if permitted)**
8. **Training Completion Certificate / Letter from Industry.**