S.Y.B.Sc. (Physics)

Semester-III

&

Semester-IV

Syllabus

2022 Pattern

Anekant Education Society's

Tuljaram Chaturchand College

of Arts, Science and Commerce, Baramati

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

Course Structure for S.Y.B.Sc. Physics 2022 Pattern

Semester	Paper Code	Title of Paper	No. of Credits
III	USPH231	Mathematical Methods of Physics-I	3
	USPH232	Electronics/Instrumentation	3
	USPH233	Practical-I	2
IV	USPH241	Oscillations, waves, and Sound	3
	USPH242	Optics	3
	USPH243	Practical-II	2

Program Outcomes

PO1: Disciplinary Knowledge

PO2: Critical Thinking and Problem solving

PO3: Social competence

PO4: Research-related skills and Scientific temper

PO5: Trans-disciplinary knowledge

PO6: Personal and professional competence

PO7: Effective Citizenship and Ethics

PO8: Environment and Sustainability

PO9: Self-directed and Life-long learning

Class : S.Y.B.Sc. (Semester- III)

Paper code : USPH231

Paper : I Title of Paper: Mathematical Methods in Physics -I

Credit : 3 No. of Lectures: 48

Learning Objectives:

- To impart knowledge about various mathematical tools employed to study physics problems.
- To introduce students the methods of mathematical physics.
- To develop required mathematical skills to solve problems in quantum mechanics, electrodynamics, and other fields of theoretical physics.

Learning Outcomes:

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

CO1: Understand the complex algebra useful in Physics courses.

CO2: Understand the concept of Curl and Divergence.

CO3: Understand the concept of partial differentiation.

CO4: Understand the role of partial differential equations in Physics.

CO5: Understand vector algebra useful in Mathematics and Physics

CO6:Understand the singular points of the differential equation.

CO7: Significance of mathematics formulations for understanding of physics principles

UNIT 1: Complex Numbers (12)

1.1 Introduction to complex numbers.

1.2 Rectangular, polar, and exponential forms of complex numbers.

1.3 Argand diagram, Algebra of complex numbers using Argand diagram.

1.4 De-Moivre's Theorem (statement only)

1.5 Powers, roots and log of complex numbers.

1.6 Trigonometric, hyperbolic, and exponential functions.

1.7 Applications of complex numbers to determine velocity and acceleration in curved motion.

1.8 Problems.

UNIT 2: Vector Algebra (04)

2.1 Introduction to scalars, vectors, dot product and cross product.

2.2 Scalar triple product and its geometrical interpretation.

2.3 Vector triple product and its proof.

2.4 Problems.

UNIT 3: Vector Analysis (16)

3.1 Scalar and vector fields.

3.2 Differentiation of vectors with respect to scalar.

3.3 Vector differential operator and Laplacian operator.

3.4 Gradient of scalar field and its physical significance.

3.5 Divergence of scalar field and its physical significance.

3.6 Curl of vector field.

3.7 Vector integrals: Line, surface and volume integral with their examples.

3.8 Statements of Gauss-Divergence theorem and Stoke's theorem.

3.9 Different vector identities.

3.10 Problems.

UNIT 4: Partial Differentiation and Differential Equation (16)

4.1 Definition of partial differentiation.

4.2 Successive differentiation.

4.3 Total differentiation.

4.4 Exact differential.

4.5 Chain rule.

4.6 Theorems of differentiation.

4.7 Change of variables from Cartesian to polar co-ordinates.

4.8 Implicit and explicit functions.

4.9 Conditions for maxima and minima (without proof).

4.10 Degree, order, linearity and homogeneity of differential equation.

4.11 Concept of Singular points. Example of singular points ($x = 0$, $x = x_0$ and $x = \infty$) of differential equation.

4.12 Problems.

Reference Books:

1. Methods of Mathematical Physics by Laud, Takwale and Gambhir
2. Mathematical Physics by B. D. Gupta
3. Mathematical Physics by Rajput and Gupta
4. Mathematical Methods in Physical Science by Mary and Boas
5. Vector analysis by Spiegel and Murrey
6. Mathematical Methods for Physicists by Arfke and Weber, 5th Edition, Academic Press.
7. Engineering Mathematics by H.K.Dass, S.Chand publication.

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

Justification

PO1: Disciplinary Knowledge

CO1: Understand the complex algebra useful in Physics courses.Weightage: 3

Complex algebra is directly related to disciplinary knowledge in physics and is a foundational mathematical tool.

CO2: Understand the concept of Curl and Divergence.Weightage: 3

Understanding Curl and Divergence is essential in physics, especially in fields like vector calculus, fluid dynamics, and electromagnetism.

CO4: Understand the role of partial differential equations in Physics.Weightage: 3

Partial differential equations play a crucial role in modeling physical phenomena, and understanding their role is vital for disciplinary knowledge.

CO5: Understand vector algebra useful in Mathematics and Physics.Weightage: 3

Vector algebra is fundamental in physics, and understanding it is crucial for various applications within the discipline.

CO7: Significance of mathematics formulations for the understanding of physics principles.Weightage: 3

Recognizing the significance of mathematical formulations is crucial for applying mathematical concepts to physics principles, reinforcing disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO6: Understand the singular points of the differential equation.Weightage: 2

Understanding singular points involves critical thinking skills and their role in solving differential equations, contributing partially to critical thinking and problem-solving.

Class : S.Y.B.Sc. (Semester- III)
Paper code : USPH 232 (A)
Paper : A Title of Paper: Electronics-I
Credit : 3 No. of lectures: 48

Learning outcomes:

On successful completion of this course the students will be able to
CO1: Apply laws of electrical circuits to different circuits.

CO2: Understand the properties and working of transistors.

CO3: Understand the functions of operational amplifiers.

CO4: Design circuits using transistors and operational amplifiers.

CO5: Understand the Boolean algebra and logic circuits.

CO6: Use of knowledge in electronics based project work for demonstration.

CO7: Application of logic and electronics for new ideas and societal demands.

UNIT-1: NETWORK THEOREMS [12]

1.1 Kirchhoff's laws (revision)

1.2 Voltage and Current divider circuits

1.3 Thevenin's theorem

1.4 Norton's theorem

1.5 Super-position theorem

1.6 Maximum power transfer theorem

1.7 Problems.

UNIT-2: TRANSISTORS [12]

2.1 Bipolar junction transistors, n-p-n and p-n-p Transistors

2.2 Transistor biasing

2.3 CB, CC, CE configurations and their Characteristics- Active, saturation and cut-off regions. **2.4** Current gains α, β, γ and their relationships.

2.5 DC operating point and AC and DC Load line, Q-Point.

2.6 Problems

UNIT-3: OPERATIONAL AMPLIFIERS [12]

3.1 Operational Amplifier

3.2 Characteristics of an Ideal and Practical Op-Amp (IC 741),

3.3 Concept of Virtual ground.

3.4 Applications of Op-Amps: Inverting and Non-inverting Amplifiers, Adder, Subtractor, Differentiator, Integrator, Problems

UNIT-4: DIGITAL ELECTRONICS [12]

5.1 Binary Number system.

5.2 Decimal to Binary and Binary to Decimal Conversion,

5.3 Octal Numbers,

5.4 Hexadecimal Numbers,

5.5 ASCII code, Excess-3 code, Gray Code.

5.6 Basic Gates- AND, OR and NOT Gates. XOR and XNOR Gates

5.7 NAND and NOR Gates as Universal Gates. De Morgan's Theorems.

5.8 Boolean Laws. Simplification of Logic Circuit using Boolean algebra.

REFERENCE BOOKS:

1. Electronics Principles, Malvino, 8th Edition Tata Mc-Graw Hills.
2. Principles of Electronics, V. K. Mehta, S. Chand Publication New Delhi.
3. Op Amp and Linear integrated circuits, Ramakant Gaikwad, Prentice Hall of India Pub.
4. Integrated Circuts, K.R. Botkar, Khanna Publications, New Delhi
5. Digital Principles and Applications, Malvino and Leech Tata Mc-Graw Hills Pub

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

Justification

PO1: Disciplinary Knowledge

CO1: Apply laws of electrical circuits to different circuits.Weightage: 3

Applying laws of electrical circuits is directly aligned with disciplinary knowledge in electronics.

CO2: Understand the properties and working of transistors.Weightage: 3

Understanding the properties and working of transistors is crucial knowledge in the discipline of electronics.

CO3: Understand the functions of operational amplifiers.Weightage: 3

Understanding the functions of operational amplifiers contributes directly to disciplinary knowledge in electronics.

CO4: Design circuits using transistors and operational amplifiers.Weightage: 3

Designing circuits using transistors and operational amplifiers is a practical application of disciplinary knowledge.

CO5: Understand Boolean algebra and logic circuits.Weightage: 3

Understanding Boolean algebra and logic circuits is an integral part of disciplinary knowledge in electronics.

CO6: Use knowledge in electronics-based project work for demonstration.Weightage: 3

Applying knowledge in project work demonstrates practical application within the discipline.

CO7: Application of logic and electronics for new ideas and societal demands.Weightage: 3

Applying logic and electronics for new ideas and societal demands is an extension of disciplinary knowledge in response to real-world needs.

PO2: Critical Thinking and Problem Solving

CO4: Design circuits using transistors and operational amplifiers.Weightage: 3

Designing circuits involves critical thinking and problem-solving within the domain of electronics.

CO7: Application of logic and electronics for new ideas and societal demands.Weightage: 3

Applying logic and electronics to address new ideas and societal demands requires critical thinking and problem-solving skills.

PO3: Social Competence

CO7: Application of logic and electronics for new ideas and societal demands.Weightage: 2

While the application of logic and electronics can have societal implications, the relation is not as direct as in other outcomes.

PO9: Self-directed and Life-long Learning

CO6: Use knowledge in electronics-based project work for demonstration.Weightage: 2

Applying knowledge in project work contributes to self-directed and life-long learning, as it involves independent application and demonstration.

Class : S.Y.B.Sc. (Semester-IIII)
Paper code : USPH232 (B)
Paper : Title of Paper: Instrumentation
Credit : 3 No. of lectures: 48

(For the students who have offered Electronic Science at F. Y. B. Sc.)

Learning outcomes: -

After successful completion of this course the students will be able to-

CO1: Understand the principles and functions of different instruments.

CO2: Use different instruments for measurement of various parameters.

CO3: Getting information about various sensing parameter conditions for instrumentation.

CO4: Design experiments or demo using sensors for application.

CO5: Design application based instrumentation for demonstration using sensors.

CO6: Use of knowledge in electronics based project work for demonstration.

CO7: Application of logic and electronics for new ideas and societal demands.

UNIT 1: FUNDAMENTALS OF MEASUREMENT (14)

1.1 Aims of measurement [Ref 1, Pages: 1-2]

1.2 Functional elements of typical measurement system (block diagram and its explanation) [Ref 1, Pages: 6-8]

1.3 Standard measurements and types of calibration methods [Ref 1, Pages: 19-27]

1.4 Static characteristics (accuracy, precision, sensitivity, linearity, repeatability, reproducibility, drift, hysteresis, resolution) [Ref 1, Pages: 29-33]

1.5 Dynamic characteristics: concepts of zero, first and second order systems, examples of first-order resistance thermometer and thermal element, examples of second order: U- tube manometer [Ref 1, Pages: 81-106]

1.6 Errors in measurement. (Definition and types)

1.7 Problems.

UNIT 2: TRANSDUCERS (14)

2.1 Measurement of displacement: variable resistance, inductance and capacitance methods. Variable capacitance transducers [Ref 1, Pages: 815-825]

2.2 Measurement of force: Load cell, cantilever beam

2.3 Measurement of temperature: I) Scales of temperature (Kelvin, Celsius, Fahrenheit etc.)

II) Methods of temperature measurement:

a. Non-electrical method – liquid filled thermometer, bimetallic thermometer.
b. Electrical method – Platinum resistance thermometer
c. Thermistor – PTC and NTC with characteristics

2.4 Problems [Ref 1, Pages: 739-758, 788-793].

UNIT 3: MEASUREMENT OF PRESSURE (08)

3.1 Unit of pressure, concept of vacuum, absolute gauge, and differential pressure
3.2 Elastic transducer – diaphragm, corrugated diaphragm, bellows, Bourdon tube
3.3 Electric type - LVDT, strain gauge
3.4 Problems.

UNIT 4: ANALOG SIGNAL CONDITIONING (12)

4.1 Steps involved in Signal Conditioning, impedance matching.
4.2 OP-AMP circuit used in instrumentation –precision rectifier, comparator, logarithmic amplifier, current to voltage and voltage to current converters
4.3 Instrumentation amplifier (Three OP-AMP configuration) [Ref 1, Pages: 873-903]
4.4 Active Filters-Low pass, High pass filter (First order) [Ref 1, Pages: 913-918]
4.5 Problems.

REFERENCE BOOK:

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

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

Justification

PO1: Disciplinary Knowledge

CO1: Understand the principles and functions of different instruments.Weightage: 3

Understanding the principles and functions of instruments is foundational knowledge in the field of instrumentation.

CO2: Use different instruments for measurement of various parameters.Weightage: 3

Using instruments for measurement involves applying disciplinary knowledge in instrumentation.

CO3: Getting information about various sensing parameter conditions for instrumentation.

Weightage: 3

Gathering information about sensing parameters is directly related to disciplinary knowledge in instrumentation.

CO4: Design experiments or demos using sensors for application.Weightage: 3

Designing experiments with sensors involves applying disciplinary knowledge to create practical applications.

CO5: Design application-based instrumentation for demonstration using sensors.Weightage: 3

Designing application-based instrumentation with sensors aligns with disciplinary knowledge in instrumentation.

CO6: Use knowledge in electronics-based project work for demonstration.Weightage:

Applying knowledge in electronics-based project work contributes to disciplinary knowledge in instrumentation.

CO7: Application of logic and electronics for new ideas and societal demands.Weightage: 3

Applying logic and electronics for new ideas and societal demands extends disciplinary knowledge to address real-world needs.

PO2: Critical Thinking and Problem Solving

CO4: Design experiments or demos using sensors for application.Weightage: 3

Designing experiments with sensors requires critical thinking and problem-solving skills within the context of instrumentation.

CO5: Design application-based instrumentation for demonstration using sensors.Weightage: 3

Designing application-based instrumentation involves critical thinking and problem-solving in the application of instrumentation principles.

CO7: Application of logic and electronics for new ideas and societal demands.Weightage: 3

Applying logic and electronics for new ideas and societal demands requires critical thinking within the field of instrumentation.

PO3: Social Competence

CO7: Application of logic and electronics for new ideas and societal demands.Weightage: 2

While the application of logic and electronics can have societal implications, the relation is not as direct as in other outcomes.

PO9: Self-directed and Life-long Learning

CO6: Use knowledge in electronics-based project work for demonstration.Weightage: 2

Applying knowledge in project work contributes to self-directed and life-long learning, as it involves independent application and demonstration.

Class : S.Y. B. Sc. (Semester- III)

Paper code : USPH 233
Paper : III
Title of Paper: Practical-I No. of Practical: 10
Credit : 2

Course Outcome:

CO1: Acquire technical and manipulative skills in using laboratory equipment, tools, and materials.
CO2: Demonstrate an ability to collect data through observation and/or experimentation and interpreting data.
CO3: Demonstrate an understanding of laboratory procedures including safety and scientific methods.
CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.
CO5: Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.
CO6: Use of experiment to analyse various experimental parameters concerning their application .
CO7: Experimental Models for easy understanding and explanation Physics concepts.

List of Experiments: (Students have to perform Any 10 Experiments)

1. Circuit Theorems (Thevenin's, Norton's and Maximum power transfer theorem)
2. Transistor characteristics (CE configuration)
3. *Thermal conductivity of rubber tube*
4. OPAMP as inverting and non inverting amplifier
5. Study of logic gates (using IC) and verification of De Morgan's theorem
6. Use of CRO (AC/DC voltage measurement, frequency measurement)
7. Measurement of displacement (linear and angular) using potentiometer/variable inductor
8. *Measurement of force using load cell.*
9. *Measurement of pressure using elastic diaphragm (in variable Capacitor/Bourdon Tube)*
10. OPAMP as an adder and subtractor
11. Platinum Resistance Thermometer
12. Integrator and differentiator using IC 741
13. Characteristics of Thermistor
14. Study of Thermocouple
15. *Study of thermal conductivity by Lee's method*
16. *Phase shift Oscillator using IC 741*
17. Simulation of experiments (Any two)
    a. Thevenin's Theorem and Norton's theorem
    b. Newton's Law of Cooling
    c. Lee's Disc Apparatus
    d. Thermo Couple-Seebeck Effect

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

Justification

PO1: Disciplinary Knowledge

CO1: Acquire technical and manipulative skills in using laboratory equipment, tools, and materials.Weightage: 3

Acquiring technical skills in a laboratory setting is fundamental to building disciplinary knowledge.

CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.Weightage: 3

Visualizing and experiencing abstract concepts directly contribute to disciplinary knowledge.

PO2: Critical Thinking and Problem Solving

CO2: Demonstrate an ability to collect data through observation and/or experimentation and interpreting data.Weightage: 3

Critical thinking is essential in collecting and interpreting data in a laboratory setting.

CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.Weightage: 3

Visualizing abstract concepts contributes to critical thinking skills.

PO3: Social Competence

CO5: Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.Weightage: 3

Collaborative learning and teamwork in a laboratory setting directly contribute to social competence.

PO4: Research-related Skills and Scientific Temper

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

Weightage: 2

Understanding laboratory procedures is part of research-related skills, but the link may not be as direct.

CO4: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.Weightage: 2

Visualizing abstract concepts can be part of developing a scientific temper, but the link may not be as strong.

PO5: Trans-disciplinary Knowledge

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

Weightage: 2

Collaborative learning and teamwork contribute to trans-disciplinary knowledge, but the link may not be as strong.

PO6: Personal and Professional Competence

CO6: Use of experiment to analyze various experimental parameters concerning their application.Weightage: 2

Analyzing experimental parameters can contribute to personal and professional competence, but the link may not be as direct.

PO7: Effective Citizenship and Ethics

CO3: Demonstrate an understanding of laboratory procedures including safety and scientific methods.Weightage: 3

Understanding laboratory procedures, especially safety and scientific methods, directly contributes to effective citizenship.

PO8: Environment and Sustainability

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

Weightage: 2

Adhering to laboratory safety procedures can indirectly contribute to considerations of environment and sustainability.

PO9: Self-directed and Life-long Learning

CO6: Use of experiment to analyze various experimental parameters concerning their application.Weightage: 2

Analyzing experimental parameters is relevant to self-directed and life-long learning, though the link may not be as direct.