Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS,

SCIENCE AND COMMERCE, BARAMATI

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

Faculty of Science

Department of Physics

RevisedSyllabus Submitted IQAC

For

M.Sc. in Physics

From Academic Year 2022-2023

INDEX

PREAMBLE

Physics, a core discipline, is the fundamental and foremost to all natural sciences. It has been significant and influential through advances in its understanding that have translated into new technologies. Physics interact with the society and other discipline such as Medicine, Chemistry, Agriculture, Engineering etc. in many important ways. Physics department in Tuljaram Chaturchand College has highly qualified faculty members and support staffs and is committed towards the development of innovative and handy ways of teaching at graduate, post graduate and developing a core research group for carrying out cutting edge research in various research fields like Condensed Matter Physics, Solid State Physics, Electronics, Theoretical Physics, Atomic & Molecular Physics and Nuclear Physics. The department also offers Doctoral Programme in order to nurture young minds towards embracing various scientific challenges. Extra care is taken to pay individual attention to the students in their laboratory work and tutorial sessions. Project work and problem sessions are encouraged to develop innovative and analytical approach to physics learning.

GOALS

The goal of the Physics education is to provide the student with a broad understanding of the physical principles of the universe, to help them develop critical thinking and quantitative reasoning skills, to empower them to think creatively and critically about scientific problems and experiments. It's provided training for students and planning careers in physics including research, teaching, industrial jobs, government jobs or other sectors of our society.

OBJECTIVES

1. To endow with a conducive and friendly environment that nurtures excellence and high standards of professionalism in teaching, learning and research.
2. To augment the level of participation in research, dissemination and preservation of knowledge for both academic and social development.
3. Prepare the student in assets of Physics and the principles of analytical methods required for the conclusion of physical tests.
4. Provide an opportunity for students to deepen his/her knowledge in the branches of Physics so that views on the outskirts of contemporary science.

5. Training the students on the way of scientific research and enable it to contribute to it under the supervision.
6. Continued development of faculty members by sending them for training courses so as to maintain a high degree of efficiency and performance.
7. Support and encourage the scientific cooperation between faculty members in the department and co-operation with other departments in the field of multi-purpose research.
8. Spread the spirit of competition and encouragement and give the opportunity to all members.
9. Preparation of national cadres by basic physics and knowledge that contribute to community service.
10. To establishes collaborations with other eminent institution.

Proposed Structure of M.Sc.Physicsand syllabus for M.Sc. I Physics first semester as follows:

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M.Sc. I & II CourseStructure

M.Sc.-I

Semester-I

Course Number	Course Code	Course Name	Credit
1	PSPH 111	Mathematical Methods in Physics	4
2	PSPH 112	Classical Mechanics	4
3	PSPH 113	Quantum Mechanics-I	4
4	PSPH 114	Electronics	4
5	PSPH 115	Electronics Laboratory-I	4
6	PSPH 116	Basic Physics Laboratory-I	4
Total Credit			**24**

Semester-II

Course Number	Course Code	Course Name	Credit
7	PSPH 121	Physics of Semiconductor Devices	4
8	PSPH 122	Atoms, Molecules & Laser	4
9	PSPH 123	Quantum Mechanics-II	4
10	PSPH 124	Electrodynamics	4
11	PSPH 125	Electronics Laboratory-II	4
12	PSPH 126	Basic Physics Laboratory-II	4
Total Credit			**24**

M.Sc. II CourseStructure

Semester-III

Course Number	Course Code	Course Name	Credit
13	PSPH 231	Statistical Physics	4
14	PSPH 232	Solid State Physics	4
15	PSPH 233	Experimental Techniques in Physics-I	4
16	PSPH 234	CB Group –I a) Nano-technology-I b) Energy studies - I c) Biophysics-I d) Physics of Thin Films-I e) Electronic Instrumentation-I f) DFT-I g) Astrophysics - I	4
17	PSPH 235	Special Lab-I	4
18	PSPH 236	Special Lab-II	4
Total Credit			**24**

Semester-IV

Course Number		Course Name	Credit
19	PSPH 241	Nuclear & Particle Physics	4
20	PSPH 242	Material Science	4
21	PSPH 243	Experimental Techniques in Physics-II	4
22	PSPH 244	CB Group –II a) Nano-technology-II b) Energy studies - II c) Biophysics-II d) Physics of Thin Films-II e) Electronic Instrumentation-II f) DFT-II g) Astrophysics - II	4
23	PSPH 245	Special Lab-III	4
24	PSPH 246	Project	4
Total Credit			**24**

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M.Sc. I CourseStructure

Semester-I

Course Number	Course Code	Course Name	Credit
1	PSPH 111	Mathematical Methods in Physics	4
2	PSPH 112	Classical Mechanics	4
3	PSPH 113	Quantum Mechanics-I	4
4	PSPH 114	Electronics	4
5	PSPH 115	Electronics Laboratory-I	4
6	PSPH 116	Basic Physics Laboratory-I	4
Total Credit			**24**

SYLLABUS (CBCS) FOR M.Sc. PHYSICS
(W.E.F. June 2022)

Name of the Programme	: M.Sc. PHYSICS
Programme Code	: PSPH
Class	: M.Sc.
Semester	: I
Couse Name	: Mathematical Methods In Physics
Course Code	: PSPH111
No. of lectures	: 60

Course outcomes:

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

1. From this course, the students are expected to learn some mathematical techniques required to understand the physical phenomena at the postgraduate level.
2. The students are expected to be able to solve simple problems in probability, understand the concept of independent events and work with standard continuous distributions.
3. The students will have idea of the functions of complex variables; solve nonhomogeneous differential equations and partial differential equations using simple methods.
4. The students are expected to be able to solve simple problems on Fourier series and Fourier transform, Laplace transform etc.
5. From this course, students have practiced formulating good questions and explaining to others

Unit 1: Complex Analysis (1 Credit)

Complex number, Complex function (polynomial, Exponential, Trigonometric complex function, Logarithm), differentiation, Analytical function, Cauchy-Riemann condition, Line integrals, Cauchy integral formula, Derivative of analytical functions, Power Series, Taylor's theorem, Laurent's theorem, Calculus of residues, Evaluation of real definite integrals
References: 1-5

Unit 2: Vector Space and Matrix Algebra (1 Credit)

Revision on Vector space: Vectors (dependent and independent), Vector space, Hilbert space, Dimension of vector space, Matrix representation, Similarity transformation, Eigen values and Eigen vectors, Inner product, Orthogonality, Introduction only to Gramm-Schmidt orthogonalization procedure.
Matrix: Types of matrix, Rank of matrix, Eigen values and Eigen vectors, Unitary transformation, Diagonalization
References: 6, 7

Unit 3: Special Functions **(1 Credit)**

Bessel function, Legendre, Hermite, and Laguerre functions – Generating function, Recurrence relations and their differential equations, Orthogonality properties, Bessel's function of first and second kind.

References: 4, 5, 7

Unit 4: Fourier Series and Integral Transforms **(1 Credit)**

Fourier series: Definition, Dirichlet's Condition, Fourier Integral and Fourier transform, convolution theorem, Parseval's identity, Laplace transform and its properties, Fourier transform and Laplace transform, Dirac Delta function.

References: 3, 4, 7

Reference Books:

1. Complex Variables and Application- J. W. Brown, R. V. Churchill - McGraw Hill
2. Complex Variables – Seymour Lipschutz
3. Mathematics for Physical Sciences – Mary Boas, John Wiley and Sons
4. Mathematical methods in Physics- B. D. Gupta
5. Mathematical methods in Physics- Satyaprakash
6. Linear algebra – Seymour Lipschutz, Schaum Outline Series McGraw Hill Edition
7. Mathematical Method for Physicists, Arfken and Weber, 6th Edition,Academic Press
8. Fourier Series - Seymour Lipschutz, Schaum Outlines Series

SYLLABUS (CBCS) FOR M.Sc. PHYSICS
(W.E.F. June 2022)

Name of the Programme	: M.Sc. PHYSICS
Programme Code	: PSPH
Class	: M.Sc.
Semester	: I
Couse Name	: Classical Mechanics
Course Code	: PSPH112
No. of lectures	: 60

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

1. The students will introduce about the newton's laws of motion and knowledge about the applications of newton's laws of motion.
2. This paper enables the students to understand the Langrangian approach in classical mechanics.
3. The students should be able to understand Hamiltonian formulation with applications
4. The paper also enables the students to know about variational principle with applications.
5. The students should be able to understand central forces and types of central forces in detail, ideas regarding equations of orbit and deduction of Kepler's laws.

Unit 1: Constrained Motion and Lagrangian formulation (1 Credit)

Constrained Motion, Constraints and their Classification**,** Degrees of freedom, generalized coordinates, Virtual Displacement, Principle of Virtual Work, D'Alembert Principle, Configuration space, Lagrange's equation of motion, Theorem on total energy, Cyclic coordinates, Generalized momenta.

Problems solving

Unit 2: Hamilton's formulation and Variational Principle (1 Credit)

Hamilton's function and Hamiltonian equation of motion, Phase space, Jacobi integrals and energy conservation, Lagrangian and Hamiltonian of relativistic particles and light rays, Variational principle, Euler's equation, Applications of Variational principle, Concept of symmetry.

Problems solving

Unit 3: Canonical Transformations and Poisson's Bracket (1 Credit)

Introduction- Background and definition, Legendre transformations, Generating function, Conditions for canonical transformation, Poisson's bracket-definition, identities, Poisson's theorem, Jacobi identity, Invariance of Poisson Bracket under canonical transformation.

Problems solving

Unit 4: Central Forces and Non-Inertial Frames of Reference (1 Credit)

Introduction, definition, and properties of Central Force, two body central force problem, Stability of orbit, Orbits of artificial satellite, Kepler's problem, Inertial forces in rotating frame, Coriolis force and its effect, Foucault's pendulum.

Problems solving

Reference Books:

1. Classical mechanics by J.C. Upadhyaya, Himalaya Publishing House.
2. Classical mechanics by N.C. Rana and P.S. Jog, Tata Mc-Graw Hill Publishing Company limited, New Delhi.
3. Classical Mechanics by P.V. Panat, Narosa publishing Home, New Delhi.
4. Classical Mechanics by Kumar, Gupta, Sharma.
5. Classical Mechanics by H. Goldstein, Narosa Publishing Home, New Delhi.
6. Classical Mechanics by D. S. Mathur.
7. Introduction to Classical Mechanics by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.

SYLLABUS (CBCS) FOR M.Sc. PHYSICS
(W.E.F. June 2022)

Name of the Programme : M.Sc. PHYSICS
Programme Code : PSPH
Class : M.Sc.
Semester : I
Couse Name : Quantum Mechanics- I
Course Code : PSPH113
No. of lectures : 60

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

1. Understand the drawbacks of Classical Mechanics and necessity of Quantum Mechanics
2. Understand the central concepts and principles in quantum mechanics
3. To understand the behaviour of particles under Classical and Quantum conditions.
4. Understand the Operators in Quantum Mechanics.
5. Learn about Approximation Methods to solve problems.

Unit 1: General Formalism of Quantum mechanics(1 Credit)

Postulates of Quantum MechanicsRepresentation of states and dynamical variables, observables, self-adjoint operators, eigen functions and eigen values, degeneracy, Dirac delta function, Completeness and closure property, Physical interpretation of eigen values, eigen functions and expansion coefficients, eigen values and eigen functions of momentum operator.

Unit 2: Representation of States – Dirac notation (1 Credit)

Hilbert space, Dirac's bra and ket notations and its properties, dynamical variables and linear operators, projection operator, unit and unitary operator, matrix representation of an operator, change of basis, unitary transformation. Eigen values and eigen functions of simple harmonic oscillator by operator method.

Unit 3: Angular Momentum (1 Credit)

Eigen values and eigen functions of L^2 and Lz operators, ladder operators L+ and L–, Pauli theory of spins (Pauli's matrices), matrix representation of J in |jm> basis. Addition of angular momenta, Computation of Clebsch-Gordon coefficients in simple cases (J1=1/2, J2=1/2)

Unit 4: Approximation Methods (1 Credit)

Time-independent Perturbation theory: Nondegenerate, Stark effect, Time dependent Perturbation theory: Transition amplitude 1^{st} and 2^{nd} order, Fermi's Golden rule, Harmonic perturbation.

Reference Books:

1. A Textbook of Quantum Mechanics by P.M. Mathews and Venkatesan.
2. Quantum mechanics by A. Ghatak and S. Lokanathan
3. Quantum Mechanics by L.I. Schiff
4. Modern Quantum mechanics by J. J. Sakurai
5. Quantum Physics by R. Eisberg and R. Resnick
6. Introduction to Quantum Mechanics by David J. Griffiths
7. Introductory Quantum mechanics by Granier, Springer Publication.
8. Introductory Quantum Mechanics, Li Boff, 4^{th} Edition, Pearson Education Ltd
9. Quantum Mechanics Noureddine Zettili, A John Wiley and Sons, Ltd., Publication
10. Principles of Quantum Mechanics, Shankar R. II^{nd} Edition (Plenum, 1994)
11. Advanced Quantum Mechanics by Satyaprakash.
12. Quantum mechanics by Chatwal Anand 4^{th} edition.

SYLLABUS (CBCS) FOR M.Sc. PHYSICS
(W.E.F. June 2022)

Name of the Programme	: M.Sc. PHYSICS
Programme Code	: PSPH
Class	: M.Sc.
Semester	: I
Couse Name	: Electronics
Course Code	: PSPH114
No. of lectures	: 60

Course outcomes:

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

1. Manipulate voltage, current and resistances in electronic circuits
2. Demonstrate familiarity with basic electronic components and use them to design simple electronic circuits
3. Design and analyse of electronic circuits,
4. Evaluate frequency response to understand behaviour of Electronics circuits
5. Design and develop data converters

Unit1: Study and applications of Operational Amplifiers (1 Credit)

Characteristic of op-amp, Parameters of ideal op-amp, Applications of Operational Amplifiers: Inverting and Non-inverting amplifier, Adder and Subtractor, Integrator and Differentiator, Active filters: LPF, HPF, BPF, and Notch filter 1^{st} and 2^{nd} order with designing, Instrumentation Amplifier, Function Generator – Square wave, triangular, saw tooth, sine wave. Half wave and full wave precision rectifiers, Sample and hold circuits.

Unit 2: Communication Electronics (1 Credit) Basic principle of amplitude, frequency and phase modulation, Simple circuits for amplitude modulation and demodulation, Digital modulation (PCM) and demodulation,Fundamentals of optical communication, Microwave Oscillators (reflex, klystron, magnetron and Gunn diode), Radio detector

Unit 3: Digital Logic circuits (1 Credit)

Combinational Logic: Review of Boolean identities and its use to minimize Boolean Expressions, Minimization of Boolean Expressions using Karnaugh map: SOP and POS,Multiplexer and Demultiplexer

Sequential Logic; Flip-flops (RS, JK, MS-JK, D and T),
Shift registers using IC 7495: Applications as SISO, SIPO, PISO, PIPO etc
Counters: Synchronous, asynchronous and combinational counters, Decade counter IC 7490 with applications, Up-down counter

Unit 4: Data Converters (1 Credit)

Digital to analog Converters:Binary weighted type, R-2R ladder, Study of IC 0808,
Analog to digital converters:Single slope, Dual slope, Flash/Simultaneous type, Counter type, Successive approximation type

Reference Books:

1. Operational Amplifiers – G.B.Clayton (5th edition) Newnes
2. Operational Amplifiers Applications – G.B.Clayton
3. Electronic Principles – A. P. Malvino (TMH Publication)
4. Op-amps and Linear Integrated circuits – Gayakwad (Prentice Hall)
5. Linear Integrated circuits – D.Roy Choudhury, Shail Jain
6. Integrated circuits – Botkar
7. Digital Principles and Applications: Leach and Malvino
8. Data Converters – B.S. Sonde.

SYLLABUS (CBCS) FOR M.Sc. PHYSICS
(W.E.F. June 2022)

Name of the Programme	: M.Sc. PHYSICS
Programme Code	: PSPH
Class	: M.Sc.
Semester	: I
Couse Name	: Electronics Laboratory-I
Course Code	: PSPH115
No. of Practicals	: 10

Course Outcomes:

Students will have achieved the ability to:

1. Understand the behaviour of electronic components and perform analysis and design ofbias circuits for diodes, transistors etc.
2. Set up testing strategies and select proper instruments to evaluate performance characteristics of electronic circuit.
3. Choosing testing and experimental procedures on different types of electronic circuit and analyse their operation different operating conditions.
4. Understand the basic operational amplifier characteristics, OPAMP parameters,applications as inverter, integrator, differentiator etc
5. Learn interfacing with peripheral I/O devices

(Students must perform Any 8 Experiments)

1. Voltage to Frequency Convertor using OP-AMP.
2. DAC (4-bit R-2R Ladder Type).
3. Active filter- Low pass, High pass, Band pass and Notch Filter using OP-AMP.
4. Function generator using OP-AMP.
5. Constant current source using OP-AMP.
6. Study of multiplexer and Demultiplexer.
7. Frequency modulation and demodulation.
8. Pulse code modulation and demodulation.
9. FSK modulation and demodulation.
10. Amplitude modulation and demodulation
11. Optical fibre communication.
12. Op-amp based clipper and clampers

13. Study of optocoupler using IC MCT-2E
14. Study of IC 7490 (Decade counter)
15. Design, built and test oscillator – Wien Bridge oscillator

Additional Activity (Any one Activity equivalent to two experiments)

Students must perform at least one additional activity out of two activities in addition to eight experiments mentioned above. Total Laboratory work with additional activities should be equivalent to ten experiments.

1. **Mini Projects**
2. **Industrial Visit / Study Tour/ Field visit**

SYLLABUS (CBCS) FOR M.Sc. PHYSICS
(W.E.F. June 2022)

Name of the Programme : M.Sc. PHYSICS
Programme Code : PSPH
Class : M.Sc.
Semester : I
Couse Name : Basic Physics Laboratory-I
Course Code : PSPH116
No. of Practicals : 10

Course Outcomes:

Students will have achieved the ability to:
1. Learn various experimental and computational tools thereby developing analytical abilities to address real world problems.
2. Adopt the skills related to research, education, and industry- academia.
3. Understand the principle and working of Photonic devices like LED, Laser diode, photodetectors, solar cells etc
4. Extend their understanding of various particle accelerators and its industrial uses.
5. Understand about different material analysis techniques and applications.

(Students must perform Any 8 Experiments)

1. Young's Modulus of steel by Flexural Vibrations of a bar
2. Fabry-Parot Etalon.
3. Hall Effect.
4. Resistivity of Ge at various temperature by Four Probe method and determination of band gap.
5. Determination of wavelength of He-Ne LASER by Reflection grating
6. Michelson Interferometer.
7. Magnetic Susceptibility by Gauoy's method.
8. 'e' by Millikan oil drop method.
9. G.M. Counter – I Counting statistics
10. G.M. Counter –II End point energy and Absorption coefficient using G. M. tube.
11. Measurement of the focal length of a given convex lens using a laser.
12. Electron Diffraction.
13. Determination of wavelength of He-Ne LASER by transmission grating
14. Coherence and width of spectral lines using Michelson Interferometer.

15. Determination of Seebeck coefficient and understanding of Thermocouple working.

Additional Activity (Any one Activity equivalent to two experiments)

Students must perform at least one additional activity out of two activities in addition to eight experiments mentioned above. Total Laboratory work with additional activities should be equivalent to ten experiments.

1. **Mini Projects**
2. **Industrial Visit / Study Tour/ Field visit**