SHIVAJI UNIVERSITY, KOLHAPUR

ACCREDITED BY NAAC WITH 'A^{++}' GRADE

REVISED SYLLABUS FOR

BACHELOR OF SCIENCE
Physics PART- III
Semester V & VI

NEP 2020 (2.0) SYLLABUS TO BE IMPLEMENTED

FROM

JUNE, 2026 ONWARDS

SHIVAJI UNIVERSITY ,KOLHAPUR NEP-2020 (2.0): Credit Framework for UG(B. Sc.) Programme under Faculty of Science and Technology									
SEM (Level)	COURSES			OE	VSC/SEC	AEC/VEC/IKS	OJT/FP/CEP /CC/RP	TOTAL CREDITS	Degree/Cum. Cr. MEME
	Course-1	**Course-2**	**Course-3**						
SEMI (4.5)	DSC-I(2) DSC-II (2) DSC P-I(2)	DSC-I(2) DSC-II (2) DSC P-I(2)	DSC-I(2) DSC-II (2) DSC P-I(2)	OE-1(2) (T/P)		IKS-I(2)		22	UG Certificate 44
SEMII (4.5)	DSC-III(2) DSC-IV (2) DSC P-I(2)	DSC-III(2) DSC-IV (2) DSC P-I(2)	DSC-III(2) DSC-IV (2) DSC P-I(2)	OE-2(2) (T/P)		VEC-I(2) (Democracy, Election and Constitution)		22	
Credits	**8(T)+4(P)=12**	**8(T)+4(P)=12**	**8(T)+4(P)=12**	**2+2=4 (T/P)**		**2+2=4**		**44**	**ExitOption:4credits NSQF/Internship/Skill courses**
	Major		**Minor**						
SEMIII (5.0)	Major V(2) Major VI (2) Major P III (2)		Minor V(2) Minor VI (2) Minor P III(2)	OE-3(2) (T/P)	VSC I (2) (P) (Major specific) SEC I(2) (T/P)	AECI(2) (English)	CC-I(2)	22	UG Diploma 88
SEMIV (5.0)	Major VII(2) Major VIII (2) Major P IV (2)		Minor VII(2) Minor VIII (2) Minor P IV(2)	OE-4(2) (T/P)	SEC II(2) (T/P)	AECII(2) (English) VEC-II(2) (Environmental studies)	CEP-I (2)	22	
Credits	**8(T)+4(P)=12**		**8(T)+4(P)=12**	**2+2=4 (T/P)**				**44**	**ExitOption:4credits NSQF/Internship/Skill courses**
SEMV (5.5)	Major IX(2) Major X (2) Major P V A(2) Major P V B(2)	Major I (ELEC)(2) Major P-I (ELEC) (2)		OE-5(2) (T/P)	VSC II (2) (P) (Major specific)	AECIII(2) (English)	OJT(4)	22	UG Degree 132
SEMVI (5.5)	Major XI(2) Major XII (2) Major P VI A(2) Major P VI B(2)	Major II (ELEC)(2) Major P-II (ELEC) (2)			VSC III (2) (P) (Major specific) SEC III(2) (T/P)	AECIV(2) (English) IKS-II(2) Major specific)	FP(2)	22	
Credits	8(T)+8(P)=16	4(T)+4(P)=8		2(T/P)	2(T/P)+4(P)=6	4+2=6	4+2=6	44	
Total Credits	**40+20=60**		**24**	**10**	**12**	**16**	**10**	**132**	**Exit option**
SEMVII (6.0)	Major –XIII(4) Major -XIV(4) Major(P),-VII(4) Major (P)-VIII(2)	Major III (4) (ELEC)	RM-I(4)					22	UG Honours Degree 176
SEMVIII (6.0)	Major –XV(4) Major -XVI(4) Major(P),-IX(4) Major (P)-X(2)	Major IV (4) (ELEC)					OJT(4)	22	
Credits	16(T)+12(P)=28	8(T)	4					44	
Total Credits	**68+28=96**		**28**	**10**	**12**	**16**		**176**	**Exit option**
SEMVII (6.0)	Major –XIII(4) Major -XIV(4) Major(P),-VII(2)	Major(4) (ELEC)	RM-I(4)				RP-(4)	22	UG Honours with research Degree 176
SEMVIII (6.0)	Major –XV(4) Major -XVI(4) Major(P),-VIII(2)	Major(4) (ELEC)					RP-(8)	22	
Credits	16(T)+4(P)=20	8(T)	4				12	44	
Total Credits	**60+28+88**		**28**	**10**	**12**	**16**	**22**	**176**	

Note:

University may decide to offer maximum of three subjects (Courses) in the first year. The student may select one subject out of combination ofthree subjects (Courses). (which a student has chosen in the first year) as a MAJOR subject (Course) and one subject (Course) as MINOR Subject in the second year. Thereby it is inferred that the remaining third subject (Course) shall stand discontinued.

DSC: Discipline Specific Core

Major: Manditory/Elective

Minor: Course may be from different discplines of same facultyof DSCMajor.

OE: (open elective): Elective courses/open elective to be choosen from facultyother than that of the Major.

VSC/SEC: Vocational skill courses(Mjor related)/Skill enhancement courses.

AEC/ VEC / IKS: Ability Enhancement Courses (English, Modern Indian Language) /Value Education Courses/ Indian Knowledge System (Generic & Specific)

1. Year of Implementation: June 2026
2. Preamble: The systematic and planned curricula from these courses shall motivate and encourage learners to understand basic concepts of Physics.
3. Medium of Instruction: English
4. Eligibility for Admission: As per the rules & regulations of Shivaji University, Kolhapur.
5. Scheme of teaching & Examination Pattern: As per the rules & regulations of Shivaji University, Kolhapur.

Structure of the Programme:

Semester	**Code**	***Major***	**Code**	***Elective***
V	Physics Major IX	Classical Mechanics	Physics Major I (Elective)	Nuclear and Particle Physics
	Physics Major X	Mathematical Physics & Electrodynamics	Physics Major I (Elective)	Energy Studies and Nanotechnolgy
	Physics Major Practical V	Major: Practical V (a)	Physics Major P-I (Elective) Practical	Major P-I (Elective) Practical: Nuclear and Particle Physics
	Physics Major Practical V	Major: Practical V (b)	Physics Major P-I (Elective) Practical	Major P-I (Elective) Practical: Energy Studies and Nanotechnology
	Physics VSC II Major Specific Practical (P)	VSC II Major Specific Practical (P)		
	OE-5 Practical	OE-5 Practical		
	OJT (04)			
VI	Physics Major XI	Quantum Mechanics	Physics Major II (Elective)	Solid State Physics
	Physics Major XII	Statistical Mechanics	Physics Major II (Elective)	Atomic and Molecular Physics and Astrophysics
	Physics Major Practical VI	Major: Practical VI (a)	Physics Major P-II (Elective) Practical	Major P-II (Elective) Practical: Solid State Physics
	Physics Major Practical VI	Major: Practical VI (b)		
	Physics VSC III Major Specific (P)	VSC III Major Specific (P)	Physics Major P-II (Elective) Practical	Major P-II (Elective) Practical: Atomic and Molecular Physics and Astrophysics
	Physics SEC III (P)	SEC III (P)		
	IKS-II (Major Specific)	IKS-II (Major Specific)		
	FP (02)			

Program Outcomes (POs)

After completing the B.Sc. (Physics) program, students will be able to:

PO1: Demonstrate a fundamental and conceptual understanding of core areas in Physics such as mechanics, thermodynamics, modern physics, electronics, and optics.

PO2: Apply physical principles and experimental techniques to analyze scientific problems and interpret data meaningfully.

PO3: Use critical thinking and problem-solving skills in theoretical and laboratory-based physics contexts.

PO4: Operate scientific equipment, conduct experiments, and analyze the results using appropriate computational tools.

PO5: Develop communication skills to present scientific information effectively through oral, written, and digital formats.

PO6: Exhibit ethical practices, social responsibility, and environmental awareness through field-based, community, and laboratory engagements.

PO7: Demonstrate continuous learning and research aptitude required for higher education and employability in scientific and technological sectors.

Program Educational Objectives (PEOs)

The B.Sc. (Physics) graduates are expected to:

PEO1: Gain a solid foundation in physics and related fields enabling them to pursue advanced degrees in Physics, Engineering, or interdisciplinary sciences.

PEO2: Acquire skills for employment in education, research, industry, communication, and service sectors.

PEO3: Demonstrate analytical skills, a scientific mindset, and problem-solving abilities relevant to both academic and societal challenges.

PEO4: Engage in lifelong learning with a commitment to ethical and sustainable scientific practices.

PEO5: Contribute to community and national development through scientific awareness, innovation, and entrepreneurship.

Program Specific Outcomes (PSOs)

B.Sc.III (Physics Major)

Shivaji University, Kolhapur (Effective from June 2026)

After successfully completing the B.Sc. II Physics program, the students will be able to:

PSO1: Master Core Theoretical Concepts: Demonstrate comprehensive understanding and problem-solving proficiency in fundamental areas including Classical Mechanics (Lagrangian Mechanics and D'Alembert's Principle, Rigid body motion), Mathematical Physics & Electrodynamics (orthogonal curvilinear coordinate systems , behavior of charged particles under electric and magnetic fields, fundamentals of electromagnetic waves), Quantum Mechanics (Schrödinger equation and its applications, various operators in quantum mechanics), and Statistical Mechanics (fundamental concepts of statistical physics, applications of Maxwell–Boltzmann, Bose–Einstein Statistics and Fermi–Dirac Statistics).

PSO2: Apply Practical Skills: Develop experimental skills by conducting practical's related to general physics , optics, electricity and magnetism , semiconductor physics and electronics

PSO3: Integrate Elective Knowledge: Select and excel in one elective from the pair *Nuclear and Particle Physics, and Energy Studies and Nanotechnolgy (Sem V) and Solid State Physic, and Atomic and Molecular Physics and Astrophysics (Sem VI),* applying theoretical principles through dedicated practical sessions, to build specialization and foster interdisciplinary thinking.

PSO4: Develop Vocational and Professional Competencies: Acquire hands-on vocational skills through skill enhancement courses, execute a field project involving real-world physics applications, and demonstrate workplace readiness via on-job training.

PSO5: Synthesize and Communicate Physics: Integrate knowledge across core, elective, practical, project, and training components to solve complex problems, interpret experimental data, and communicate findings effectively through reports, and project presentations, preparing for higher studies, research, or careers in academia, industry, or technology sectors.

Shivaji University, Kolhapur
B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-V
Major IX: Classical Mechanics

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Unit: I

1. **Lagrangian Formulation** **(10)**

   Constraints, Configuration Space, Degrees of freedom, generalized coordinates, Principle of virtual work, D'Alembert's principle, Lagrange's equation from D'Alembert's principle, Applications of Lagrange's equation: particle in space, Atwood's machine and a bead sliding on uniformly rotating wire under force free condition.

2. **Mechanics of Small Oscillations** **(05)**

   Problem of Small Oscillations, Example of linear tri atomic molecule and two coupled Oscillator, General Theory of Small Oscillations, Normal Coordinates and Normal Modes of Vibration.

Unit: II

1. **Techniques of Calculus of Variation** **(10)**

   Some techniques of calculus of variation, Hamilton's principle, Deduction of Lagrange's equation from Hamilton's principle, Deduction of Hamilton's principle from D'Alembert's principle, Applications of variation principle: shortest distance problem, Brachistochrone problem, and Geodesic of a spherical surface.

2. **Rigid Body Motion** **(05)**

   Motion of a rigid body in space, Euler's theorem, Angular momentum and kinetic energy, Euler's equation of motion.

References Books

1. Classical Mechanics, Goldstein Herbert, Narosa Publication
2. Classical Mechanics, Gupta, Kumar and Sharma, Pragati Prakashan.
3. Introduction to Classical Mechanics, Takwale R.G., Puranik P.S., Tata McGraw
4. Classical Mechanics, Panat P.V., NarosaPublication
5. An Introduction to Mechanics, D. Kleppner& R. Kolenkow, Cambridge
6. Classical Mechanics, N.C. Rana & P.S. Joag, Tata McGraw-Hill

Course Outcomes-

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

1. Understand fundamental concepts such as constraints, degrees of freedom, configuration space, and generalized coordinates in analytical mechanics.

2. Apply Lagrangian Mechanics and D'Alembert's Principle to derive and solve equations of motion for mechanical systems.
3. Analyze systems undergoing small oscillations and determine normal modes and frequencies for coupled systems.
4. Apply Calculus of Variations and Hamilton's Principle to derive equations of motion and solve classical variational problems.
5. Analyze rigid body motion using concepts of angular momentum, kinetic energy, and Euler's Equations of Motion.

Shivaji University, Kolhapur
B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-V
Major X: Mathematical Physics & Electrodynamics

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Unit: I

1. **Orthogonal Curvilinear Coordinates** **(09)**

Introduction to Cartesian, Spherical polar and Cylindrical coordinate systems, Concept of orthogonal curvilinear coordinates, Unit tangent vectors, Arc length, Area and Volume elements in orthogonal curvilinear coordinate system, Del, Gradient, Divergence, Curl and Laplacian in orthogonal curvilinear coordinate system, Extension of del, gradient, divergence, curl and Laplacian in Cartesian, Spherical polar and Cylindrical coordinate systems.

2. **Partial Differential Equation** **(06)**

Introduction to differential equations, Order and degree of partial differential equations, Method of separation of variables for solving second order partial differential equations, Form of two-dimensional Laplace differential equation in Cartesian coordinates and its solution, Three-dimensional partial differential equation in Cartesian coordinates and its solution.

Unit: II

1. **Charged Particles Dynamics** **(9)**

Poisson's and Laplace's equations. Physical significance of Poisson's and Laplace's equations, Laplace's equation in one dimension and its solutions, Motion of charged particle in uniform electric field E, Motion of charged particle in uniform magnetic field $\vec{B}$, Motion of charged particle in Crossed uniform electric field $\vec{E}$ and magnetic field $\vec{B}$.

2. **Electromagnetic Waves** **(6)**

Wave equation for $\vec{E}$ and $\vec{B}$ fields in vacuum, plane wave solutions, transverse nature of electromagnetic waves, plane electromagnetic waves in vacuum, skin depth, Poynting's theorem, conservation of energy in electromagnetic fields, Boundary conditions for electromagnetic field vectors.

Reference Books

1. Mathematical Methods for Physicists, G. Arfken, Weber, Elsevier.
2. Mathematical Physics, H. K. Das
3. Differential Equations, Gupta Malik and Mittal.
4. Mathematical Physics, B. S. Rajput.

5. Introduction to Electrodynamics , David. J. Griffiths , Pearson Publishing
6. Classical Electrodynamics, Puri S.P., Tata McGraw/Alpha Science
7. Classical Electrodynamics, Jackson J. D., Wiley India
8. Electromagnetics, Laud B.B., New Age International.

Course Outcomes-

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

1. Understand and apply the mathematical framework of orthogonal curvilinear coordinate systems, including gradient, divergence, curl, and Laplacian, in Cartesian, cylindrical, and spherical coordinates.
2. Solve partial differential equations using appropriate techniques such as separation of variables, and apply them to physical problems like the Laplace's Equation in two and three dimensions.
3. Analyze the behavior of charged particles under electric and magnetic fields using Poisson's Equation and Laplace's Equation, and study motion in uniform and crossed fields.
4. Understand the fundamentals of electromagnetic waves, including wave equations, transverse nature, energy transport through Poynting's Theorem, and boundary conditions in different media.

Shivaji University, Kolhapur

B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026

Semester-V

Major: Practical V (a)

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I

1. Resonance pendulum
2. Surface tension of soap solution
3. Surface tension of mercury by Fergusson's modified method
4. Surface tension of a liquid by method of ripples.
5. Y by flat spiral spring
6. Velocity of sound using Kundt's tube /CRO
7. Frequency of electrically maintained tuning fork by Melde's experiment

Group II

1. Cardinal points by turn table
2. Cardinal points by Newton's method
3. Diffraction at single slit
4. Determination of Cauchy's constants
5. Diffraction at cylindrical obstacle
6. Verification of Malus' Law using Polarized Light.
7. Spherical aberration

Course Outcomes (COs)

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

1. Understand and explain the fundamental principles of mechanics, elasticity, oscillations, and wave motion through laboratory experiments such as resonance pendulum, Melde's experiment, Kundt's tube, and flat spiral spring.
2. Determine physical properties of materials and liquids, including surface tension, Young's modulus, and velocity of sound, using appropriate experimental methods and analyze the associated sources of error.
3. Investigate optical phenomena such as diffraction, polarization, cardinal points of lenses, chromatic dispersion, and spherical aberration through experimental observations and measurements.
4. Develop experimental skills in data collection, graphical analysis, error estimation, and scientific report writing while using standard laboratory instruments and techniques.

Shivaji University, Kolhapur

B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026

Semester-V

Major: Practical V (b)

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I

1. Self-inductance by Owen's bridge
2. Self-inductance by Maxwell's bridge
3. Measurement of low resistance by Carey-Foster's bridge
4. Resistance of BG by half deflection method
5. Absolute capacity of condenser using BG
6. High resistance by leakage method using BG
7. Measurement of dielectric constant of given material

Group II

1. To verify the truth tables of NAND, NOR, Ex-OR and Ex-NOR gates by using basic gates with IC-74series.
2. NAND and NOR gates as universal gate
3. Negative feedback amplifier
4. To study Op-amp as an inverting amplifier
5. Op-Amp as Schmitt trigger
6. To design and test an astable multivibrator using IC-555 Timer
7. To design and test monostable multivibrator using IC-555 Timer.

Course Outcomes (COs)

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

1. Apply the principles of electrical circuits and bridge networks to measure electrical parameters such as resistance, inductance, capacitance, dielectric constant, and galvanometer characteristics.
2. Perform experiments involving electrical measurements and analyze experimental data to determine the accuracy, precision, and limitations of measuring instruments and methods.
3. Design, construct, and verify digital logic circuits using basic and universal gates, and analyze their functionality through truth tables and logical operations.
4. Develop and test analog and digital electronic circuits using operational amplifiers, feedback amplifiers, and IC-555 timer applications such as Schmitt triggers, astable, and monostable multivibrators.

Shivaji University, Kolhapur

B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026

Semester-V

Major I (Elective): Nuclear and Particle Physics

Theory: 30Hours **Marks-50** **(Credits: 02)**

Unit: I

1. **General Properties of Atomic Nucleus and Nuclear Energy (07)**

   Key characteristics of a nucleus (composition, charge, mass, shape, size, radius, magnetic moment and Quadrupole moment). Mass defect, Binding energy, Binding energy curve, Liquid drop model, Semi-empirical mass formula, Nuclear fission, Nuclear fusion, Atomicenergy program in India.

2. **Particle Accelerators (08)**

   Cyclotron: construction, working, theory, limitations, Principle of phase stability. Synchrocyclotron: construction, working. Electron synchrotron, Proton synchrotron, Betatron: principle, construction, working, theory. Nuclear accelerators in India.

Unit: II

1. **Nuclear Detectors. (07)**

   Ionisation chamber: principle, working. Geiger-Muller counter: principle, construction, working, dead time, recovery time, quenching mechanism. Scintillation Counter:photomultiplier tube, scintillators, pulse formation, resolving power. Wilson cloud chamber.

2. **Elementary Particles. (08)**

   Classification of Elementary Particles, Fundamental Interactions, (Gravitational, Electromagnetic, Strong, Weak) Conservation laws: Angular momentum, Energy, Charge, Lepton Number, and Baryon Number. Quark Model (Brief description), God particle, Ghost particle, Large Hadron Collider (LHC).

Reference Books:-

1. Nuclear Physics - D.C.Tayal - Himalaya Publishing House.
2. Concepts of nuclear physics - Bernard L. Cohen (Tata McGraw-Hill 1998)
3. Nuclear Physics - Satya Prakash - Pragati Prakashan
4. Nuclear Physics - Dr. S. N Ghoshal - S. Chand
5. Atomic and Nuclear Physics-Subrahmanyam and Brijlal Revised by JivanSeshan- S.Chand
6. Introduction to Nuclear and Particle Physics- V. K. Mittal, Verma, andGupta -Eastern Economy Edition

7. Atomic energy in India – A. K. Tyagi and P. R. Vasudeva Rao
8. Nuclear and Physics: An Introduction - S.B. Patel - New Age InternationalPublishers
9. Adventure of the LHC – Daniel Denegri (2021)
10. The Large Hadron Collider: A Marvel of Technology – Edited by LyndonR. Evans (2008)

Course outcomes: -

The course outcomes of Nuclear and Particle physics

1. Students will be able to understand nuclear structure including Nuclear size, mass, density, angular momentum, binding energy and magnetic dipole moments.
2. Students will be able to analyze Nuclear models such as liquid drop models(semi empirical mass formula) to explain Nuclear stability
3. Students will be able to explain radioactive decay and Nuclear reactions.
4. Students will be able to understand the four fundamental forces acting on subatomic particles and will be able to apply symmetry and conservation laws to interactions and decay

Shivaji University, Kolhapur

B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026

Semester-V

Major I (Elective): Energy Studies and Nanotechnology

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Unit: I

1. **Solar Energy** **(08)**

   Renewable energy and its importance, Solar energy, Solar energy spectrum, Solar constant, Clarity index, Solar insolation. Utilization of Solar Energy: (A) Thermal Route: Solar thermal devices, Essential subsystems of solar thermal power plants, Examples of solar thermal power plants. (B) Photovoltaic Route: Solar cells, I–V characteristics of solar cells, generations of solar cells, Essential subsystems of solar photovoltaic systems, Power output of solar cells and solar photovoltaic panels, Merits and demerits of solar photovoltaic systems.

2. **Wind Energy** **(07)**

   Origin of wind, Wind energy as a renewable energy source, Wind energy conversion chains, Wind power density, Power output of wind turbines for a given incoming wind velocity, Types of wind turbine generator units (HAWT and VAWT), Horizontal-axis propeller-type wind turbine generator unit, Mono, twin and three blades wind turbine generator units, Planning of wind farms and site selection, Advantages, limitations, and environmental impact of wind energy.

Unit: II

1. **Nanoscience** **(06)**

   The development of nanoscience, Length scales relevant to nanoscience, Surface-to-volume ratio, Quantum confinement, Classification of nanostructures: 0D, 1D, 2D, 3D. Size-dependent optical, electrical, and magnetic properties,

2. **Nanotechnology** **(09)**

   Making of nanostructures: Top-Down Approach (Mechanical Ball Milling, Lithography), Bottom-Up Approach (Sol-gel method and Chemical Vapour Deposition), Fundamental principles of the Nucleation and Growth mechanism. Applications of Nanotechnology: Energy applications, Environmental applications, and Biomedical applications.

Reference Books:

1. Non-Conventional Energy Sources, G. D. Rai, Khanna Publishers.
2. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, Tata McGraw Hill.
3. Renewable Energy Sources, John Twidell and Tony Weir, Routledge.
4. Introduction to Nanotechnology, Charles P. Poole Jr. and Frank J. Owens, Wiley India Pvt. Ltd.
5. Nanotechnology: Principles and Practices, Sulabha K. Kulkarni, Capital Publishing Company.
6. Textbook of Nanoscience and Nanotechnology, B.S. Murty, P. Shankar et al., Universities Press.
7. Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Guozhong Cao, World Scientific Publishing.
8. Science at the Nanoscale, Andrew T. S. Wee, Chorng Haur Sow, Chin Wee Shong, Jenny Stanford Publishing

Course Outcomes (CO's):

After successfully completing this course, the student will be able to

1. Analyse solar radiation parameters and differentiate between thermal and photovoltaic conversion routes to assess the efficiency and output of various solar energy devices.
2. Explain wind energy conversion chains and calculate power density to determine the suitability of different wind turbine types (HAWT and VAWT) for specific site conditions and environmental impacts.
3. Relate the physical principles of nanoscience, such as quantum confinement and high surface-to-volume ratios, to the unique optical, electrical, and mechanical changes observed in 0D to 3D nanostructures.
4. Compare Top-Down and Bottom-Up synthesis methodologies (like ball milling vs. CVD) and propose qualitative nanotechnology solutions for challenges in energy, environment, and medicine.

Shivaji University, Kolhapur
B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-V
Major P-I (Elective) Practical: Nuclear and Particle Physics

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group – I

1. e/m of electron by Thomson Method.
2. Study of Tunnelling effect using a tunnel diode
3. To build a nucleus and study radioactive decay and half life time using PhET simulation.
4. To study the phototransistor characteristics.
5. To measure the absorption coefficient of a given transparent medium (using a semiconductor Photodiode and a monochromatic light source)
6. To design and study the temperature sensor circuit using thermistor.
7. To measure the numerical aperture of the optical fibre.

Group - II

1. To determine Ionization potential of hydrogen.
2. To determine the fine structure constant of sodium doublet lines.
3. To determine the work function of a metal using photoelectric cell.
4. To design a voltage divider circuit using a LDR.
5. To study the variation of total thermal radiation with temperature using torch bulb filament.
6. Activity based experiment to demonstrate randomness in radioactive decay.
7. Study of neutron diffraction pattern

References

1. Experiments in Engineering physics' by M.N. Avadhanulu, A.A. Dani, P.M. Pokley – S. Chand and Co, New – Delhi.
2. B. Sc Practical Physics by C.L. Arora Published by S. Chand and Co, New – Delhi.
3. B. Sc. Practical Physics by P.S. Hemne, Harnam Singh, S. Chand Publication.
4. Advanced Practical Physics for Students by B. L. Worsnop and H. T. Flint,
5. Build a Nucleus - Nuclear Physics | Nuclear Decay | Isotope - PhET Interactive Simulations.
6. A Laboratory Manual for Undergraduate Classes by D.P. Khandelwal, (Vani Publishing House, New Delhi.
7. Electronic Devices and Circuits Lab Manual – David A. Bell.
8. Nuclear Physics: Principles and Applications – John Lilley.
9. Practical Physics – S. L. Gupta and V. Kumar (Pragati Prakashan)

Course Outcomes:

After successfully completing this course, the student will be able to:

1. Apply fundamental concepts of modern physics, atomic physics, nuclear physics, semiconductor physics, and optics through laboratory experiments and simulations.
2. Design, assemble, and analyze electronic sensor circuits and semiconductor-device-based systems such as photodiodes, phototransistors, thermistors, LDRs, and tunnel diodes.
3. Perform experimental measurements, collect and interpret data, estimate uncertainties, and determine physical parameters such as e/m ratio, ionization potential, work function, absorption coefficient, numerical aperture, and fine structure constant.
4. Investigate quantum and nuclear phenomena including tunneling, photoelectric effect, radioactive decay, neutron diffraction, and statistical randomness using experimental and simulation-based techniques, and communicate the results effectively through scientific reports.

Shivaji University, Kolhapur
B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-V
Major P-I (Elective) Practical: Energy Studies and Nanotechnology

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group - I

1. Study of PV Panel Characteristics Using Series-Connected Solar Cells and Evaluation of Power, Efficiency, and Fill Factor.
2. Study of PV Panel Characteristics Using Parallel-Connected Solar Cells and Evaluation of Power, Efficiency, and Fill Factor.
3. Measurement of Solar Constant
4. Estimation of Solar Insolation and Atmospheric Clarity Index.
5. To calculate wind power density for a given wind velocity.
6. Study of the angular response of a photovoltaic cell using a polar graph.
7. Determination of Band-gap energy using LED.

Group - II

1. Performance Evaluation of a Solar Box Cooker / Solar Water Heater
2. Analysis of Nanoparticle Size Reduction via Mechanical Ball Milling
3. Determination of band gap energy of p-n junction diode.
4. Study of quantum dots using simulation.
5. To study surface area to volume ratio with particle size using simulation
6. Study of Wind Turbine Power Output Characteristics for HAWT Models
7. To study the temperature sensor using thermistor

References

1. Experiments in Engineering physics' by M.N. Avadhanulu, A.A. Dani, P.M. Pokley – S. Chand and Co, New – Delhi.
2. B. Sc Practical Physics by C.L. Arora Published by S. Chand and Co, New – Delhi.
3. B. Sc. Practical Physics by P.S. Hemne, Harnam Singh, S. Chand Publication.
4. Advanced Practical Physics for Students by B. L. Worsnop and H. T. Flint,
5. Build a Nucleus - Nuclear Physics | Nuclear Decay | Isotope - PhET Interactive Simulations.
6. A Laboratory Manual for Undergraduate Classes by D.P. Khandelwal, (Vani Publishing House, New Delhi.
7. Electronic Devices and Circuits Lab Manual – David A. Bell.
8. Nuclear Physics: Principles and Applications – John Lilley.
9. Practical Physics – S. L. Gupta and V. Kumar (Pragati Prakashan)

Course Outcomes:

After successfully completing this course, the student will be able to:

1. Apply the fundamental principles of renewable energy systems, semiconductor devices, and nanoscience through experimental investigations and simulations.
2. Evaluate the performance characteristics of solar energy systems and wind energy devices by measuring parameters such as power output, efficiency, fill factor, solar insolation, solar constant, and wind power density.
3. Perform experimental measurements and data analysis to determine material and device properties including band-gap energy, temperature sensitivity, particle size effects, and photovoltaic response characteristics.
4. Analyze nanoscale phenomena and renewable energy technologies using laboratory experiments, simulations, graphical methods, and scientific reporting techniques.

Shivaji University, Kolhapur
B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-V
Vocational Skill Course (VSC)–II Major Specific Practical

Theory: 30 Hours **Marks-50** **(Credits:02)**

Group I: Applied Electrical Circuits and Sensor Technology

1. To study decay of Current in RC Circuit using Microammeter.
2. To determine mutual inductance of a two coil by Maxwell method.
3. To study the variation of inductive reactance and capacitive reactance with frequency of an ac source.
4. To study the phase relationship between current and voltage in an AC circuit containing R and L.
5. Determination of Inductance and Capacitance by Three-Voltage Method.
6. IR obstacle sensor using Arduino Kit.
7. Gas sensor using Arduino Kit.

Group II: Applied Optics and Computational Physics

1. To determine the radius of curvature of a convex mirror by plane mirror method
2. Determine the focal length of a co-axial lens System or of an eye piece by measuring the magnification produced by it at two different distances.
3. To determine (i) radius of curvature of a lens Surface (ii) refractive index of the materials of the lens by Boys' method.
4. To determine the angular magnifying Power of telescope by slit method.
5. Python program to find the numerical solution of first-order differential equation.
6. Simulation of simple harmonic motion (SHM) using Python programme.
7. To Study the projectile motion with and without air resistance using python programme.

References:

1. B.Sc. Practical Physics – Dr. P.S. Hemne and Harnam Singh – S. Chand Publishing, New Delhi.
2. Advanced Practical Physics for Students – B.L. Worsnop & H.T. Flint – Asia Publishing House.
3. B.Sc. Practical Physics – C.L. Arora – S. Chand and Co., New Delhi.
4. Experiments in Engineering Physics – M.N. Avadhanulu, A.A. Dani and P.M. Pokley – S. Chand and Co., New Delhi.
5. A Text Book of Practical Physics – Indu Prakash & Ramakrishna – Kitab Mahal, New Delhi.
6. Practical Physics – P.R. Sasi Kumar – PHI Learning Pvt. Ltd., New Delhi.

7. Practical Physics – Y.P. Singh – SRGPC Publication, Sagar (M.P.), India.

Course Outcomes (COs)

1. Understand and analyze AC electrical circuits, including RC and RL circuits, and apply methods such as Maxwell's method and three-voltage method to determine inductance, capacitance, and mutual inductance.
2. Develop the ability to study frequency response and phase relationships in electrical circuits by analyzing variation of inductive and capacitive reactance and current–voltage phase differences.
3. Design and implement sensor-based systems using Arduino, including IR obstacle detection and gas sensing, and interpret their practical applications.
4. Apply principles of optics and computational physics, including determination of focal length, refractive index, and magnifying power of optical instruments, along with solving and simulating physical systems (SHM, projectile motion, differential equations) using Python.

Shivaji University, Kolhapur

B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026

Semester-V

OE-5 (P) - Astronomy and Sky gazing

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I

1. Introduction to the telescope (Structure and uses)
2. Study of light spectra (line and continuous) using a spectrometer
3. Measuring star brightness (using Lux meter)
4. Diagrammatic study of various phases of solar and lunar eclipses
5. Basic night sky observation with the unaided eye (Phases of the Moon, Pole star, constellation, and planet identification)
6. Exploring the sky using Stellarium software – I (Constellation study)
7. Exploring the sky using Stellarium software – II (Planet study)

Group II

1. Constellation map drawings – a) Orion, b) Ursa Major (Big Dipper), c) Auriga, d) Taurus.
2. To use the idea of parallax to determine a large distance.
3. Study of Solar Spectrum.
4. Sunspot activity analysis.
5. Measurement of Relative Humidity
6. Analysis of Drought and Flood Years Long-Term Rainfall Data
7. Analysis of temperature variations using long-term meteorological data
8. Analysis of long-term CO_2 variations and their relationship with temperature trends

Course Outcomes (COs)

1. Understand the basic principles and working of astronomical instruments such as telescopes, spectrometers, and lux meters, and apply them to study light, spectra, and celestial observations.
2. Develop the ability to observe and interpret celestial phenomena, including phases of the Moon, eclipses, constellations (like Orion and Ursa Major), planets, and identification of the Pole Star using both unaided eye and Stellarium software.
3. Apply scientific concepts such as parallax, spectral analysis, solar activity, and atmospheric measurements (e.g., humidity) to analyze physical and astronomical data.
4. Analyze and interpret long-term environmental and astronomical datasets, including rainfall, temperature, CO_2 trends, and sunspot activity, to understand climate patterns and their interrelationships.

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B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-V
OE-5 (P) – खगोलशास्त्र व आकाश निरीक्षण

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I

1. दुर्बिणीचीओळख (रचना व उपयोग)
2. वर्णपट मापकाच्या साहाय्याने प्रकाशाच्या वर्णपटाचाअभ्यास
   (रेषीय व सलग वर्णपट)
3. ताऱ्यांच्या तेजस्वितेचे मापन (लक्समीटरच्या साहाय्याने)
4. सूर्य व चंद्रग्रहणांच्या विविध अवस्थांचा आकृतीद्वारेअभ्यास.
5. उघड्या डोळ्यांनी रात्रीच्या आकाशाचे मूलभूत निरीक्षण (चंद्राच्या कला, ध्रुवतारा, नक्षत्र व ग्रहांचीओळख)
6. स्टेलॅरियम सॉफ्टवेअरच्या साहाय्याने आकाशाचा अभ्यास – I (नक्षत्रांचाअभ्यास)
7. स्टेलॅरियम सॉफ्टवेअरच्या साहाय्याने आकाशाचा अभ्यास – II (ग्रहांचा अभ्यास)

Group II

1. नक्षत्र नकाशा रेखाटन [अ) मृग (Orion), ब) सप्तर्षी (Big Dipper), क) सारथी (Auriga) ड) वृषभ (Taurus)
2. दृष्टिलंबन (Parallax) संकल्पनेचा वापर करून मोठ्या अंतराचे मापन
3. सौर वर्णपटाचाअभ्यास
4. सौर डाग क्रियाशीलतेचे विश्लेषण
5. सापेक्षआर्द्रतेचे मापन
6. दुष्काळ आणि पूर वर्षांतील दीर्घकालीन पर्जन्यमानाची आकडेवारी – विश्लेषण
7. दीर्घकालीन हवामानशास्त्रीय आकडेवारीचा वापर करून तापमानातील बदलांचे विश्लेषण
8. दीर्घकालीन CO_2 बदलांचे आणि त्यांचा तापमानातील प्रवृत्तींशी असलेल्या संबंधांचे विश्लेषण

Shivaji University, Kolhapur
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Semester-VI
Major XI: Quantum Mechanics

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Unit: I

1. **Schrodinger's Wave Equation** **(07)**

   Wave function and its physical interpretation, Condition of physically acceptable wave function, Normalization and orthogonal conditions of wave function, Schrödinger's time independent (Steady state) wave equation in 1-D and 3-D, Schrödinger's time dependent wave equation, Probability current density (equation of continuity), Expectation values of dynamic variables.

2. **Operators in Quantum Mechanics** **(08)**

   Introduction to operator and commutation algebra, Eigen function and eigen value equation, Linear momentum operator (p), Kinetic energy operator (T), Hamiltonian operator (H), Parity operator (π), Angular momentum operator (L) and its component in cartesian and spherical coordinate system. Commutator bracket involving position and linear momentum, components of angular momentum.Ladder (raising and lowering) operators. Eigen values of L_z and L^2.

Unit: II

1. **Applications of Schrodinger Equation** **(08)**

   Particle in a rigid box (infinite potential well) in one dimension and three dimensions, Step potential- reflection and transmission coefficients, Potential barrier: tunneling effect (qualitative treatment), explanation of α- decay, One dimensional simple harmonic oscillator (operator method): energy levels, zero point energy.

2. **Hydrogen atom** **(07)**

   Schrodinger wave equation for Hydrogen atom in spherical polar coordinates, Separation of radial and angular parts, Solution of radial part and angular parts of Schrodinger's wave equation, explanation of energy eigen values using solution of radial parts of Schrodinger wave equation. Significance of quantum numbers n, l, m_l and m_s .

Reference Books:

1. Modern Physics, R. Murugeshan, S. Chand and Company Ltd.
2. Introduction to Quantum Mechanics, David J. Griffiths, Cambridge University Press
3. Atomic Physics, J B Rajam, S Chand and Co.
4. Perspectives of Modern Physics, Arthur Beiser, McGraw Hill International Editions.
5. Concepts of Modern Physics, Arthur Beiser, Ahobhit Mahajan, S. Rai Choudhury, Sixth Edition, Tata McGraw Hill Education Private Ltd.

6. Modern Physics, S. L. Kakani and Shubhra Kulkarni, Viva books Private Ltd.
7. Modern Physics, D. L. Sehgal, K. L. Chopra and N. K. Sehgal, Reprint, Sultan Chand & sons.
8. Introduction to Modern Physics, F. K. Richtmyer, E. H. Kennard, John N. Cooper, Sixth Edition, Tata McGraw Hill Education Private Ltd.
9. A Text book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, Tata McGraw Hill
10. Quantum Mechanics Theory and Applications, A. K. Ghatak and S. Lokanathan, Macmillan India Ltd.
11. Quantum Mechanics, Chatwal and Anand, Himalaya Publishing house.
12. Quantum Mechanics, Gupta, Kumar, Sharma, 2011, Jai Prakash Nath Publications.
13. Advanced Quantum Mechanics, Satya Prakash, KedarNath Ram Nath Meerut.
14. Advanced Quantum Mechanics, B. S. Rajput, Ninth Edn., Pragati Prakashan.
15. Quantum Mechanics, B. N. Srivastava, Pragati Prakashan.
16. Quantum Mechanics, S. P. Singh, M. K. Bagade, Kamal Singh, S. Chand & company Ltd, New Delhi.

Course Outcomes (COs):

After successfully completing this course, the student will be able to do the following:

1. To understand the Schrödinger wave equations and its behavior with restriction and non-restriction of particle.
2. To understand the various operators in quantum mechanics and how it use.
3. To understand the applications of Schrodinger wave equation and simple harmonic oscillator in operator method.
4. To understand the Schrodinger equation for Hydrogen atom in spherical polar coordinates and significance of quantum numbers n, l, m_l and m_s .

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Semester-VI
Major XII: Statistical Mechanics

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Unit: I

1. **Basic concepts of Statistical Physics** **(7)**

   Phase space, Microstates and Macrostate, Accessible microstates, apriori probability and Thermodynamic probability, Probability of distribution, the most probable distribution. Entropy and its statistical interpretation, Relation between entropy and thermodynamic probability.

2. **Classical Statistical Mechanics** **(8)**

   Assumptions of Maxwell-Boltzmann statistics, Maxwell-Boltzmann distribution law, Evaluation of constants α and β. Molecular speed distribution: most probable, average, and rms speeds, Law of equipartition of energy, Application to ideal gas, Limitations of classical statistics

Unit: II

1. **Black Body Radiation** **(5)**

   Experimental study of black body radiation spectrum, expression for energydensity, radiation pressure, relation for radiation pressure due to diffuse radiation in terms of energy density.

2. **Quantum Statistics** **(10)**

   Bose-Einstein statistics, B-E distribution law, derivation of Planck's radiation formula, deductions of Rayleigh-Jean's law, Wien's distribution law, Wien's displacement law and Stefan's law from Planck's formula. Fermi-Dirac Statistics, F-D distribution law, comparison between M-B, B-E and F-D statistics.

References

1. Heat, Thermodynamics and Statistical Physics: N. Subrahmaniam, Brijlal and P. Homme
2. Fundamentals of Heat : D.S. Mathur.
3. Textbook of Heat : J.B. Rajam.
4. Textbook of Heat : G.R. Noakes.
5. Thermodynamics : F.W. Sears.
6. Thermodynamics: J.P. Holman.
7. Heat, Thermodynamics and Statistical Physics : Agarwal and Satya Prakash.
8. Thermal Physics: S.Garg, R.Bansal and C. Ghosh.
9. Thermodynamics, Kinetic Theory and Statistical Thermodynamics :F.W.Sears and G.L.Salinger.
10. Heat and Thermodynamics: M. W. Zimansky and R. Dittam

11. Physics for Degree Students B.Sc. - Arora, Hemne, S. Chand.
12. Concepts of Modern Physics - Arthur Beiser, McGraw-Hill.

Course Outcomes (COs):

After successfully completing this course, the student will be able to do the following:

1. Understand fundamental concepts of statistical physics such as phase space, microstates, macrostates, and entropy, including their statistical interpretation.
2. Apply Maxwell–Boltzmann Statistics to derive distribution laws and evaluate molecular speeds and thermodynamic properties of ideal gases.
3. Analyze molecular energy distribution using the law of equipartition of energy and identify the limitations of classical statistical mechanics.
4. Explain black body radiation and apply Planck's Radiation Law to derive important results such as Wien's displacement law and Stefan's law.
5. Apply Bose–Einstein Statistics and Fermi–Dirac Statistics to analyze quantum systems and compare them with classical statistics.

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B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-VI
Major: Practical VI (a)

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I

1. η by Flat spiral spring
2. Y by Koenig's method
3. Y by Cornu's method
4. To investigate the motion of coupled oscillators.
5. Velocity of sound by resonating bottle
6. Thermal conductivity of material by Lee's method
7. Surface tension of mercury by Quincke's method

Group II

1. Searl's Goniometer - Cardinal points
2. Searl's Goniometer – Equivalent focal length
3. Dispersive power of prism
4. Double refracting prism
5. Thickness of mica sheet by using Fresnel's biprism
6. Diameter of Lycopodium powder
7. Lloyds single mirror

Course Outcomes (COs):

After successfully completing this course, the student will be able to do the following:

1. Determine the mechanical properties of materials, including Young's modulus and modulus of rigidity, using experimental methods and analyze the behavior of elastic materials under different conditions.
2. Measure physical parameters related to wave motion, acoustics, heat transfer, and surface phenomena such as velocity of sound, thermal conductivity, and surface tension using standard laboratory techniques.
3. Investigate optical properties of lenses, prisms, and interference systems by determining cardinal points, focal lengths, dispersive power, refractive behavior, and dimensions of microscopic objects.
4. Develop proficiency in experimental design, precision measurement, data analysis, graphical representation, uncertainty estimation, and scientific interpretation of laboratory results.

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B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-VI
Major: Practical VI (b)

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I

1. Frequency of oscillator using Wien's bridge
2. Calibration of bridge wire by Griffith's method
3. Calibration of bridge wire by Carey-Foster's bridge
4. Measurement of B_H , B_V and θ using Earth Inductor
5. Comparison of capacities using DeSauty's bridge using headphone and AF generator
6. Mutual inductance of transformer using BG
7. Self-inductance of coil by Rayleigh method using BG

Group II

1. Crystal oscillator
2. Voltage sweep generator using UJT
3. Characteristics of FET
4. FET as VVR.
5. Study of quantum tunnelling phenomenon using python program (transmission probability versus barrier width)
6. To study Maxwell- Boltzmann speed distribution using Python program.
7. Study of Fermi-Dirac Distribution using Python program

Course Outcomes (COs):

After successfully completing this course, the student will be able to do the following:

1. Apply bridge methods and electromagnetic principles to determine electrical and magnetic parameters such as inductance, capacitance, oscillator frequency, and components of the Earth's magnetic field.
2. Perform calibration and precision measurements using electrical instruments and analyze experimental data to evaluate circuit and magnetic characteristics.
3. Design, construct, and characterize electronic circuits involving crystal oscillators, UJT-based sweep generators, and field-effect transistors (FETs) for various applications.
4. Utilize computational tools and Python programming to simulate and analyze quantum tunneling, Maxwell–Boltzmann distribution, and Fermi–Dirac statistics, and interpret the physical significance of the results.

Shivaji University, Kolhapur

B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026

Semester-VI

Major II (Elective): Solid State Physics

Theory: 30Hours **Marks-50** **(Credits: 02)**

Unit: I

1. **Crystal Structure** **(8)**

Solids: amorphous, polycrystalline and crystalline materials; lattice, basis, unit cell – primitive, non-primitive unit cell, symmetry operations, symmetry elements of cube, Bravais lattice in two and three dimensions, Miller indices, Miller indices and interplanar spacing, Simple crystal structures: SC, BCC, FCC and HCP (Co-ordination number, atomic radius, atoms per unit cell and packing fraction)

2. **X-Ray Diffraction** **(7)**

Reciprocal lattice and its properties, Diffraction of X-rays by crystals, Ewald construction, Bragg's law in reciprocal lattice, Experimental methods in X-ray diffraction (Laue method, rotating crystal method, powder photograph method), Analysis of cubic crystal by powder method.

Unit: II

1. **Elementary Band Theory of Solids** **(8)**

Concept of density of states, Bloch theorem (statement only), Kronig-Penney model, Origin of energy gap, Velocity of electrons according to band theory, Effective mass of an electron, Distinction between metals, Semiconductors and insulators, Hall Effect- Hall voltage and Hall Coefficient.

2. Superconductivity **(7)**

Idea of superconductivity, Critical temperature, Critical magnetic field, Meissner effect, Type- I and Type- II superconductors, BCS theory of superconductivity, London equation and penetration depth (without derivation), Isotope effect, Application (magnetic levitation)

Reference Books

1. Introduction to Solid State Physics, Charles Kittle, 8th Ed. 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prenice-Hall of India.
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
4. Solid State Physics, Neil W. Aschroft and N. David Mermin,1976, Cengage Learning.
5. Solid State Physics, Rita John,2014, Mc-Graw Hill.
6. Solid State Physics, Adrianus J. Dekker, Macmillan Publishers India Ltd.
7. Solid State Physics, M.A. Wahab,3rd Ed.,2018, Narosa Publishing House Pvt. Ltd.
8. Solid State Physics, S.O. Pillai, 5th Ed., New Age International(P) Ltd., Publishers.

9. Fundamentals of Solid State Physics, Saxena-Gupta-Saxena, (Pragati Prakashan Meerut).
10. Solid State Physics, R. L. Singhal.
11. Solid State Physics, C. M. Kachhava (Tata McGraw Hill Publication).
12. Elements of X-ray diffraction, B.D. Cullity and S. Stock.

Course outcomes:

After completing this course students will be able to

1. Remember the different types of Bravais lattices in three dimensions
2. Understand the simple crystal structures
3. Apply the concept of reciprocal lattice to study the Bragg's law
4. Analyse the cubic crystal structure using powder x-ray diffraction pattern
5. Explain distinction between metals, semiconductors, and insulators based on band theory of solids
6. Understand the concept of superconductivity

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B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-VI
Major II (Elective): Atomic and Molecular Physics and Astrophysics

Theory: 30Hours **Marks-50** **(Credits: 02)**

Unit: I

1. **Atomic Spectra** **(08)**

   Introduction of atomic structure and spectra, Spectral notations and optical spectral series for doublet structure, Spectrum of sodium and its doublet fine structure, Selection and intensity rules for fine structure doublets, Normal order of fine structure doublets, Electron spin-orbit interaction, Normal Zeeman effect (qualitative explanation) and anomalous Zeeman effect and their explanation from vector atom model, Lande's g factor.

2. **Molecular Spectra** **(07)**

   Molecular bond, Electron sharing, H^{2+} molecular ion, the hydrogen molecule, Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibrational spectra,
   Raman Effect, Characteristic properties of Raman lines, Difference between Raman spectra and infrared spectra, Classical theory of Raman Effect, Applications of Raman effect.

Unit: II

1. **Stellar Evolution** **(08)**

   H-R Diagram (only diagram), Main Sequence stars, Evolution from the Main Sequence to Red Giants, Chandrasekhar Limit and White Dwarfs, Neutron Stars (only concept), Black Holes (only concept). Milky Way galaxy, Position of the Sun in the Galaxy, Solar System - Inner planets, Asteroid belt, Outer planets.

2. **Sun** **(07)**

   Composition and structure of Sun, Solar interior – Core, Radiative zone, Convective Zone, Photosphere, Chromospheres and Corona, Sunspots and Solar cycle, Magnetic fields in solar interior and flux emergence, Solar Flares, Coronal Mass Ejections, Solar Corona and Solar wind, Solar radio bursts, Noise storms, Space Weather.

Reference books

1. Atomic and Nuclear Physics – H. Semat and T. E. Albright.
2. Introduction to Atomic Spectra – H. E. White.
3. Atomic Spectra - J B Rajam
4. Concepts of Modern Physics – Arthur Beiser.
5. Perspectives of Modern Physics – Arthur Beiser.
6. Modern Physics- Agarwal
7. Spectroscopy (Atomic and Molecular) – Gurdeep Chatwal, Sham Anand.

8. Astronomy – Fundamentals and Frontiers – Robert Jastrow and M. H. Thompson
9. Astronomy – Frank Bash.
10. Foundation of Astronomy, Michael A. Seeds, 10th edition Thomson Learning, Inc., USA.

Course Outcomes:

After completing this unit, students will be able to:

1. Explain fine-structure splitting, doublet formation, and Zeeman effects using the vector atom model.
2. Interpret rotational, vibrational, and electronic spectra to understand molecular structure and energy transitions.
3. Describe the Raman effect, differentiate it from infrared spectroscopy, and explain its applications.
4. Outline the evolutionary stages of stars using the H–R diagram and explain the basic properties of white dwarfs, neutron stars, and black holes.
5. Describe the structure, magnetic activity, and eruptive phenomena of the Sun and their impact on space weather.

Shivaji University, Kolhapur
B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-VI
Major P-II (Elective) Practical: Solid State Physics

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I

1. Seeback effect: Determination of thermoelectric voltage as a function of the temperature difference
2. Measurement of specific heat of given solid
3. Determination of Crystal Structure and Lattice Parameter from Powder X-Ray Diffraction Data.
4. Study of dielectric constant of given ferroelectric material using IC 555.
5. Measurement of resistivity by two probe method
6. Study of Hall effect by virtual lab
7. Study of B-H curve by virtual lab

Group II

1. To determine the Fermi energy of copper
2. To find the ionization potential of Argon/Mercury using a thyratron tube / Voltage regulation using IC 317
3. Study of variation of magnetic field with distance / Measurement of dielectric constant of given material
4. Study the variation of the thermo electric EMF./ Study of variation of magnetic field along the axis of circular coil
5. Hysteresis by magnetometer method. / To determine hysteresis loss by C.R.O.
6. UJT as a voltage sweep generator/ To study the absorption spectra of Iodine vapour to determine dissociation energy of iodine molecule and force constant.
7. Study of Molecular Absorption Spectra Using Potassium Permanganate Solution

References:

1. Practical Physics, C. L. Arora (S. Chand. Publications)
2. Introduction to Solid State Physics, Charles Kittel (Wiley)
3. Elements of X Ray Diffraction, B. D. Cullity & S. R. Stock (Pearson)
4. The book of 555 Timer Projects, Dogan Ibrahim

Course outcomes:

After successfully completing this course, the student will be able to:

1. Apply the fundamental concepts of thermoelectricity, solid-state physics, magnetism, dielectric materials, and spectroscopy through laboratory experiments and virtual simulations.

2. Determine and analyze material properties such as specific heat, resistivity, dielectric constant, Hall coefficient, Fermi energy, crystal structure, lattice parameters, and magnetic characteristics using experimental techniques.
3. Perform measurements, collect and interpret experimental data, estimate uncertainties, and evaluate physical parameters using appropriate instruments, electronic circuits, and computational tools.
4. Investigate the structural, electrical, magnetic, thermal, and optical properties of materials through characterization methods and effectively communicate scientific findings through reports and presentations.

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B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026

Semester-VI

Major P-II (Elective) Practical: Atomic and Molecular Physics and Astrophysics

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I

1. To estimate the temperature of flame by studying reversal of spectral lines (D)
2. Identification of unknown element from line emission spectra.
3. Determination of Wavelengths in the Hydrogen Spectrum (Balmer Series)
4. Measurement of the wavelength separation of D-lines using diffraction grating.
5. To analyse Raman spectra and calculate the force constant of a given sample.
6. Absorption spectra of $KMnO_4$.
7. Calibration of a Prism Spectrometer and Identification of Unknown Atomic Spectral Lines (Hydrogen Source).

Group II

1. Study of solar spectrum.
2. Verification of Hubble's law using galaxy redshift data.
3. To use idea of parallax to determine large distance
4. Sunspot activity analysis/ Analysis of the Rotational Spectrum of a Diatomic Molecule for Determination of Moment of Inertia and Bond Length
5. Constellation map drawings – a) Orion b) Ursa Major (Big Dipper) c) Auriga d) Taurus.
6. Determination of the Solar Rotation Period Using Sunspot Tracking
7. Orbital Analysis of the Galilean Satellites of Jupiter for Verification of Kepler's Third Law and Determination of Jupiter's Mass

References:

5. Practical Physics, C. L. Arora (S. Chand. Publications)
6. Introduction to Solid State Physics, Charles Kittel (Wiley)
7. Elements of X Ray Diffraction, B. D. Cullity & S. R. Stock (Pearson)
8. The book of 555 Timer Projects, Dogan Ibrahim

Course outcomes:

After successfully completing this course, the student will be able to:

1. Apply the principles of atomic, molecular, and astronomical spectroscopy to analyze emission, absorption, Raman, and solar spectra and identify elemental and molecular characteristics.

2. Determine physical parameters such as wavelength, wavelength separation, force constant, temperature, bond length, moment of inertia, distance, rotational period, and celestial masses using spectroscopic and astronomical observations.
3. Analyze experimental and observational data using graphical, computational, and statistical methods to verify fundamental laws and concepts in spectroscopy and astrophysics.
4. Demonstrate proficiency in the use of spectroscopic instruments, astronomical datasets, and observational techniques, and effectively communicate scientific findings through laboratory reports and presentations.

Shivaji University, Kolhapur
B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-VI
Vocational Skill Course (VSC)–III Major Specific Practical

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I: Mechanical Properties, Oscillations & Acoustic Instrumentation

1. To calibrate the torch bulb filament from resistance measurement.
2. To determine the current sensitivity of a morning coil galvanometer.
3. To study one-dimensional elastic collision using two hanging spheres.
4. To study damping of a bar pendulum.
5. To study oscillations of a rubber band and to draw potential energy curve for it.
6. To determine the surface tension of water by Capillary rise method.
7. To study the characteristics of loudspeaker, Woofer, and tweeter.

Group II: Optoelectronics, Digital Electronics & Sensor Systems

1. To study characteristics of photodiode and use as light sensor.
2. Design and construction of an automatic streetlight controller using transistor and LDR.
3. Infrared proximity sensor circuit using transistors and photodiode.
4. Construction and truth table verification of RS Flip-Flop using NOR(IC 7402)/NAND(IC 7400) gates.
5. Construction and truth table verification of Clocked RS Flip-Flop using NOR (IC7402)/NAND(IC 7400) gates.
6. Fire sensor using Arduino Kit.
7. Pulse sensor using Arduino Kit.

References:

1. B.Sc. Practical Physics – Dr. P.S. Hemne and Harnam Singh – S. Chand Publishing, New Delhi.
2. Advanced Practical Physics for Students – B.L. Worsnop and H.T. Flint – Asia Publishing House.
3. B.Sc. Practical Physics – C.L. Arora – S. Chand and Co., New Delhi.
4. Experiments in Engineering Physics – M.N. Avadhanulu, A.A. Dani and P.M. Pokley – S. Chand & Co., New Delhi.
5. A Text Book of Practical Physics – Indu Prakash and Ramakrishna – Kitab Mahal, New Delhi.
6. Practical Physics – P.R. Sasi Kumar – PHI Learning Pvt. Ltd., New Delhi.
7. Practical Physics – Y.P. Singh – SRGPC Publication, Sagar (M.P.), India.

Course Outcomes (COs)

1. Understand and apply the principles of mechanical properties and oscillatory motion, including elasticity, damping, surface tension, and collisions through experimental analysis.
2. Develop the ability to analyze acoustic systems and instrumentation, including the working and characteristics of devices such as loudspeakers, woofers, and tweeters.
3. Apply concepts of optoelectronics and sensor systems to design and analyze circuits using photodiodes, LDRs, infrared sensors, and Arduino-based applications.
4. Design and verify digital electronic circuits, including flip-flops and logic gates, and implement real-time applications such as automatic streetlight controllers and sensor-based systems.

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B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-VI
Skill Enhancement Course (SEC)–III Practical

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Group I

1. Measurement of the distance between two coherent sources in the Biprism experiment
2. Study of dispersion of light.
3. Determination of ‘g’ by a simple pendulum
4. Study of coupled oscillations
5. Verification of Hooke’s law
6. Determination of surface tension by the capillary rise method
7. Study of the magnetic field using a magnet and a compass

Group II

1. Measurement of the phase shift of the RC network using the CRO
2. Study of the Half adder circuit
3. Study of the Full adder circuit
4. Tracing of the given electronic circuit/ build the given circuit using a breadboard
5. Assembling of the given electronic circuit (soldering method)
6. Verification of Thevenin’s theorem
7. Verification of Norton’s theorem

Course Outcomes (COs)

1. Understand and apply fundamental principles of mechanics and oscillations, including simple harmonic motion, coupled oscillations, and Hooke’s Law, to determine physical quantities such as acceleration due to gravity and surface tension.
2. Develop experimental skills in optics and wave phenomena, including interference (biprism experiment) and dispersion of light, to measure wavelengths and analyze optical behavior.
3. Apply concepts of electric circuits and network theorems, including phase shift in RC circuits, and verification of Thevenin’s Theorem and Norton’s Theorem for simplifying complex networks.
4. Design, construct, and test basic electronic and digital circuits, including half and full adders, circuit assembly using breadboards and soldering techniques, and troubleshooting practical electronic systems.

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B.Sc. Part-III PHYSICS (NEP 2.0) Syllabus June-2026
Semester-VI
Indian Knowledge Systems (IKS)–II

Theory: 30 Hours **Marks-50** **(Credits: 02)**

Unit 1:

1. **Introduction to Indian Knowledge System in Physics (06)**

   Definition and scope of Indian knowledge systems in the context of physics, Historical overview of ancient Indian contributions to science, Key texts and scholars in Indian physics.

2. **Vedic & Classical Indian Physics (09)**

   Concepts like Prakriti (nature), Purusha (consciousness), and their relevance to physics, Vedic cosmology and its connection to modern cosmological theories, Theory of five elements (Panchabhuta) and the concept of ether (Akasha), Concepts like sound (Nada), light (Prakasha), and heat (Tejas) in Indian physics.

Unit 2:

1. **Modern Indian Physicists and Their Contributions (09)**

   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 in Collaboration with Albert Einstein.

   Homi Bhabha: Development of nuclear physics in India, Contributions to cosmic ray research.

   Vikram Sarabhai: Contributions to space physics and the establishment of ISRO.

2. **Modern Physics and Indian Knowledge Integration (06)**

   Understanding Indian perspectives on environmental conservation and sustainability, Concepts like Prithvi (Earth) and its ecological significance, Discussion of contemporary physics and its relationship with Indian knowledge systems, Case studies of research that integrates Indian concepts into modern physics, Research trends and potential future developments.

References:

1. "Indian Physics: Outline of Early History" by David Pingree
2. G. Venkataraman, Bhabha and His Magnificent Obsessions.
3. R. Parthasarathy, The Bose-Einstein Phenomena.
4. "The Wisdom of the Vedas" by Jyotir Maya Nanda

Course outcomes:

1. To identify the role of Indian research institutions in advancing physics research.
2. To understand Pioneering Contributions and the significant achievements of Indian physicists.
3. To enhance Analytical and Research Skills and Apply knowledge from historical and modern Indian contributions to develop innovative solutions to contemporary scientific problems.
4. To develop curiosity and motivation to pursue advanced studies or careers in physics and related disciplines.