University of Engineering and Management

Institute of Engineering & Management, Salt Lake Campus | Institute of Engineering & Management, New Town Campus | University of Engineering & Management, Jaipur

SYLLABUS OUTLINE

Bachelor of Science (B.Sc.) in Physics

(NEP 2020 Aligned | Industry & Research Integrated)

Effective from Academic Session 2026-27

Programme	Bachelor of Science (B.Sc.) in Physics
Duration	4 Years (8 Semesters)
Total Credits	160 Credits (20 Credits per Semester)
Eligibility	10+2 with Physics and Mathematics (Chemistry / Computer Science preferred)
Framework	National Education Policy (NEP) 2020

Multiple Exit / Award Points (NEP 2020)

- After 1 Year — Certificate in Physical Sciences
- After 2 Years — Diploma in Physics
- After 3 Years — B.Sc. Physics
- After 4 Years — B.Sc. Physics (Honours / Research)

The curriculum is designed in accordance with the philosophy of NEP 2020 and benchmarks widely adopted Physics programmes covering Mechanics, Electricity & Magnetism, Thermodynamics, Quantum Mechanics, Electronics, Nuclear Physics, Computational Physics, and interdisciplinary learning.

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1. Programme Overview & Educational Objectives

Programme Educational Objectives (PEOs)

Graduates of the programme will be able to:

- Build strong conceptual understanding of fundamental and modern physics.
- Apply mathematical and computational tools to solve scientific problems.
- Perform laboratory experiments with precision and scientific ethics.
- Use simulation, AI and programming in scientific investigations.
- Undertake interdisciplinary research and innovation.
- Prepare for higher studies (M.Sc., Integrated Ph.D., Ph.D.), competitive examinations (IIT-JAM, GATE, CSIR-NET), and careers in research, industry, education, and technology.

2. Semester-wise Course Structure

L = Lecture hrs/week, T = Tutorial hrs/week, P = Practical hrs/week, S = Sessional / Fieldwork hrs/week. Credit is computed as per AICTE/NEP convention: Credit = L + T + P/2 (Sessional counted 1 hr = 1 credit).

Semester I (20 Credits)

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
1	Discipline Specific Core (Theory)	BSPH101	Mathematical Physics-I	3-1-0-0	4	4
2	Discipline Specific Core (Theory)	BSPH102	Mechanics & Properties of Matter	3-1-0-0	4	4
3	Discipline Specific Core (Practical)	BSPH191	Physics Laboratory-I	0-0-4-0	4	2
4	Multi-Disciplinary Course	BSMA103	Mathematics for Physicists-I (Calculus & Linear Algebra)	3-1-0-0	4	4
5	Ability Enhancement Course	AEC101	Communication Skills	2-0-0-0	2	2
6	Value Added Course	VAC101	Environmental Science	2-0-0-0	2	2
7	Skill Enhancement Course	SEC101	Yoga & Wellness	0-0-0-2	2	2
			Total		**22**	**20**

Semester II (20 Credits)

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
1	Discipline Specific Core (Theory)	BSPH201	Electricity & Magnetism	3-1-0-0	4	4
2	Discipline Specific Core (Theory)	BSPH202	Thermal Physics	3-1-0-0	4	4
3	Discipline Specific Core (Practical)	BSPH291	Physics Laboratory-II	0-0-4-0	4	2

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
4	Skill Enhancement Course	SEC201	Programming for Physicists (Python)	2-0-4-0	6	4
5	Ability Enhancement Course	AEC201	Ability Enhancement Course	2-0-0-0	2	2
6	Minor Course	MNC201	Minor Course	2-0-0-0	2	2
7	Community Engagement Programme	CEP201	Community Engagement	0-0-0-2	2	2
			Total		**24**	**20**

Semester III (20 Credits)

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
1	Discipline Specific Core (Theory)	BSPH301	Waves & Oscillations	3-1-0-0	4	4
2	Discipline Specific Core (Theory)	BSPH302	Optics	3-1-0-0	4	4
3	Discipline Specific Core (Theory)	BSPH303	Electronics-I	3-1-0-0	4	4
4	Discipline Specific Core (Practical)	BSPH391	Physics Laboratory-III	0-0-4-0	4	2
5	Skill Enhancement Course	SEC301	Skill Enhancement Course	2-1-0-0	3	3
6	Internship	INT301	Internship-I (School / Industry Laboratory Exposure)	0-0-0-3	3	3
			Total		**22**	**20**

Semester IV (20 Credits)

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
1	Discipline Specific Core (Theory)	BSPH401	Quantum Mechanics-I	3-1-0-0	4	4
2	Discipline Specific Core (Theory)	BSPH402	Mathematical Physics-II	3-1-0-0	4	4
3	Discipline Specific Core (Theory)	BSPH403	Electronics-II	3-1-0-0	4	4
4	Discipline Specific Core (Practical)	BSPH491	Physics Laboratory-IV	0-0-4-0	4	2
5	Ability Enhancement Course	RM401	Research Methodology	2-1-0-0	3	3
6	Project	MJP401	Minor Project	0-0-6-0	6	3
			Total		**25**	**20**

Semester V (20 Credits)

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
1	Discipline Specific Core (Theory)	BSPH501	Quantum Mechanics-II	3-1-0-0	4	4
2	Discipline Specific Core (Theory)	BSPH502	Atomic & Molecular Physics	3-1-0-0	4	4
3	Discipline Specific Core (Theory)	BSPH503	Solid State Physics	3-1-0-0	4	4
4	Discipline Specific Core (Practical)	BSPH591	Physics Laboratory-V	0-0-4-0	4	2
5	Discipline Specific Elective	ELE501	Elective-I	3-0-0-0	3	3
6	Internship	INT501	Internship-II (Research Laboratory)	0-0-0-3	3	3
			Total		**22**	**20**

Semester VI (20 Credits)

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
1	Discipline Specific Core (Theory)	BSPH601	Nuclear & Particle Physics	3-1-0-0	4	4
2	Discipline Specific Core (Theory)	BSPH602	Statistical Physics	3-1-0-0	4	4
3	Discipline Specific Core (Theory)	BSPH603	Computational Physics	3-1-0-0	4	4
4	Discipline Specific Core (Practical)	BSPH691	Physics Laboratory-VI	0-0-4-0	4	2

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
5	Discipline Specific Elective	ELE601	Elective-II	3-0-0-0	3	3
6	Project	IND601	Industry Project	0-0-6-0	6	3
			Total		**25**	**20**

Semester VII (20 Credits)

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
1	Discipline Specific Core (Theory)	BSPH701	Electromagnetic Theory	3-1-0-0	4	4
2	Discipline Specific Core (Theory)	BSPH702	Advanced Quantum Physics	3-1-0-0	4	4
3	Discipline Specific Core (Theory)	BSPH703	AI & Machine Learning for Physics	3-1-0-0	4	4
4	Discipline Specific Elective	ELE701	Elective-III	2-0-0-0	2	2
5	Project	RP701	Research Project-I	0-0-6-0	6	3
6	Internship	INT701	Industrial Internship	0-0-0-3	3	3
			Total		**23**	**20**

Semester VIII (20 Credits)

Sl. No.	Type of Course	Code	Subject Name	L-T-P-S	Contact Hrs	Credits
1	Discipline Specific Core (Theory)	BSPH801	Astrophysics & Cosmology	3-1-0-0	4	4
2	Discipline Specific Core (Theory+Lab)	BSPH802	Advanced Experimental Physics	2-0-4-0	6	4
3	Project	DIS801	Dissertation / Research Thesis	0-0-16-0	16	8
4	Sessional	SEM801	Seminar	0-0-0-2	2	2
5	Sessional	VV801	Viva Voce	0-0-0-2	2	2
			Total		**30**	**20**

3. Course Outlines — Semester I to VIII (Topic-wise)

Semesters I and II are elaborated in full detail (course objectives, outcomes, module-wise breakdown, industry/academia mapping and textbooks) in the accompanying First Semester Syllabus document and the Semester II syllabus document. Semesters III to VIII carry the same rigour and format; topic-level outlines are given below as a template, to be developed into full detailed syllabi once respective course coordinators are assigned.

Semester III

Waves & Oscillations (Credit: 4)

- Simple harmonic motion, superposition of SHMs
- Coupled oscillations, normal modes
- Wave motion: transverse and longitudinal waves, wave equation
- Velocity of waves in strings and gases

Optics (Credit: 4)

- Interference: Young's double slit, thin films, Newton's rings
- Diffraction: Fraunhofer diffraction (single/double slit, grating), resolving power
- Polarization: production and analysis, Malus's law, birefringence
- Optical fibres: structure, numerical aperture, modes

Electronics-I (Credit: 4)

- Semiconductor physics: p-n junction, diode characteristics
- Rectifiers and regulated power supplies, Zener diode
- Bipolar junction transistors: characteristics and biasing
- Transistor as an amplifier and switch

Physics Laboratory-III (Credit: 2)

- Newton's rings — radius of curvature of a plano-convex lens
- Diffraction grating — determination of wavelength
- Study of diode and transistor characteristics
- Study of a fibre-optic link (numerical aperture, attenuation)

Skill Enhancement Course (Credit: 3)

- As per SEC basket offered that semester (e.g., MATLAB/LabVIEW basics, technical drawing, or a data-analysis tool)

Internship-I — School/Industry Laboratory Exposure, 4 weeks (Credit: 3)

- Structured laboratory/industry exposure with a school, research lab, or local industry
- Submission of an internship report and viva-voce

Semester IV

Quantum Mechanics-I (Credit: 4)

- Origins of quantum theory: black-body radiation, photoelectric effect, Compton effect
- Wave-particle duality, de Broglie hypothesis, uncertainty principle
- Schrödinger equation: time-dependent and time-independent forms
- Particle in a box, quantum tunnelling (qualitative), operators and eigenvalues

Mathematical Physics-II (Credit: 4)

- Complex analysis: analytic functions, Cauchy-Riemann equations, contour integration (introductory)
- Fourier series and Fourier transforms
- Special functions used in physics: Legendre and Bessel functions (introductory)
- Partial differential equations of physics (wave, heat, Laplace equations)

Electronics-II (Credit: 4)

- Field-effect transistors (JFET, MOSFET)
- Operational amplifiers: ideal characteristics, inverting/non-inverting configurations
- Op-amp applications: adder, integrator, differentiator, comparator
- Digital electronics: logic gates, Boolean algebra, combinational circuits

Physics Laboratory-IV (Credit: 2)

- Op-amp based adder/subtractor and integrator/differentiator circuits
- Study of logic gates and verification of Boolean identities
- Determination of Planck's constant using an LED
- Study of FET characteristics

Research Methodology (Credit: 3)

- Literature survey and citation practice
- Research design, data collection and analysis
- Scientific writing, plagiarism and research ethics

Minor Project (Credit: 3)

- Identification of a small physics-based problem
- Execution under faculty supervision and preparation of a project report

Semester V

Quantum Mechanics-II (Credit: 4)

- Hydrogen-atom problem: separation of variables, quantum numbers
- Perturbation theory (time-independent, non-degenerate)
- Spin, addition of angular momenta (introductory)
- Approximate methods and their physical applications

Atomic & Molecular Physics (Credit: 4)

- Fine and hyperfine structure, Zeeman and Stark effects
- LASER: population inversion, optical resonators, types of lasers
- Molecular spectra: rotational and vibrational spectroscopy (introductory)
- Raman effect (qualitative)

Solid State Physics (Credit: 4)

- Crystal structure: lattices, unit cells, Miller indices
- X-ray diffraction and Bragg's law
- Band theory of solids, classification of solids as conductors/semiconductors/insulators
- Superconductivity and nanomaterials (introductory)

Physics Laboratory-V (Credit: 2)

- Determination of wavelength of a laser using diffraction grating
- Determination of band gap of a semiconductor by four-probe method
- Crystal structure analysis using simulation software
- Study of hydrogen/mercury spectral lines

Elective-I (Credit: 3)

- Chosen from the elective basket (Electronics, Photonics, Materials Science, Space Science, Computational Physics or Renewable Energy — see Suggested Electives)

Internship-II — Research Laboratory, 6 weeks (Credit: 3)

- Structured exposure to a research laboratory (institute/university/national lab)
- Submission of an internship report and viva-voce

Semester VI

Nuclear & Particle Physics (Credit: 4)

- Nuclear structure and properties, binding energy, nuclear models
- Radioactivity: decay laws, alpha/beta/gamma decay
- Nuclear reactions and nuclear fission/fusion (introductory)
- Elementary particles and particle accelerators (introductory)

Statistical Physics (Credit: 4)

- Phase space, macrostates and microstates, statistical entropy
- Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics
- Applications: Planck's radiation law, electron gas in metals (introductory)
- Density of states, Fermi energy

Computational Physics (Credit: 4)

- Numerical methods: root finding, interpolation, numerical differentiation/integration
- Numerical solution of ODEs (Euler, Runge-Kutta)
- Monte Carlo methods and their application to physics problems
- Introduction to MATLAB/Python for computational modelling

Physics Laboratory-VI (Credit: 2)

- Study of radioactive decay/counting statistics (simulation)
- Numerical solution of a physics ODE using Python/MATLAB
- Monte Carlo simulation of a simple physical system
- Study of Fermi-Dirac distribution using simulation

Elective-II (Credit: 3)

- Chosen from the elective basket (see Suggested Electives section)

Industry Project (Credit: 3)

- An applied project executed in collaboration with an industry partner
- Submission of a project report and industry-mentor evaluation

Semester VII

Electromagnetic Theory (Credit: 4)

- Maxwell's equations in differential and integral form (advanced treatment)
- Electromagnetic waves in free space, conductors and dielectrics
- Poynting vector and energy flow
- Waveguides and radiation from accelerated charges (introductory)

Advanced Quantum Physics (Credit: 4)

- Dirac notation, matrix formulation of quantum mechanics
- Time-dependent perturbation theory
- Introduction to scattering theory
- Basics of quantum computing (qubits, gates — introductory)

AI & Machine Learning for Physics (Credit: 4)

- Introduction to machine learning: supervised and unsupervised learning
- Neural networks and their application to physics data
- Data analysis pipelines using Python (scikit-learn, TensorFlow/PyTorch — introductory)
- Case studies: ML in particle physics, astrophysics and condensed matter

Elective-III (Credit: 2)

- Chosen from the elective basket (see Suggested Electives section)

Research Project-I (Credit: 3)

- Formulation of a research problem under faculty guidance
- Literature review, preliminary data collection/simulation and interim report

Industrial Internship — 8-10 weeks (Credit: 3)

- Structured internship with an industry, R&D lab or national laboratory
- Submission of an internship report and industry evaluation

Semester VIII

Astrophysics & Cosmology (Credit: 4)

- Stellar structure and evolution
- Galaxies and the interstellar medium
- Big Bang cosmology, cosmic microwave background
- Elementary treatment of dark matter and dark energy

Advanced Experimental Physics (Credit: 4)

- Advanced optical experiments (Michelson interferometer, etc.)
- Advanced electronics and instrumentation experiments
- Data acquisition and error analysis for research-grade experiments
- Use of simulation/digital-twin tools for advanced experiments

Dissertation / Research Thesis (Credit: 8)

- Independent research carried out under faculty supervision through the semester
- Written thesis following the Department's dissertation format

Seminar (Credit: 2)

- Oral presentation of the dissertation work to the Department
- Peer and faculty feedback session

Viva Voce (Credit: 2)

- Comprehensive oral examination covering the dissertation and the full B.Sc. Physics curriculum

4. Suggested Electives, Laboratories & Software Training

Suggested Electives

Elective Basket	Focus Areas
Electronics	Embedded Systems, Internet of Things, VLSI Fundamentals
Photonics	Optical Communication, Laser Technology, Fibre Optics
Materials Science	Nanotechnology, Thin Films, Advanced Materials
Space Science	Satellite Physics, Remote Sensing, Astronomy
Computational Physics	Artificial Intelligence, Machine Learning, Data Science
Renewable Energy	Solar Energy, Energy Storage, Hydrogen Energy

Laboratory Courses

Students will perform more than 80 experiments across the programme, including:

Mechanics • Electricity • Magnetism • Electronics • Optics • Quantum Physics • Nuclear Physics • LASER Experiments • Semiconductor Devices • Fibre Optics • FPGA & Microcontroller Basics • Sensors and Instrumentation • Computational Physics Simulations

Software & Computational Training

Python • MATLAB • Mathematica • OriginPro • LabVIEW • COMSOL Multiphysics • Scilab • Arduino IDE • Raspberry Pi • AI Tools for Scientific Computing • Jupyter Notebook • Git & GitHub

5. Internship Structure & Collaborations

Internship Structure

- Semester III: School / Industry Laboratory Exposure (4 weeks)
- Semester V: Research Laboratory Internship (6 weeks)
- Semester VII: Industrial / Research Internship (8-10 weeks)

Suggested Collaborations

DRDO • ISRO • BARC • CSIR Laboratories • IISERs • IITs • National Physical Laboratory (NPL) • Semiconductor industries • Optics and photonics companies • Renewable energy industries

Skill Enhancement Certifications

Python Programming • Scientific Computing • MATLAB • LabVIEW • AI & Machine Learning • Data Analytics • Embedded Systems • Internet of Things • Scientific Writing • Research Ethics

6. Assessment Pattern & Career Opportunities

Assessment Pattern

Component	Weightage
Continuous Internal Assessment	40%
End Semester Examination	60%

Evaluation components include:

Laboratory performance • Viva voce • Assignments • Numerical problem-solving • Programming exercises • Mini projects • Research reports • Presentations • Seminar participation • Internship assessment

Career Opportunities

- Research Scientist
- Physicist
- Data Scientist
- Semiconductor Engineer
- Optics & Photonics Engineer
- Electronics Design Engineer
- Instrumentation Engineer
- AI & Computational Scientist
- Renewable Energy Analyst
- Scientific Programmer
- Quality Assurance Engineer
- Science Educator
- Technical Consultant
- Research Associate

Graduates will also be competitive for M.Sc. Physics, Integrated Ph.D., Ph.D., IIT-JAM, GATE Physics, CSIR-UGC NET, SET, UPSC, ISRO, BARC, DRDO, and other research and public-sector opportunities.

7. Distinctive Features of the Programme

- AI & Computational Physics Laboratory with GPU-enabled computing.
- Photonics and Optoelectronics Research Lab.
- Semiconductor Devices and Embedded Systems Laboratory aligned with India's semiconductor mission.
- Annual UEM International Physics Symposium featuring researchers from academia and industry.
- Mandatory research internship every year with national laboratories and industries.
- Integration of coding, AI, simulation, and data science from the first year.
- Participation in national hackathons, innovation challenges, and undergraduate research conferences.
- Collaboration with premier institutes such as IITs, IISERs, NPL, DRDO, ISRO, and CSIR laboratories for internships, expert lectures, and joint research initiatives.